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Professional Development in Technology Integration for Mathematics Teachers in Title 1 Schools

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<u>Walden University</u>

College of Education and Human Sciences

This is to certify that the doctoral dissertation by

Nate-Nna Kalu Abba

has been found to be complete and satisfactory in all respects,
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Walden University
2024

Abstract

Professional Development in Technology Integration for Mathematics Teachers in Title 1 Schools

by

Nate-Nna Kalu Abba

MA, Walden University, 2020

MA, University of Phoenix, 2002

BS, California State Polytechnic University, Pomona, 1990

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Education

Walden University

February 2024

Abstract

For teachers to increase their instructional abilities, it is imperative they are provided with instructional support and an engaging technological professional work environment. The need is particularly great for math teachers at low socioeconomic status (SES) schools. The purpose of this basic correlational quantitative study was to explore teachers' attitudes about professional growth and leadership, digital age work and learning, and digital age learning experiences and assessments, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools. Bandura's social cognitive learning theory provided a framework for understanding self-efficacy and stages of teacher's adoption of technology. Data were collected using the Levels of Technology Innovation Digital Age Survey instrument from a convenience sampling of 80 certified high school mathematics teachers from Title 1 low SES schools, who volunteered to participate. Descriptive statistical analysis of the data including multiple regression analysis was conducted to identify relationships and correlations. Key results indicated a statistically significant relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration. The study contributes to positive social change by providing stakeholders with the efficacy of professional development for teachers on technology integrated instructional curriculum to improve students' academic achievement and provide them with 21st century skills for college and career.

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Dedication

I want to thank Almighty God for His infinite mercies and grace bestowed upon my family and me.

This study is dedicated to the memory of my dearly departed parents: Late Chief (Engineer) Nkata Kalu Abba and Late Chief (Elder) Mrs. Ekenma Abba. Although neither of you are here with us to witness the fruits of your labor, I believe both of you are resting in the bosom of the Lord and are proud of my achievements. Continue to rest in peace!

This study is also dedicated to my lovely wife – Lady (Lolo) Patricia “Obidiya” Abba. I am forever indebted to you for your love, patience, and support throughout my doctoral journey. You didn’t give up on me. A special dedication goes to our children: Anison, Nwojo, Ezinne, and Uchenna. All of you were an inspiration to me and motivation for me to keep moving forward. Thank you all for your moral support and being there for me.

A warm appreciation to my siblings: Dr. Martha Ukoha, Lady Mercy Okafor, Lady Ogbeyalu Kalu, and Mr. Emeka Abba. Warm regards to “Big Uncle” Chief (Engr.) Dr. Nwojo Agwu and Chief (Mrs.) Chinny Agwu. Thank you all for your moral support and encouragement.

I also want to extend my warm appreciation to other family members including my nieces, nephews, in-laws, and my dearly departed mother-in-law Late Madam Ihudiya Eme Uche Eme. Thank you all for your support and prayers.

Ekele diri Chineke! Chineke Imele!

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I want to extend an immense gratitude and appreciation to my Committee Chair: Dr. Naffziger for his guidance and invaluable support throughout my doctoral journey. I am also deeply grateful to my Methodologist, Dr. Foshay for his numerous and invaluable constructive feedback, clarifications of the methodology component, lessons, and redirections, along the way.

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Lastly, I want to extend my warm appreciation to my colleagues for checking up on me including: Tony Rainwater, Dr. Sybil Acevedo, Jay Windley, and Moses “Big Moe” Chinegwu.

I am thrilled that this journey is coming to an end, and I look forward to the exciting opportunities and possibilities that are before me. Thank you all.

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Chapter 1: Introduction to the Study

Introduction

Integrating technology into the curriculum functions can improve the learning process by making it more efficient, meaningful, and enriching for the student (DeCoito & Richardson, 2018; Francis, 2017; Higgins et al., 2019; Liu et al., 2017; Mendoza, 2018; Tyler-Wood et al., 2018). Although digital technologies, specifically computer technologies, are ubiquitous in the educational field, especially in classrooms, these technologies continue to be underutilized, and their true potential as educational tools and aids are not being fully realized. Harrell and Bynum (2018) stressed that successful student use of technology in education hinges on knowing how to manage technology efficiently and overcoming barriers that come with integrating technology.

Kuo and Belland (2019) posited that the integration of computer technologies can be characterized as a recursive spiral where advancement requires an ongoing reconciliation of previous skills along with adaptation of new requirements. Specifically, “to use computers as a cognitive tool in knowledge construction, educators must acknowledge the computer as a learning tool and be able to incorporate it into the classroom” (Kuo & Belland, 2019, p. 2). Karlin et al. (2018) believed that successful implementation of education technologies depends upon extensive, high-quality teacher professional development (PD) and ongoing support. These include site-based technical support and feedback to teachers, hands-on modeling instruction, and continuous articulation of new technology introduction and student achievement (Kormos, 2022; McComb & Eather, 2017; Torff, 2018).

The need is particularly great for math teachers at low socioeconomic status (SES) schools who lag behind their counterparts at higher SES schools in their technology integration skills (Kormos, 2022; Roth Wake & Mills, 2018). The National Center for Education Statistics (2023) defined high-poverty schools as those in which 75% or more students come from families eligible for subsidized school meals.

The purpose of this correlational quantitative study was to find relationships among teachers' attitudes about professional growth and leadership, digital age work and learning, and digital-age learning experiences and assessments, and their level of technology integration for high school mathematics teachers in Title 1 (U. S. Department of Education. National Center for Education Statistics: Title 1.) low SES schools. This research incorporated teachers' attitudes on the integration of technology, with a view to minimizing the problems with and improving their attitudes regarding PD.

This study may pave the way toward positive social change with teachers benefiting from the professional and instructional strategies introduced in future PD to improve their knowledge and skills. These teachers may function as catalysts in affecting positive change in the instructional practices of most teachers in their respective schools. This research may also create an impetus for future staff development strategies and assist schools in low SES professional learning communities (PLCs) to provide productive collaborative environments to facilitate teachers' improved use of technology in the classroom. PLCs are groups of educators involved in site-based, ongoing, collaborative PD. This research may also create an impetus for a valuation of specific areas where PD in the integration of technology can be targeted for future research (Kopcha et al., 2020).

This chapter is divided into 13 sections, starting with the synthesis and more detailed discussion and analyses of the background of research literature related to the scope of the study topic. The next section includes the restatement of the problem statement, including its current relevance and discussion of a meaningful gap in the current research literature. The following section includes the background, the purpose of this study, and its methodology. Other sections include the statement of the research questions, the theoretical framework for the study, nature of the study, operational definitions, assumptions, scope and delimitations, limitations; significance of the study, and a summary and transition to the review of literature to be proffered and synthesized in Chapter 2.

Background

Research on PD for math teachers in low SES schools found a lack of sufficient resources, poor quality training, and few opportunities for teachers to facilitate and participate in leadership roles in PD sessions (Darling-Hammond et al., 2017; Wake & Mills, 2018); fragmented presentation (Baker & Galanti, 2017); lack of technical support and technology leadership (Kormos, 2022); lack of sufficient technological tools and lack of sufficient, effective PD (Harrell & Bynum, 2018); accountability (Martin & Farmer, 2022; Wieczorek, 2017); inadequate resourcing for PD (Darling-Hammond et al., 2017); and exhibition of poor attitudes (Kormos, 2022; Wright et al., 2019). New information technologies and processes are emerging faster than they can be integrated into course material, meaning that many teachers are often behind in their knowledge of the technologies' implementation (Chen et al., 2020; Gunduzalp, 2021; Lemoine et al., 2020; Mitchell, 2021; & Van Den Beemt et al., 2020).

Much of the research on technology PD has focused on teacher learning in the context of teacher PLCs, including low SES PLCs (Agbelusi et al., 2022; DeCoito & Richardson, 2018; & Wieczorek, 2017). According to Roesken-Winter et al. (2021), when PLCs are implemented as a PD strategy, they can lead to organizational improvements in the areas of collaboration, providing the means for continuous improvement for student learning and shared data-driven strategic decisions. Williams and Welsh further contended that several significant improvements occur in student-achievement data during district-wide implementation of PLCs (a large effect size of .67% for high schools was noted for mean percentage passing). According to Rotermund et al. (2017), technology integration was the second most common topic for PD (67%), only followed by a PD on content specific area (57%).

Many high school mathematics teachers in Title 1 SES schools have negative attitudes toward technology integration PD (Kormos, 2022; Lee et al., 2018; Torff, 2018; Wake & Mills, 2018; Wickham & Mullen, 2020). These negative attitudes exhibited by the teachers towards technology integration are compounded by the reality that many of these teachers need this PD because they have a deficit in technology integration compared to teachers in high SES schools (Wake & Mills, 2018).

Math teachers at low SES schools often lag their counterparts at higher SES schools in their technology integration skills (Ball et al., 2019; Hohlfeld et al., 2017;

Makki et al., 2018; Ross, 2019; Torff, 2018). Dilemmas of practice include determining the role of technology, navigating through multilevel obstacles, employing existing knowledge to frame emerging phenomena. and creating and testing the new knowledge to improve teaching and learning (Kormos & Julio, 2020). Further, Kormos and Julio (2020) reported that there appear to be steady declines in the use of technology in K-12 urban classrooms and observed that operational integration of computer technology into urban-classroom instruction has yet to be realized. Kormos and Julio's study focused on school settings and classrooms where the teachers work so that there was legitimacy with all educators involved in the study.

Research by Hall et al. (2019), Karlin et al. (2018), Kormos and Julio (2020), Morales (2021), and Xie et al. (2021) supported the investigation addressed in this study, which is that many teachers have negative attitudes about PD to integrate technology into their classrooms. Another issue is the one-size-fits all PD workshops that have been shown to be ineffective in influencing teachers' technology integration practices (Thomas, S. 2016). Research by Hall et al. (2019) revealed that considerable training in integration of technology seemed to emphasize technology awareness and expertise, while ignoring the vibrant associations between content, technology, and instruction. The resultant misalignment indicates that instructors study about "technology," but they still struggle in applying it use in their student's education. Prast et al. (2018) insisted that the outmoded methodologies are broadly seen as too fragmented, out of orientation with modern theories of education reform and scholarship, and not linked faithfully to classroom instruction.

Problem Statement

Although there is much current research on technology integration PD in the secondary mathematics classroom (Agyei, 2019; Ball, L. et al., 2018; Getenet, 2017; Hill, K. et al., 2017; Hill, J. & Uribe-Florez, 2020), a dearth of research exists to address technology integration PD for Title 1 low SES school mathematics teachers. Research by Cappola (2020), Gomez (2020), Jones and Smith (2020), Kormos (2022), Kormos and Wisdom (2021), Phillips (2021), Wager and Foote (2013), and Anthony and Clark (2011), were among the few that dealt with this topic. These studies illuminated teachers' dilemmas and coping strategies in their efforts to integrate technology in mathematics classes in Title 1 low SES schools.

The problem addressed in this research study was to understand the relationships among teachers' attitudes about digital age work and learning , professional growth and leadership , digital citizenship and responsibility , and digital age learning experiences and assessments, and their level of technology integration. This research addressed technology integration PD for Title 1 low SES school mathematics teachers. I investigated teachers' attitudes toward technology, technology integration, and classroom practice and application, and the relationship between PD and their level of technology integration skills.

Purpose of the Study

The purpose of this correlational quantitative study was to investigate whether there are statistically significant and meaningful relationships among teachers' attitudes about digital age work and learning, professional growth and leadership, digital citizenship and responsibility, digital-age learning experiences, and assessments, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools. This research incorporated teachers' attitudes on the integration of technology, with a view to minimizing the problems and improving their attitudes regarding PD. The independent constructs in this quantitative study included digital age work and learning, professional growth and leadership, digital citizenship and responsibility and digital-age learning experiences, and assessments. The dependent construct was the teachers' level of technology integration.

Research Question

To complete inferential analysis of PD for technology integration for mathematics teachers in low SES schools, the following research question (RQ) was examined based on surveys of participants and their attitudes in technology integration.

RQ: What is the relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration?

H_0: There is no statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

H_a: There is a statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

Theoretical Framework

Social cognitive learning (Bandura, 1991) is used as a basis for social learning (Straub, 2009); in this context, teachers through modeling and observing others adopt a particular innovation, and over time, may be more inclined to consider adoption themselves. Accordingly, social learning not only influences the decision whether to adopt technology into the classroom but expands the possibilities to include technology-integrated curriculum and a student-centered learning classroom environment. The social cognitive theory as postulated by Bandura (1991) provided a framework for understanding stages of teacher's adoption of technology. According to Bandura, ''within the model of triadic reciprocity, action, cognition, and environmental factors act together to produce changes'' (1986, p. 521). Teachers learn to use new tools actively to construct knowledge in the process of learning through interactions with their environment, building up meaning of the environment through interactions within a social framework.

Perera and John (2020) and Schunk and DiBenedetto (2020) contended that social cognitive theory assumes that an individual's on-going functioning is a creation of incessant inter-play between cognitive, behavioral, and contextual factors. As related to this study, as teachers strive to improve on teaching and integration of technology into the classroom, they continue to seek ways of improving their skills, including participating in technology integration PD; learning effective methods; improving their intellectual capabilities, self-efficacy, and social skills; and incorporation of environmentally beneficial factors. The continuous and reciprocal nature of this theory aligned with this study's main objective of improving teacher's integration of technology through continuous learning and application of objective and proven methods.

PD is based on social cognitive theory, as it involves an environment of collaboration and inquiry. It is steeped in learning-oriented and progressive-growth approach that uses each teacher's knowledge, beliefs, and practical experiences to construct meaning and understanding that will be beneficial to all stakeholders for sustained improvement. PD is constructivist in nature because it is built on learning and sharing ideas and experiences to arrive at a common purpose: improved student learning outcomes, common lesson plans, solving problems, and improved school environment.

The social cognitive theory related to the present study through an understanding of how teachers through modeling and observing others adopt a particular innovation. Based on this adoption and with consistent trials and applications, teachers may be motivated to increase and incorporate the application daily in classroom instruction. Appropriately, social learning not only influences the decision on whether to adopt technology into the classroom but expands the possibilities to include technology integrated curriculum and student-centered learning classroom environment. Social cognitive theory as a constructivist construct relates to the RQ, through its ability to provide a framework for understanding the stages of teacher's adoption of technology.

These stages utilize PD sessions to build upon modeling and observation attributes, through discovery learning (Ozdem-Yilmaz & Bilican, 2020).

Some aspects of social cognitive theory were concentrated upon and addressed in this study, including the syntheses and measurement of teacher motivation, beliefs, self-efficacy, and attitudes. I investigated the degree to which teachers are motivated to develop a sense of agency including goals, outcome expectations, and self-efficacy. The theoretical framework of social learning as an overriding framework supported a dynamic relationship with the research instrument. The framework underlined how teachers through modeling, scaffolding, and observing others adopt a particular innovation of technology into their classroom, while the Levels of Technology Innovation (LoTi) instrument used attributes, including awareness, exploration, integration, and refinement, to solidify the teacher's adoption of the technology. Hatlevik et al. (2018) suggested that self-efficacy influences achievement behaviors, including task choice, determination, perseverance, and use of effective learning strategies.

Nature of the Study

This study was a correlational, quantitative research study using a survey methodology. Creswell (2013) stated, "A survey design provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population" (p. 201). Data were collected with the LoTi Digital Age Survey (Appendix A) developed by Learning Quest, Inc. (2013). The use of LoTi provided quantitative data to measure the teacher's technology use in the classroom and its integration in the curriculum. The independent variables in this quantitative study included digital age work and learning , professional growth and leadership , digital citizenship and responsibility , and digital-age learning experiences and assessments. The dependent variable was the level of technology integration.

The LoTi is aligned with the National Education Technology Standards for Teachers and sanctioned by the International Society for Technology in Education (ISTE). This alignment is essential because it provides support for ongoing professional learning, implementation planning, equitable access, support for digital age learning and work, and student-centered learning. The instrument is geared towards customized input for doctoral dissertation studies and primarily provides data that answer the RQ.

It is paramount to maintain confidentiality. The school districts under study were in southern California, 60 miles east of Los Angeles. The 10 comprehensive high schools serve 42,000 students from preschool through adult education in a diverse urban/suburban environment (California Longitudinal Pupil Achievement Data System, 2019). One hundred high school mathematics teachers from local comprehensive high schools were invited to participate in this study. This resulted in a beginning sample size of $N = 100$. Krejcie and Morgan's (1970) formula was employed as a power-based analysis to validate the sample size. These considerations included type of statistical tests, statistical significance level or the alpha value (α), effect size of the statistical analysis, and statistical power of the test.

The desired sample size consisted of 100 high school mathematics teachers. Krejcie and Morgan's (1970) formula was employed as a power-based analysis to validate the sample size. This study included convenience sampling of the population of approximately 350 mathematics teaching staff. Criteria used in selecting the participants were as follows: (a) They were educators from the selected school district and teachers from the comprehensive high schools selected, and (b) the teachers who volunteered for the study were the certificated teachers of record in their respective classrooms.

Operational Definitions

Digital- age learning experiences & assessments: Teacher preparation for student instruction and assessment (Mehta, 2011).

Digital age, work, and learning: (a) Student learning and creativity, and (b) application to global environments (Mehta, 2011).

Digital citizenship & responsibility: Technology use and application to global communities (Mehta, 2011).

Levels of use of technology: Framework for analyzing characteristics and benchmarks of technology implementation according to the teacher's LoTi level (Mehta, 2011).

Professional growth and leadership: Content on PD opportunities accessible to teachers (Mehta, 2011).

Assumptions

The following were assumed to be true: (a) All participants would provide 100% of their effort and time, (b) all participants could make significant contributions to student learning by integrating technology into the classroom and throughout the curriculum, (c) support by the school administration and school district is crucial to the success of any school-wide/district-wide changes in curriculum and technology integration, (d) participants in the study would accurately and truthfully answer all questions, and (e) the data collection instrument had been tested for both reliability and validity based on prior use.

Scope and Delimitations

The desired sample consisted of 100 high school mathematics teachers from local Title 1 comprehensive high schools, in a suburban area in California. These educators taught within a common curriculum and used the same district-wide pacing guide. These educators directly impacted and instructed students. They attended mandated PD training to increase their instructional abilities to increase student learning gains and achievement. The study is limited to public high schools in a suburban area of southern California. Other public schools in the State of California were not surveyed in this study, hence the narrowed scope and delimitation of the study to the 10 school districts.

Limitations

The first limitation of this study is the generalizability of the findings , which may be limited because the participants were selected for ease of accessibility -- only high school mathematics teachers --and time constraints and limited financial resources. Data in this study were collected from local comprehensive high schools in school districts located within a specific area in the State of California. The findings of this study are limited to only those situations that are similar to the participants within this particular setting. Math was chosen as the subject of this research because math improves the personal scientific literacy of citizens, enhances competitiveness in the rapid technological advancement, and underpins all other Science, Technology, Engineering and Math disciplines (Douglas & Attewell, 2017; Cowling et al., 2022; Maass et al., 2019). As Title 1 schools with low SES students, I wanted to conduct this research to better address issues that may mitigate teachers and students from thriving in math and building a solid foundation in the recent technology frontier.

The second limitation of this study pertained to attitudes. A general reliance upon teacher attitudes within the scope of this study was a limitation because attitudes may lead to multiple sources of teacher bias and may change over time. The third limitation was data collection. The data set collected is dependent upon the participants' inclination and integrity to cooperate and contribute to the study. To minimize this limitation, anonymity of respondents was sought. The fourth limitation is researcher bias. This refers to objectivity and researcher bias because I am a teacher and am employed in one of the school districts. Such limitations are addressed by complete disclosure throughout the study.

The fifth limitation of this study is the LoTi instrument (Appendix A). The use of this measurement tool is only one indicator of teachers' attitudes towards integrating and implementing technology in the classroom. While I suggested that the LoTi instrument be used to evaluate the relationships between attitude and digital-age work, professional growth, digital citizenship, digital-age learning experiences, and teacher's technology integration, I also recognize that other instruments could have been successful for this purpose. The independent variables were subscales of the LoTi, and the total LoTi score was the independent variable. Thus, the independent variables were not independent of the dependent variable. The sixth limitation of this study was the RQ. The quantitative data are limited to public high school mathematics teachers and may not be comparable to teachers from private high schools and teachers of other subjects.

Significance

This study contributes to the syntheses of the social cognitive theory (Bandura, 1991) because ultimate results include sustained teacher actions that can subsequently increase their students' knowledge base, improve academic achievement, improve benefits to the school learning environment, and promote social change in the education field and society as a whole. This study may help understand classroom instruction, student success, and increase the importance for practice in the studied population.

The study helps fill a gap in literature by synthesizing teachers' attitudes about learning and teaching and how they think about technology and its influences. This study contributes and addresses a gap in the research base required to address which constructs can evaluate relationships between teachers' attitude and propensity to use and integrate technology into their classroom and curriculum. This study also helps fill a gap in the literature focusing on individual teachers' attitudes with using educational technologies and could uncover more information about dynamic methods of teaching and learning with technology.

This research can help increase the understanding of PD for mathematics teachers in low SES schools and its impact on teachers' proclivity to integrate technology into their classrooms. This study can benefit teachers, administrators, school districts, and, ultimately, students. Possible benefits include increased teacher quality and increased teacher collaboration in sharing ideas and teaching strategies (Gutierez & Kim, 2017), personalized and effective PD (Hall et al., 2019), enhanced student learning (Bocanet & Fleseriu, 2020; Erkulova et al., 2020), teachers being important facilitators of educational sustainability (Heasly et al., 2020; Salīte et al., 2020), and improved school and student outcomes (An & Mindrila, 2020; Kent, 2019). Additional benefits include analyzing barriers that hinder teacher implementation of technology, leading to constructive structures and strategies that can accelerate appropriate technology integration and alignment with curriculum (Harvey & Marlatt, 2020; Lee et al., 2018).

This study can contribute and increase understanding in the research base by determining which constructs can predict teachers' attitude to utilize and integrate technology into their classroom and curriculum. A comprehensive exploration of the problem, including the review of applicable literature, are outlined in a later chapter. Part of the outcome of this research suggests strategies to support teachers with the necessary tools to develop confidence with technology use and to create a positive learning environment for students. This research also presents findings for future research.

This research presents foundational impetus for future staff development strategies and can assist PLCs (Grimus, 2020; Lawrence et al., 2020; Thomas, C. 2020) to afford productive collaborative environments to facilitate teachers' improved use of technology in the classroom. This research addressed specific areas where PD in the integration of technology can be targeted across the district as well as in individual schools, which may ultimately improve and sustain student achievement. Additional benefits include new awareness into the attitudes of teachers towards the implementation of technology and the perceived values of actual implementation. Analyzing reasons and barriers that mitigate teacher implementation may lead to constructive structures and strategies that may accelerate technology integration and alignment with curriculum (Beberman, 2020; Lemoine et al., 2020).

This study may contribute to positive social change that benefits teachers, administrators, school districts, and, ultimately, students. This research contributes to an overall conceptual understanding of the nature and the importance of facets of social capital in affecting the knowledge sharing in learning communities, especially in the high school setting. This study provides information to enlighten the community and encourage input from all stakeholders. It may benefit the fields of educational technology, instructional technology, preservice teacher education, and teacher PD.

Summary

Chapter 1 provided an overview of issues emanating from the attitudes of teachers toward digital-age work and learning and technology use in their classrooms. I examined attitudes toward technology integration and classroom practice. These exploratory and developmental questions guided the intent of this study. Analyses and syntheses of theoretical framework were explored in this research. The results from this study add a body of knowledge on the relationship between PD and the level of technology integration skills of mathematics teachers in low SES and Title 1 schools. Results are also important to state and local stakeholders and policymakers to improve technology integration and effective utilization by teachers.

In the ensuing Chapter 2: Literature Review, I present research studies that relate and contribute to this study . The review provides syntheses of current research on PD and educational technology, theoretical foundations, social implications, attitudes of teachers towards technology, gaps in research, impact of PD, and future research implications.

Chapter 3 includes a discussion on the research study methodology. In this section, I explain the design and approach, setting and sampling, data collection instruments, procedures, and data analysis procedures for the study. Articulation of the measures taken to protect participant's integrity and confidentiality are discussed. Chapter 4 presents data collected in the study, with me reporting on research findings in table and figure format, related to the posed RQ.

Chapter 5 includes the summary and conclusions of this quantitative study. An evaluation of the research and the implications for social change is offered. I also discuss recommendations, strengths in addressing the problem, and lessons learned from this research, and I address reflections and conclusions.

Chapter 2: Literature Review

Introduction

Many high school mathematics teachers in Title 1, low- SES schools have negative attitudes toward technology integration PD (Kormos, 2022; Lee et al., 2018; ; Torff, 2018; Wake & Mills, 2018; Wickham & Mullen, 2020). These negative attitudes are compounded by the reality that many of these teachers need this type of PD because they have a deficit in technology integration compared to teachers in high-SES schools (Wake & Mills, 2018).

The purpose of this correctional quantitative study was to investigate if there were statistically significant and meaningful relationships among high school mathematics teachers' attitudes about professional growth and leadership, digital age work and learning, digital age learning experiences and assessments, digital citizenship and responsibility, and their level of technology integration in Title 1, low SES schools. This study incorporated teachers' perceptions on the integration of technology, with a view to minimizing the problems and improving their attitudes regarding PD.

U. S. Department of Education. National Center for Education Statistics: Title 1. (2020) defined Title 1 schools as schools offering targeted assistance to low-income children or schools with high rates of low-income children who use Title 1 funds to support school-wide programs. According to Thomas (2020), most students in these schools receive reduced or free meals and generally live in a low socioeconomic area. These schools also generally have less technology overall and less technology utilization in the classroom. Kormos and Julio (2020) reported that there appears to be steady declines in the use of technology in K–12 urban classrooms, further observing that operational integration of computer technology into urban classroom instruction is yet to be realized.

Although there is extant research on technology integration PD in the secondary mathematics classroom (Agyei, 2019; Drijvers et al., 2018; Hill et al., 2017; Hill & Uribe-Florez, 2020), a dearth of research exists addressing technology integration PD, specifically for Title 1, low-SES school mathematics teachers. The research of Yolcu (2019), Olszewski and Crompton (2020), and Phillips (2021) are some of the few available studies dealing with this topic. These researchers illuminated teachers' dilemmas and coping strategies in their efforts to integrate technology in mathematics classes in Title 1, urban schools.

Math teachers at low SES schools often lag behind their counterparts at higher SES schools when it comes to technology integration skills (Ball et al., 2019; Jones & Smith, 2020; Kormos, 2022; Person, 2020; Phillips, 2021; Ross, 2019; Torff, 2018). Some of the challenges math teachers at low-SES schools face include determining the role of technology, navigating through multilevel obstacles, meeting misaligned expectations, and gaining knowledge and skills despite limited PD.

In this literature review, I present research concerning effective PD for refining teachers' attitudes toward the integration and use of technology in their respective classrooms. Syntheses of constructivist values and a description of their relationship to the dynamic forces of PD on teachers' attitudes concerning technology integration are also presented. This literature review includes a discussion of the theories and main ideas used to analyze and ground the data collected for this study. Future research areas of need to fill the gaps in literature are identified, including a description of how this study addressed those gaps.

In the first section of this chapter, I introduce the literature search strategy, including the library databases and search engines used and the scope of literature reviewed. The second section includes a discussion of the theoretical foundation of this study. The third section contains a summary of underlying factors affecting teachers' perceptions towards educational technology and the implications for PD. Finally, in the fourth section, I present a summary of the major themes in the literature, including how the results of this study fill a gap in the literature related to PD for mathematics teachers in Title 1 schools.

Literature Search Strategy

When embarking on this literature review, I first reflected upon the problem, the purpose, and RQ of the study. This reflection guided the search for related literature using the ProQuest Central, Education Research Complete, EBSCO, Education and Information Technology Digital Library, and Education Resource Information Center databases, accessed through the Walden University Library. The search parameters used included peer-reviewed research studies that employed quantitative approaches and were published in professional journals. The literature reviewed provided distinctive perspectives and support for the method used in this study from numerous fields of study, including information systems and technology, education, psychology, math, and science education.

I used reference lists from selected articles and studies to search for and locate additional resources that were not in ProQuest Central, Education Research Complete, EBSCO, Education and Information Technology Digital Library, and Education Resource Information Center. Internet searches and college libraries (both online and physical) were used to obtain this relevant material. Supplementary resources included seminal books and papers presented at national conferences that were peer-reviewed and essential in addressing the issues of PD and its effect on teacher attitudes on technology integration into the classroom.

Quantitative case studies were included in my search, with parameters selected to epitomize a diversity of theoretical viewpoints, systems, objectives, and populations. Key search terms used included *professional development* ; *technology integration* ; *teacher attitudes* ; *digital age learning experiences and assessments*; *digital age, work, and learning*; *digital citizenship and responsibility*; and *professional growth and leadership*.

Theoretical Foundation

Social cognitive learning theory (Bandura, 1991) was used as a basis for social learning theory in the context of the current study . Through modeling and observing others, teachers adopt a particular innovation and, over time, may be more inclined to consider adoption themselves. Accordingly, social learning not only influences the decision whether to adopt technology into the classroom but expands the possibilities to include technology-integrated curriculum and the student-centered learning classroom environment (Bandura, 1991). The social cognitive theory as postulated by Bandura (1991) provided a framework for understanding the stages of teachers’ adoption of technology. According to Bandura (1986), “ Within the model of triadic reciprocality, action, cognition, and environmental factors act together to produce changes” (p. 521).

The triangulation and interaction of teachers participating in PD, acquiring knowledge to improve their abilities, and implementing the newly acquired knowledge all act to produce positive change. Accordingly, an increase in attainment of designated goals spurs further participation in PD and results in an increase in productivity, both in the classroom and in adoption of technology. The interaction of teacher perceptions and environmental factors, including the educational need and academic advantages of integration of technology into the classroom, produces the needed change, which, in turn, fuels social learning.

Teacher self-efficacy refers to self-referent judgments of ability to organize and accomplish the actions required to successfully perform teaching tasks (Perera & John, 2020). According to Granziera and Perera (2019), teacher work engagement and job satisfaction were also found to be reciprocally linked over time. Bandura (1991) stated that “self-efficacy beliefs function as an important set of proximal determinants of human self-regulation” (p. 257). Gabriel et al., (2020) research on the model displaying self-regulation in a three-step cycle, including forethought, performance, and self-regulation, also provided a basis for the social cognitive theory. Frazier et al., (2021) contended that self-regulation is critical for behavioral change regardless of the context, provided the context for developing self-regulation and effective learning and teaching that promote student success. Specifically, in the current study, self-efficacy refers to the individual teachers' judgement of their competencies to consolidate knowledge and understanding from participating in PD to attain proficiency in technology integration in the classroom.

According to Bandura (1986), social cognitive theory explains human agency through the interdependence of three main determinants using a three-point model called "triadic reciprocal causation" (p. 23). The model visually resembles a triangle with the following points interacting and mutually influencing each other: personal factors, including cognitive, affective, and biological events; environment; and behavior. According to Iqbal et al., (2021), the cognitive approach focuses on making knowledge meaningful and helping learners organize and relate new information to prior knowledge in memory. Bandura (1991) postulated that social cognitive theory describes learning that is affected by cognitive, behavioral, and environmental factors that exert simultaneous and reciprocal influence over each other and the individual. PD is steeped in a learning-oriented and progressive growth approach that uses each teachers' knowledge, beliefs, and practical experiences to construct meaning and understanding that is beneficial to all stakeholders for sustained improvement. PD is involved in an environment of collaboration and inquiry.

PD is constructivist in nature because it is built on the learning and sharing ideas and experiences to arrive at a common purpose, including improved student learning outcomes, common lesson plans, solving problems, and improved school environment. The practice of PD is seen as an intentional strategy for system-wide change (Summers et al., 2018), which increases the efficacy of teachers and administrators (Segal & Heath, 2020) and goes a long way toward motivating teachers and administrators to maintain confidence and high expectations for increasing student academic performance (Gaham, 2021; Johnson, 2021).

Assumptions appropriate to the application of the social cognitive theory, as proposed in this study, included expectations that all participants would provide 100% of their effort and time, all participants could make significant contributions to student learning by integrating technology into the classroom and throughout the curriculum, and the support of the school administration and school district are crucial to the success of any school-wide/district-wide changes in curriculum and technology integration. Other assumptions included expectations that PLCs for mathematics teachers in this study are built on learning and sharing ideas and a commonality in problem-solving strategies that can result in increases in the efficacy and motivation of teachers and administrators for improved school learning environment with the attendant high expectations for increased and sustained student academic performances.

The social cognitive theory related to this study provided an understanding of how teachers, through modeling and observing others, adopt a particular innovation. Based on this adoption and with consistent trials and applications, these teachers may be motivated to increase and incorporate the application daily in classroom instruction. Subsequently, social learning not only influences the decision on whether to adopt technology into the classroom but expands the possibilities to include technology-integrated curriculum and the student-centered learning classroom environment. The RQ in this study addressed the relationship between teachers’ perceptions and attitudes towards integration and technology use in their classrooms and the relationship between the amount of PD and the teachers' implementation of technology-integrated instruction.

As a constructivist construct, the social cognitive theory relates to the RQ in the theory's ability to provide a framework for understanding the stages of teachers' adoption of technology. These stages can be used in PD sessions to build upon modeling and observation attributes through discovery learning (Iqbal et al., 2021). Discovery learning encourages learners to discover principles and important relationships by engaging the learners in such activities as asking questions, being involved in hands-on activities, being actively involved in the learning process, and investigating a phenomenon, all to improve their understanding of concepts and increase utilization. Subsequently, teachers can gain new knowledge that can be applied directly within their classrooms.

Underlying Factors

Studies in technology integration have explored the effectiveness of the strategies employed in the support of technology integration in classroom instruction (Beberman, 2020; Burton, 2018; Kormos, 2022; Phillips, 2021). The researchers have designed PD activities to facilitate the expansion of teachers' technical skills, comfort with technology, knowledge of resources, and knowledge of implementation and classroom management strategies when integrating technologies. Participants' stages of adoption were assessed at the beginning of the project and at the end to ascertain teachers' perceived capabilities. At the end of the study, data analyses revealed that teachers' comfort with and enthusiasm for technology integration in the curriculum increased over the course of the PD.

Researchers of PD for math teachers in low-SES schools found a lack of sufficient resources, inadequate quality training, and few opportunities for teachers to facilitate and participate in leadership roles in PD sessions (Beberman, 2020; Caruso, 2020; Morales, 2021; Person, 2020), fragmented presentation (Ghan, 2021), lack of technical support and technology leadership (Francom, 2020), high cost or location (Ghan, 2021; Sims & Fletcher-Wood, 2021), one-size-fits-all (Villalobos, 2020), and exhibition of poor attitudes (Morales, 2021). Research also showed that new information technologies and processes emerged faster than they could be integrated into course material, meaning that many teachers were often behind in their knowledge of the technologies' implementation (Bowman et al., 2022; Sprott, 2019).

The research on technology PD has focused on teacher learning in the context of teacher PLCs, including specific studies of low-SES PLCs (Gomez, 2020; Jones & Smith, 2020 ; Kormos, 2022; Man, 2019; Phillips, 2021; Xie et al., 2021). Other researchers have suggested that teacher PLCs could lead to long-term capacity development (Hall et al., 2019). Caruso (2020) and Person (2020) posited that when PLCs are implemented as a professional-development strategy, they can lead to organizational improvements in the areas of collaboration, providing the means for continuous improvement for student learning, and shared data-driven strategic decisions.

According to Norton et al., (2019) in a study by the National Center for Educational Statistics, less than half of the 3,000 surveyed teachers reported using technology often during instructional time for administrative tasks, including taking attendance; grading papers; and communicating with fellow teachers, students' parents, and other staff members. This study underscored the seeming gap between the amount of technology available in the classroom and teachers' effective use and integration of the technology into classroom to improve student educational outcomes. Teachers taught material in the perspective of a rich, learning environment in which the student is an active participator and learner. Based on the efficient integration of educational technology in the classroom, the teacher's role is being transformed from the traditional dispenser of information to that of a contemporary facilitator of learning.

Educational technology has systematically challenged the teaching-learning methodology in the classroom and tasks for 21st century educational stakeholders and teachers. The prior and current view of the integration of educational technology have been validated by the presentation of information to the student in a lecture format, thus viewing the student as an impassive learner. The technology integration process has necessitated a deep modification from an instructor-based presentation to a constructivist viewpoint of scholarship that is student-centered rather than teacher-centered (Serin, 2018). In the constructivist learning paradigm, the learner creates new knowledge through a method of evaluating new and current information and comparing it to prior knowledge (Young et al., 2019). With the ubiquitous nature of technology in society, its successful use in the educational system is partly contingent on teachers being willing to provide a technology-rich curriculum and environment to prepare students for a technological, industrial society (Office of Educational Technology, 2022). Technology in education has been linked to enhanced student engagement, motivation, and self-confidence, while enhancing study and organizational skills, subsequently improving academic growth (Burton, 2018).

Teacher Perceptions Toward Educational Technology

The integration of technology into education, especially into the classroom, remains a progressive process. According to the ISTE (2022), as technology integration continued to increase in society and in the educational landscape, it is vital that teachers possess the skills and behaviors of digital-age professionals. In the field of education, technology appears to be an imperative in the quest for academic excellence in schools and the educational system. The evolution of teachers toward the utility and simplicity of technology integration knowledge and use is dynamic and not stagnant (Ottenbreit-Leftwich et al., 2018). Since technologies change rapidly, teachers and learners are frequently required to adapt and update their digital mastery skills and capabilities (OECD, 2018).

The penchant of teachers to share knowledge and challenge their students to utilize critical-thinking skills daily is important for learning to take place in the classroom. Teachers play a significant role in the classroom as it relates to the dissemination of information to their students, enabling and encouraging the learning process, and initiating the feedback loop to increase understanding for their students (Das, 2019). Teacher attitudes related to technology in education had been found to affect teacher use of technology in lesson planning and presentation to their students (Yildiz Durak, 2021).

Effective and efficient usage of educational technology by teachers require the possession of a positive attitude toward teaching and interacting with students. Equally, positive attitudes were supported when teachers were at ease with the technology and erudite on its use and could utilize its exceptional capabilities to teach lessons that challenge students (Yildiz Durak, 2021). It appears that when teachers identify technology to be beneficial and that using that technology would increase their efficiency, their motivation to integrate technology into their classroom would be meaningfully improved (DeCoito & Richardson, 2018). Mouza (2019) indicated that most educators had the belief that students' use of digital devices had a beneficial effect on students' education.

A survey administered to 1,208 K-12 teachers by Common Sense Media (2019) revealed that about one third of teachers do not routinely use technology products provided to them by their school or district because they are not relevant to their student needs or their efforts to develop students' knowledge and skills. Subsequently, when technology is utilized, it typically is not used to support the kinds of instruction (e.g., student centered) believed to be most powerful for facilitating student learning (ISTE, 2022). Hence it is crucial to understand the methods that beliefs, experience, habits, and the school environment reciprocally impact each other relative to teacher's educational technology usage in the classroom (Bower, 2019).

Backfisch et al., (2021) argued that it was no longer adequate and acceptable to recommend that educators continued to use low-level technology as sufficient in meeting the educational needs of the 21st century learner, rather it depends on how they are used during teaching. The way teachers view their role impacts the way they teach with technology (Beberman, 2020). Teachers’ beliefs about their classroom practices appear to influence their everyday usage of technology in their classroom (Granziera & Perera, 2019; Person, 2020; Caruso, 2020). According to Sprott (2019), beliefs about teaching and technology, established classroom practices, and reluctance to change influence teachers’ use of technology. Changing a teaching methodology to one that integrates technology in the classroom requires more than just an exploration of new methods (Susanto et al., 2020). This adjustment requires a different attitude and purpose that substantially transforms the learning environment, both for the teacher and student. Integration of technology in education entails the use of newer teaching strategies and systems that positively challenges traditional methods.

To utilize technology in the facilitation of student learning, teachers need supplementary understanding and abilities that build upon and integrate with their content knowledge. Yildiz Durak (2021), Bowman et al., (2022), and Seufert et al., (2021), argued that teachers’ decision to integrate technology were based heavily on the level of support the teachers received, their own beliefs about using technology, and their skills with using technology for instruction. The use of technology required of teachers to teach and facilitate learning in the classroom requires some aspects of change, including the following findings of Ottenbreit-Leftwich et al., (2018) and Kopcha et al., (2020): (a) beliefs, attitudes, or pedagogical ideologies; (b) content knowledge; (c) pedagogical knowledge of instructional practices, strategies, methods, or approaches; and (d) novel or altered instructional resources, technology, or materials. Studies have shown that teachers that have constructivist beliefs tend to use more educational technology than those with more traditional beliefs (Pozo et al., 2021).

The use of technology to teach and support student learning requires educators to have supplementary knowledge and expertise that builds upon and interconnects with a strand of technological pedagogical content knowledge (TPACK). According to Mourlam et al., (2021), this TPACK specifically emphasized relevant knowledge of information and communication technologies. Further, Mourlam et al., reported that these facets are situated upon the common principle that effective technology integration depends on the synthesis of the interactions among pedagogy, content, and technology. Technology integration requires that teachers understand (a) the technology tools themselves, combined with (b) the specific affordances of each tool when used to teach content, to enable difficult concepts to be learned more readily, resulting in the achievement of meaningful student outcomes (Mourlam et al., 2021).

Teachers are often hesitant to adopt curricular and instructional innovations, especially technological improvements, because technology tools and resources are constantly changing (Seufert et al., 2021), lack of time, and the availability of computers and software applications (Vongkulluksn et al., 2020). Francom (2020) asserted that although teachers often believe that technology helps them complete professional or personal tasks more efficiently, they are reluctant to incorporate the same tools into their classroom for a variety of reasons, including the lack of relevant knowledge, low self-efficacy, and existing belief systems.

Studies by Hall, et al., (2019), Kopcha et al., (2020), Jones and Smith, (2020), and Kormos and Julio (2020) indicated that to achieve technology integration that targets student learning, teachers need knowledge that enables them to (a) identify which technologies they need to support specific curricular goals; (b) enable students to use appropriate technologies in all phases of the learning process, including exploration, analysis, and production; (c) specify how the tools would be used to help students meet and demonstrate those goals; and (d) select and use appropriate technologies to address needs, solve problems, and resolve issues related to their own professional practice and growth. From the perspective of teachers and other stakeholders, there continues to be trepidation concerning the reasons that technology is being underutilized in the classroom (Bocanet & Fleseriu, 2020). Stakeholders have sought answers as to why educational technologies are not objectively utilized in current educational practices. Several researchers have attempted to offer explanations for these inconsistencies. Studies by Gomez (2020); Kormos (2022); and Man (2019) reported that when teachers are blamed for letting technological resources go unused, teachers often cite numerous rationalizations, including a shortage of time to learn technology use and the turnaround period to use it with their students, a dearth of applicable training presented at expedient periods, and the lack of technical resources to find a resolution to problems that may occur.

It appeared rational that for technology to be integrated into a classroom, it is essential that teachers must have access to the proper technology, have enough time to develop and participate in technology-based learning approaches (Vongkulluksn et al., 2020), acquire the expertise to objectively manipulate the technology, and have the determination to align the proposed technology into the curriculum to obtain optimal results by focusing the instruction and challenging the student with assignments that require higher order thinking skills. The successful integration of technology is achieved when the technology is transparent, available to students, reinforces the curriculum, and supports the students as they master their objectives and goals (ISTE, 2022).

According to Bowman et al., (2022), the five types of barriers to technology include resources, knowledge and skills, institution, attitudes beliefs, and subject culture, and are interconnected with a need to be studied equally to comprehend the reasons for the nominal integration of technology in today's schools. The researchers further posit that teachers' attitudes and beliefs are influenced by each of the other barriers and that those attitudes and beliefs directly impact the teachers' integration of technology.

Studies by Francom (2020), Seufert et al. (2021), Sprott (2019), and Xie et al. (2021) sought to distinguish among two categories of impediments that obstructed the instructor's utilization of technology in the classroom. They include first-order barriers exemplified as external to the instructor including resources training, support, software, and equipment. The other include second-order barriers exemplified as internal to the instructor including their self-confidence, principles, the ways their students learn and the apparent significance of technology in the instruction and knowledge acquisition progression. Xie, et al. (2021) conceptualized that teacher beliefs and attitudes are pertinent factors to recognize and focus on when trying to support technology integration in the classroom. Vongkulluksn et al., (2020) examined the role of value on teachers' internalization of external barriers vis-à-vis their personal beliefs for classroom technology integration. It is practical to presume that when teachers have positive feelings regarding the use of technology, these outlooks support their motivations to use technology in the classroom. It is noteworthy that teachers' attitudes concerning the use of technology is considerably influenced by perceived usefulness and ease of use, suggesting that when the use of technology is perceived to be an enhancement to one's productivity, teachers are likely to develop a positive attitude toward its use (Scherer et al., 2019).

Technology integration into the curriculum functions to improve the learning process by making it more efficient, meaningful, and enriching for the student (Gomez, 2020; Jones & Smith, 2020; Kormos, 2022; Man, 2019; Phillips, 2021). Researchers posit that the rationale behind integrating technology is not to make an entire unit technologically driven, but to critically examine a unit's instructional value, including where technology effectively supports student learning. Morales (2021); Kormos and Julio (2020) believe that successful implementation of education technologies depends upon extensive, high-quality teacher PD and ongoing support.

Technology in education serves as a channel for expedited and more cognitive understanding between the participants in the classroom, and between the student and his or her environment. Current curriculum standards from national organizations focus on providing relevant, meaningful tasks, developing higher order thinking skills, and integrating technology as a tool to support learning (ISTE, 2022). It is essential that the constructivist model be incorporated into the amalgamation as a solid base, for authentic scholarship and academic dialogue to take place. Furthermore, learner-centered curriculum highlights conducting mathematical inquiries (National Council of Teachers of Mathematics [NCTM] (2021) and using technology to facilitate collaborative problem-solving (ISTE, 2022).

Positive teachers' attitudes toward technology naturally portends improved teachers' integration of technology into their teaching and into their classrooms. This technology integration process necessitates a deep modification from an instructor-based presentation to a constructivist viewpoint of scholarship, which is student-centered rather than teacher-centered. Studies have indicated that it is no longer adequate and acceptable to recommend that educators continued to use low-level technology as sufficient in meeting the educational needs of the 21st century learner (Backfisch et al., 2021; Bowman et al., 2022; Bower, 2019; Mourlam et al., 2021; Yildiz Durak, 2021). Effective teachers' integration of technology in education entails the use of newer teaching strategies and systems that positively challenge traditional methods (Francom, 2020).

Implications for PD

Existing research has shown that effective teacher preparation is a key factor for successful integration and sustainability of information and communications technology in education (Gomez, 2020; Morales, 2021; Phillips, 2021; Xie et al., 2021). Many teachers have found it demanding to learn how to integrate technologies appropriately in curriculum, and sustained involvement is critical for that complex mission (Burton, 2018). The focused selection of professional teacher learning activities that are linked to their classroom and teaching practices strengthens the likelihood that teachers will commit themselves to obtaining the latest knowledge to transfer it into teaching (Caruso, 2020).

The emphases of most PD are to concentrate on increasing and improving content knowledge and promote productivity and self-improvement. For any PD to be operative and efficient, teachers must endeavor to accentuate their PD capabilities into action. PD improves teachers' confidence to teach, learn, and explore with students, while assisting an initiative-taking approach into the nature of teaching, knowledge acquisition, and educational growth (Person, 2020). PD activities that create relationships amongst teachers' and students' perspectives appears to be greatly appreciated and incorporated by teachers and all stakeholders.

The National Center for Educational Statistics (NCES) 2020 survey found that educational technology training to be relevant and aligned to school and district goals, with a little over 70 percent of schools said that their teachers used technology for activities normally done in the classroom. A little over 8 in 10 schools rated the overall quality of their software for teaching and learning as good (53 percent) or very good (31 percent). (https://nces.ed.gov/pubs2021/2021017Summary.pdf). Findings from a study by Ertmer et al., (2012) suggested that in general, teachers were able to enact technology integration practices that closely aligned with their beliefs, while at the same time working hard to surmount external barriers that impede full technology integration in the classroom.

Haug and Mork (2021) contend that in PD what teachers experienced is content specific pedagogical processes as contrasted to broad teaching skills, are effortlessly incorporated by teachers, which subsequently exert profound influence on student learning. Significant gauges of PD successful programs would revolve around participants' increase in the understanding of content knowledge and putting into practice inquiry system as well as the impact on students' learning. Mourlam et al., (2021) asserted that in-service teachers had existing pedagogical content knowledge (PCK) on which to build, rather what they generally lacked is specific knowledge about the technology itself, including the extent they could combine technology with their existing PCK to support students' content learning. Xie et al., (2021) proffered that efficient PD for technology integration warrants an emphasis on content that included: (a) technology knowledge and skills; (b) technology-supported pedagogical knowledge and skills (the ability to see a clear connection between the technology being used and the subject content being taught); and (c) technology-related classroom management knowledge and skills.

Existing research data offered fundamental promise that the TPACK model improves teachers' knowledge and skills to support productive technology integration in their classroom (Yildiz Durak, 2021). Although ideal intentions for PD abound, research conducted by Francom (2020) suggested that much of technology integration training appeared to focus mainly on technology knowledge and skills while overlooking the dynamic relationships between technology, pedagogy, and content. Hall et al., (2019) pointed out that teachers had a preponderance to adopt PD pedagogies when they perceive ownership by being able to select content and pertinent hands-on activities. During PD training, teachers increased their motivation when the themes being worked upon built upon prior knowledge, aligned to their personal interests and beliefs, and stimulated ownership proclivities in their acquisition of knowledge. Gore et al., (2021) explained that these ownership methods assist teachers to embrace key conceptual differences related to their prior knowledge assumptions underlying learner-centered instruction. Teachers were most likely to adopt technology-rich, learner-centered tasks; when they understood model lessons as learners (Iqbal et al., 2021); engaged in discussions about the concepts embedded in the lesson (An & Mindrila, 2020; Johnson, 2021); and establish connections with content and pedagogies (Granziera & Perera, 2019).

Subsequently, when teachers adopted new beliefs and perceptions about integration of technology in their instruction and student learning, they needed to comprehend how these beliefs translate into innovative classroom practices. The interface between technology and pedagogical content knowledge could be attained by using teachers' prevailing competencies as a catalyst (Heasly et al., 2020; Mourlam et al., 2021). Chen et al., (2020); Lemoine et al., (2020); and Mitchell (2021) added that PD is critical to ensuring that teachers keep up with changes in statewide student performance standards, become familiar with new methods of teaching in the content areas, learn how to make the most effective instructional use of technologies for teaching and learning, and adapt their teaching to the ever-changing school environment and an increasingly diverse student population.

PD prepare and assist teachers in providing strategies to improve teaching, facilitating learning to their students and invariably meet their responsibility to their students, parents, the school, and the community. Kopcha et al., (2020) supports the idea that proposing activities that align with the principles of effective PD may be a critical step toward long-term changes in teacher perceptions and practice. As teachers work collaboratively, they examine and study best educational practices for the purpose of improved service to students (Lemoine et al., 2020).

PD is an interactive process and require teacher-participants to be proactive in the learning process. These interactions required curriculum alignment and targeted core principles that the participants taught. This positive interchange of ideas amongst teachers increased their understanding and provided a solid opportunity for the integration of technology into the classroom, thereby positively impacting the teaching and learning process. The transformation may incorporate a forum through which teachers eventually develop their technology integration and instructional skills in the perspective of their curriculum requirements. Haug and Mork (2021) and Sancar et al., (2021) expounded that the traditional approaches were generally viewed as overly fragmented, not connected explicitly to classroom practice, and were out of alignment with current theories of learning and educational advancement. Accordingly, contemporary approaches are replacing traditional approaches more closely aligned with constructivist theory and reform efforts; specifically, they are grounded in classroom practice and involve the formation of PLCs. Further, high-quality PD engaged teachers in inquiry about the tangible tasks of teaching, assessment, observation, and reflection, and provided them with the opportunity to make connections between their learning and their classroom instruction.

The literature search generated research on other ways that technology integration skills were being measured quantitatively. Kopcha et al., (2020) described a system-based model of technology integration that used mentoring and communities of practice to support teachers as they developed the skills, pedagogy, and beliefs needed to integrate technology in a student-centered manner. This model moved teachers through four specific stages of technology adoption, towards using technology to support learning in more student-centered ways. According to Kopcha et al., (2020), the four stages overlapped and include Stage 1, which is the initial setup, where the mentor prepare the assessment of needs and create a vision of technology integration and ways of attaining stated goals.

Stage 2 is teacher preparation, where formative evaluation is conducted and evaluated. If the results are not optimal, the process restarted. Teachers are being prepared to use technology in the classroom. Stage 3 is for curricular focus and relate to the actual integration of technology into the curriculum and use student-centered methods to incorporate the technology. The mentor increased teachers' experiences in incorporating technology into student-centered teaching. Stage 4 is the community of practice, where the teachers excel and are expected to become technology leaders in their schools. The teacher leaders become mentors to other teachers and the cycle begin again. Quantitative measurement of this model is achieved through formative evaluations conducted and measured by the mentor during the technology integration stages.

Study by Kopcha et al., (2020) suggested that enacting a variety of situated learning activities around the principles of effective PD may be the key to providing teachers with the awareness and support needed to foster technology integration into their classroom instruction. The researcher posited that investigating the relationship between such activity and teachers' long-term practices with technology is a critical first step in making enduring modifications in the way teachers used technology to facilitate student learning in the classroom.

Offering teachers sufficient opportunities to engage in PD related to technology integration is imperative for teacher change (Norton et al., 2019; Scherer et al., 2019). In addition to promoting, encouraging a shared vision, and emphasizing a supportive culture to inspire improvement and technology integration, school districts should provide sufficient resources to support effective technology utilization and integration into the curriculum and learning. When constructing an efficient infrastructure, it is imperative that school districts be prepared, not only with technological resources, but also with the pedagogical proficiency required accentuating productive uses to increase teaching and learning (Bowman et al., 2022).

In a report on teacher PD in the United States, the National Staff Development Council advised educators to provide PD in more contemporary and authentic ways. Further, the education workforce needed to engage in learning the way other professionals do - continually, collaboratively, and on-the-job to address common problems and crucial challenges where they work. (Darling-Hammond et al., 2017). Ultimately, it appeared imperative that teachers believed in their own skills to implement these modifications within their school environment, content, cultures, and within their specific contexts. PD should afford teachers with specific content technology integration concepts and prospects to discover technologies in genuine instructing and learning contexts. Teacher PD should be vital in the management of technology integration in teaching and learning.

Summary

This literature review disclosed pertinent connections between technology competences, scope of PD delivered to teaching professionals, and the integration of technology in the classroom. Although these three connections had not always been considered together in the same study, a research study is needed that focused on these three facets specifically. This awareness alongside tangible and intangible aspects such as usage, accessibility, and availability of support, have been recommended by previous studies as pertinent factors for the integration and alignment of education technologies within the classroom routines of teaching professionals. This literature review provided the impetus for developing the RQ around the competencies and proclivity of PD in enhancing, supporting, and complementing the integration of technologies in the classroom.

This literature review indicated that significant barriers such as problems with technology, lack of PD on the integration of technologies in the classroom, and the education field's inability to keep up with incessant changes in technology, had directly impacted and then mitigated the use of technology in most classrooms, often to the detriment of students. Studies were reviewed that included information about technology in education, PD for the use of technology, constructivist learning, and the arduous conflict in regards the use and technology integration in classrooms. It is imperative to determine the best practices in designing and delivering PD to low SES mathematics teachers so that low SES school districts and communities could maximize the benefits.

This research increased the understanding of the disparity in PD for mathematics teachers in low SES schools and its impact on teachers' proclivity to integrate technology into their classroom. This study benefited teachers, students, administrators, school districts, and all stakeholders. Possible benefits included increased teacher quality, increased teacher collaboration in sharing ideas and teaching strategies (Burton, 2018; Man, 2019; Phillips, 2021; Scherer et al., 2019), enhanced student learning (Kormos & Julio, 2020), knowledge acquisition, and educational growth (Person, 2020), and improved school and student outcomes (Gomez, 2020; Jones & Smith, 2020; Kormos, 2022). Additional benefits included analyzing barriers that hinder teacher implementation of technology, leading to constructive structures and strategies that accelerated technology integration and alignment with curriculum (Gomez, 2020; Kormos, 2022; Man, 2019; Phillips, 2021).

All the studies in this literature review indicated that PD coupled with effective technology integration played a key role in positive student learning outcomes, improved teacher technology efficacy, and impacted the teaching and learning process. This literature review informed the choice and design of survey items used in this study, with the next section discussing the details of the research methodology.

Chapter 3: Research Method

Introduction

The purpose of this correlational quantitative study was to investigate if there were relationships among teachers' attitudes about professional growth and leadership, digital age work and learning, digital-age learning experiences and assessments, digital citizenship and responsibility, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools. The PD was intended to improve teachers' instructional abilities and attitudes through integrating technology into their classrooms. This research incorporated teachers' viewpoints, experiences, and attitudes on the integration of technology. The integration of technology as an essential measure of the teaching paradigm is becoming a principal factor in how educators plan, enhance, and improve their teaching practices into their classroom and curriculum.

This chapter includes descriptions of the research design and rationale; methodology, including population, sampling, and sampling procedures; procedures for recruitment, participation, and data collection; instrumentation and operationalization of constructs; threats to validity, including ethical procedures; and a summary.

Research Design and Rationale

The nature of this study was a quantitative correlational survey research method. Skilling and Stylianides (2020) defined quantitative research as research that explains phenomena according to numerical data analyzed with mathematically based methods, especially statistics. Survey methodology was used in this study. A survey design provided a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population (Creswell, 2013).

Similar survey designs were used in earlier studies of this topic. For example, Atchley (2019), Fusco (2019), Mehta (2011), and Mehta and Hull (2013) all used a similar survey design in their studies of teacher's technology integration. Paulus et al. (2020) indicated that the better trained a teacher is in using technology, the higher the chance that the teacher will successfully integrate technology into classroom teaching and the curriculum. Also, educational technology in the classroom is only as effective and efficient as the teacher's attitude to use the technology (Yildiz Durak, 2021).

The quantitative survey research design was chosen due to the minimal time required by the participants to complete the survey instruments and the prompt turnaround of data collection and subsequent analysis and interpretation of findings. Another major advantage of this method is that it allowed me to measure the responses of several participants to a limited set of questions, thereby facilitating comparison and statistical aggregation of the data (Skilling & Stylianides (2020). Further, quantitative research methods and procedures allow researchers to obtain a broad and generalizable set of findings and present them concisely and efficiently. It also allowed statistical inferences from a sample to a given population.

This study used an empirically validated quantitative survey with multiple-choice Likert scale response items. Data came from the LoTi Digital Age Survey (Appendix A) developed by an educational consortium (Learning Quest, Inc. 2013). This survey was chosen because it had been evaluated for both reliability and validity (see Stoltzfus, 2009). The validation studies are for the entire instrument. I chose this survey because it accurately measured levels of teacher's attitude in integrating technology into the classroom.

The LoTi Digital-Age Survey provided data about the technological literacy of teachers and how teachers integrate technology into their instruction. The LoTi Digital-Age Survey is used to collect data about the dependent and independent variables. A subsection of the LoTi Digital-Age Survey is the teachers' Levels of Teaching Innovation. The Levels of Teaching Innovation provides a profile of the degree to which respondents support or implement digital teaching and learning in their respective classrooms (Learning Quest, Inc. 2013). Studies by Atchley (2019), Fusco (2019), Mehta (2011), and Mehta and Hull (2013) used similar survey design and had correlated sub scale scores with LoTi. I discuss this specificity in Chapter 5.

In this research, the independent variables were teacher attitudes toward digital age work and learning, teacher attitudes about professional growth and leadership, teacher attitudes about digital citizenship and responsibility, and teacher attitudes about digital- age learning experiences and assessments. The dependent variable was level of technology integration.

Methodology

Population

This study's population size was 320 mathematics teachers. The sample size of mathematics teachers in Title 1 high schools invited to participate was 100 teachers from five suburban school districts in southern California. Krejcie and Morgan's (1970) formula was employed as a power-based analysis to reflect the adequate sample size of 100 secondary math teachers. These educators taught within a common curriculum and used the same district-wide pacing guides. The attributes of the setting were conducive and enhanced systematic and efficient data collection procedures, internet access capabilities, and support of the school and district administrative team. These educators directly affected and instructed students. They attended mandated PD trainings to increase their instructional abilities to increase student learning gains and achievement.

One hundred high school mathematics teachers from local comprehensive high schools in five school districts were invited to participate in this study. These teachers were the population of high school mathematics teachers. This resulted in a beginning sample size of $N = 100$. Krejcie and Morgan's (1970) formula was employed as a power-based analysis to predict the sample size. I presumed a 90% response rate. According to Shieh (2016), the prospective determination of needed sample size is an essential process to ensure there is adequate statistical power to detect scientifically credible effects.

The optimal goal is to achieve a balance of the effect size, alpha value, and power level that allows the maximum level of power to detect an effect if one existed, given programmatic or logistical limitations on the other components. The main decision involves determining whether to accept the null or alternative hypothesis, among all possible outcomes. This affected the effect size, derived from Krejcie and Morgan's (1970) power analysis formula. The significance level or the alpha (α) was used to determine whether the findings of my study are statistically significant or not.

Accordingly, if the *p*-value was greater than the significance level, then the null hypothesis would be rejected.

Sampling and Sampling Procedures

The selection criteria for the schools chosen for the study were all comprehensive high schools that offered a wide array of academic programs. All schools had access to current educational technologies, including but not limited to instructional devices including ceiling-mounted projectors, Interwrite Learning pads, scanners, photo document cameras, e-textbooks, laser printers, smart boards, scientific and graphing calculators, and three to four computers in each classroom. All schools had computer laboratories dedicated to each PLC, including mathematics, language arts, and science.

This study used convenience sampling of all 350 mathematics teaching staff, yielding an actual sample of 80. Criteria used in selecting the participants included the following: (a) They were high school math teachers from the selected school district and teachers from the comprehensive high schools selected, and (b) the teachers who volunteered for the study were the certificated teachers of record in their respective classrooms. From the sample, I was able to elicit data and information related to the proclivity of the teacher's technology usage and integration into the curriculum.

Procedures for Recruitment, Participation, and Data Collection

IRB approval (number 11-17-16-0091378) from Walden University was obtained after the study proposal was defended and approved. A cover letter of application to conduct doctoral research was sent to local school district superintendents, with the attached IRB approval, proposed survey instrument, and Statement of Consent.

Approvals were received, and email invitations were sent to teachers in the research population seeking their consent to participate in the online survey. The invitation included the Statement of Consent form was sent to all mathematics teachers in the districts, and out of the approximately 320 high school mathematics teachers, 80 teachers chose to participate in the study. To safeguard the promptness of data acquisition from teachers, after 1 week, another email was sent as a reminder to the teachers to take the online survey with instructions to login including the survey link. After 2 weeks, a reminder email was sent to all teachers and school principals. The teacher's completion of the online survey served as consent to participate in the study.

All mathematics teachers recruited to participate in this study were required to be certificated and certified teachers of record. The teachers were evaluated on an annual basis by the school district in the context of their technology usage, familiarity, and adaptations to the curriculum in the classroom. Paraprofessionals, school support staff, and administrators were excluded from participation. The collection process started in Semester 1 (Fall) and ended in Semester 2 (Spring). Participating teachers were provided with an online Informed Consent form and a recruiting letter . Reminder emails were sent after 2 weeks. When they agreed to participate in the study, a link was provided to begin the online survey. I followed all procedures, including exit procedures, as outlined in the Informed Consent form, as described in the Institutional Review Board (IRB) Application to Walden University and to the school districts. The resulting obtained sample size was 80.

Participating teachers were grouped into mathematics PLC, each of which had their own distinct pedagogical culture that may have influenced technology integration, either constructively, negatively, or positively. Johnson (2021) and Gaham (2021) referred to a PLC as a group of educators who engage with colleagues in a culture of collaboration to ensure that students learn and use critical thinking skills in the process. According to Gaham, when implemented with commitment, PLCs have been significantly related to school performance, improved student success, and overall improvement in school culture.

Instrument

The instrument used in this study was the LoTi (Appendix A). Demographic questions and 50 Likert-like questions based on the ISTE National Educational Technology Standards (NETS) standards were used regarding each participant's access to technology and their integration practices. Subsequently, the LoTi survey generated a score, also called a level, based on the respondent's answers. Overall, the higher the participant's score in any one area on the survey, the more integration practices were reported by the teacher, and more ISTE NETS standards were covered.

The instrument used in this study consisted of a technology use profile. The technology use profile evaluated the teachers' technology use in the classroom, its integration to the curriculum, and the correlation of technology to increased teaching skills. Data were collected with a survey developed by LoTi Connection – LoTi Digital Age Survey (Appendix A). The survey consisted of 50 questions. The questions were based on a scale from 0 to 7. Table 1 displays question coding for Likert-like survey questions.

Table 1

Likert Scale Options for All LoTi Likert-Like Questions

Scale	Code
0	Never
1	At least once a year
2	At least once a semester
3	At least once a month
4	A few times a month
5	At least once a week
6	A few times a week
7	At least once a day

Instrumentation and Operationalization of Constructs

I obtained permission to use the LoTi products, including the LoTi survey and LoTi framework, and all survey results in this doctoral study (Appendix B). The LoTi study survey instrument is administered online to ensure full individualized participant engagement, providing scientific and objective support because this computerized avenue presented no preconception and is impartial. This method also improved validity, as the time and date of data collection are more uniform to ensure consistency in the data collection. Instrumentation consisted of a survey from an educational consortium Learning Quest, Inc. (2013). I chose this instrument because it had been evaluated for both reliability and validity with this population. The LoTi Digital Age Survey was developed to measure authentic classroom technology use, personal computer use, and current instructional practices. The LoTi survey instrument is aligned with the National

Education Technology Standards for Teachers and built upon the LoTi framework. This study required a data collection tool that would extract information concerning teachers' participation in PLCs meetings and PD and the process of technology integration into teaching and learning.

A LoTi score reported the degree to which the respondent supported and implemented instructional uses of technology in a classroom setting on a scale of 0 to 7. The attributes for the LoTi levels are listed in Table 5. The LoTi questionnaire included four constructs based on the five factors proposed to be measured by the Digital-Age Survey (Mehta, 2011): professional growth and leadership, digital age work and learning, digital-age learning experiences and assessments, and digital citizenship and responsibility. Mehta and Hull (2013) followed up with a study that used this format in examining the structural construct validity of the PD profile of the LoTi Digital-Age Survey. According to Mehta and Hull, the attributes were added later to create a personalized digital-age PD profile and evolved with current technological advancements. This framework is used to measure specific LoTi at various educational levels, including local, district, and state .

Table 2

Constructs of LoTi Likert-Like Questions

Research Question	Survey Items	Scale	Data Type	Numeric Range	Construct Name	Definition
Research Question: Independent Variables: Teacher attitudes toward Digital Age Work and Learning.	SubScale1	Numeric	Ordinal	0-7	Digital Age Work and Learning	(1) Student Learning and Creativity, and (2) Application to Global Environments (Mehta, 2011, p. 8).
Teacher attitudes about Professional Growth and Leadership	SubScale2				Professional Growth and Leadership	Content on PD opportunities accessible to teachers. (Mehta, 2011)
Teacher attitudes about Digital Citizenship & Responsibility	SubScale3				Digital Citizenship & Responsibility	Technology use and application to global communities. (Mehta, 2011).
Teacher attitudes about Digital-Age Learning Experiences & Assessments	Subscale4				Digital-Age Learning Experiences & Assessments	Teacher preparation for student instruction and assessment. (Mehta, 2011).
Dependent Variable: Level of technology integration	Subscale: LoTi (Appendix G)					

Kohl-Blackmon (2013) reported that the overall reliability coefficient of the LoTi questionnaire is .94, with each subscale's reliability ranging from .59 to .86 , agreeing with research by Griffin (2003), meaning that the reliability measures of this survey indicate that the LoTi questionnaire is a reliable instrument for measuring LoTi. Each subscale score of LoTi is generated by program, given the subscale's reliability range from the respondents' answers.

The LoTi questionnaire included four constructs proposed to be measured by the Digital-Age Survey (Mehta, 2011): professional growth and leadership, digital age work and learning, digital-age learning experiences and assessments, and digital citizenship and responsibility. Digital age work and learning refer to student learning and creativity, and application to global environments. Digital citizenship and responsibility refer to technology use and application to global communities. Digital age learning experiences and assessments refer to teacher preparation for student instruction and assessment. Professional growth and leadership refer to content on PD opportunities accessible to teachers. Analyses in Chapter 4 indicated that the correlation of the sub scales to the dependent variable as statistically moderate, which denotes a medium to high independence.

Some sample questions from the LoTi that related to my RQ include (Appendix A) the following:

- educator digital device frequency: Approximately how often do you use digital devices (e.g., laptops, handheld devices, Document cameras, and Interactive whiteboards) to do your job as an educator?
- hours digital device staff development: How many hours of digital device-related staff development have you received over the past 5 years?
- content-related digital device staff development: Which statement best describes the content of your digital-device related staff development?
- teacher computer use: How often are you (the teacher) using digital tools and resources during the instructional day?

- greatest obstacle: What do you perceive as your greatest obstacle to expanding your use of digital devices and resources in your instructional setting?

After the participants completed the survey, the completed survey data were sent back through the internet to my private email account for compilation. A secure email system through the school district with advanced password technology backbone supported the confidential input of data by the participants. Survey data were examined with respect to the relationship between teachers' attitudes towards integration and technology use in the teachers' classroom.

Data Analysis Plan

After data collection, I investigated variables that were hypothesized to affect the relationships between teachers' attitudes in the integration of educational technology in the classroom. Descriptive statistical analysis of the data including the mean and standard deviation are conducted using SPSS Statistics. Lodico et al., (2010) asserted that most quantitative studies use descriptive statistics to help reveal patterns in the data. Each of the individual items is analyzed in a descriptive manner using central tendency and frequency distribution of the data, to show patterns and trends. Data were analyzed to gain insight into the relationship between the amount of PD and teacher's implementation of technology integrated instruction.

The following RQ, null hypothesis, and alternative hypothesis guided this research:

RQ: What is the relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration?

H_0: There is no statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

H_a: There is a statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

The data analysis plan consisted of examining, categorizing, tabulating, or otherwise recombining the results, to address the initial propositions of this study. I used descriptive statistics for the survey responses to describe each construct. Methods used in this research consisted of the LoTi technology use survey and different quantitative measures in the classroom, measuring information numerically, and relating variables in questions.

Linear Regression Analysis

A linear regression assesses the linear relationship between to continuous variables to predict the value of a dependent variable based on the value of an independent variable (Laerd Statistics, 2023). According to Laerd Statistics (2023), linear regression must meet five assumptions: (a) There should be a linear relationship between the dependent and independent variables; (b) there should be independence of observations; (c) there should be no significant outliers; (d) there should be homoscedasticity, which means the similarity of variances along the line of best fit; and (e) the residuals or errors of the regression line are approximately normally distributed. These assumptions will be tested using SPSS Statistics.

To measure the relationship between the first variable: teachers' attitudes towards digital age work and learning; second variable: teachers' attitudes about professional growth and leadership, third variable: teachers' attitudes about digital citizenship and responsibility; and the fourth variable: teachers' attitudes about digital-age learning experiences and assessments, comparative analyses of participants' attitudes and LoTi levels were examined through linear regression.

I present tables to organize the descriptive data for the constructs of personal factors including attitudes towards using technology and technology usage. I use tables to provide a visual representation of the data for each construct from the survey. For each type of data collected, a descriptive statistical analysis is conducted to check for correlation to the RQ.

Threats to Validity

Several threats to internal validity existed in this research study. These threats include the potential for differences between teacher's educational levels, years of teaching experience, level of technology acumen, and numbers of PD attended. The differences between these variables could influence teacher's responses to different survey questions. Teachers from different schools may have different perspectives of technology integration due to their individual schools' level of technology integration and availability. Each site's administration may have different perspectives that may impact teachers from the site, which may subsequently impact teachers' responses. Other threats to internal validity included the timing of the survey in the school year. Threats to external validity include the population generalizability, which referred to the degree that the teachers from these school districts may not be representative of all teachers in the state or nationwide.

Creswell and Creswell (2017) stressed the importance of measurement validity including its reliability and construct validity, which is the degree to which inferences can legitimately be made. Research by Martin (2019), Booker (2017), Mitchell (2019), and Mehta and Hull (2013) utilized LoTi based on its measurement validity and reliability. Independence of the subscales may be a threat to internal validity.

Ethical Procedures

My role is to present and gather surveys. I am a teacher at one of the high schools included in this research. Because the participants were teachers, there were no supervisory or instructor relationships involving power or coercion. I had a neutral role and remained detached, and an active, interested learner. As an observer in classrooms or in computer laboratories, I am a non-participant but an objective and impartial observer. Potential bias is accounted for by utilizing a survey instrument that is evaluated for both reliability and validity. Correctional analyses were used to determine the authenticity and veracity of the results. Social desirability bias is accommodated by using standardized questions that relate directly to what the teachers experience with technology on a daily basis. These survey questions are intended to elicit responses that project the respondents' professional perspectives.

I used my Walden University e-mail address to provide participants with a letter explaining the study and notifying them of their rights to participate in the study. I sought authorization from the school district office, the respective school administrations, the individual participants, and the Walden University's IRB. Data collected were safely stored within my password-protected personal computer and backed up in a secure external flash drive. Participants cannot be identified by the records containing research data. Information and data are stored in my computer and a separate USB drive in a locked fireproof safe box, for 5 years as per Walden University's IRB policies.

The ethical protection utilized in this study is concurrent with the appropriate ethical standards referenced in the American Psychological Association (2022) guidelines. The study is conducted with professionals in an educational setting with ample structural cues. I obtained permission from the IRB to conduct the applicable research required in this study, while protecting the human interests of each participant.

Confidentiality is deliberated upon and aptly addressed at the onset of every data and information collecting occurrence. Subjective and acceptable authorizations and consents were granted to me by all participants. Each school administrative personnel, including Assistant Principals and Principals consent to the permissions. The participants in this study have the following rights accorded to them: a right to confidentiality; a right of refusal or acceptance to participate; a right to opt out at any time in the process, even after initial agreement to participate; a right to be aware of what will occur; and a right to understand what their responsibilities and expectations were.

All contributions in this study were voluntary in nature and freely exercised by all participants. Contacts with participants are professional and the working relationship is objective and respectful of the professional environment therein. The study modalities are ethical and conducive to a quantitative research study. Confidentiality of participants, their inputs and data collected, is strictly enforced and upheld. The participants' identities are closely guarded and respected by me. Conducting a study in my own work environment with its attendant conflict of interest is a challenge that is ever-present but respected and addressed, with the highest professionalism and objectivism.

According to Aytug et al., (2019), conflicts of interest are unavoidable and vary in significance, but because they had a natural tendency to create preconceptions and biases about, or otherwise influence the thinking and behavior of investigators and authors, it is essential that conflicts are managed appropriately and transparently. Furthermore, when a researcher conducting a study works with some of the participants in the study, the researcher and the IRB need to be particularly vigilant about disclosing conflicts of interests or other commitments.

Summary

Quantitative data in the form of LoTi survey were used to provide data for this quantitative research study. Survey answers were recorded and coded with coded data analyzed and generalizations extrapolated. The methodology tackled numerous factors pertinent to this study. The context of this study including my role as the researcher, selection criteria for participants, instrumentation, data collection and analysis were all presented and cumulatively contributed to an objective and logical research study.

Chapter 4 will include the analyses of the data collected utilizing the data collection instruments espoused and explained in this chapter. The RQ set the stage for this research and is analyzed and synthesized in Chapter 4. Chapter 5 will present objective interpretations, analyses, and clarifications of the data collected for this quantitative study.

I appropriate deference in designing, collecting, and recording the results of this study to maintain the highest standards of validity and ethical standards. Importance is attached to the potential social change emanating from this study. Attention to the welfare and confidentiality of willing participants, respective research sites, and potential readers is of utmost significance (Creswell, 2013).

Chapter 4: Results

Introduction

This chapter outlines the data collection process and statistical analysis findings related to the RQ and formulated hypotheses. The purpose of this correlational quantitative study was to investigate if there are statistically significant and meaningful relationships among teachers' attitudes about professional growth and leadership, digital age work and learning, digital-age learning experiences and assessments, digital citizenship and responsibility, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools.

To complete inferential analysis of PD for technology integration for mathematics teachers in low SES schools, the following RQ, null hypothesis, and alternative hypothesis were examined based on surveys of participants:

RQ: What is the relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration?

H_0: There is no statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

H_a: There is a statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

This chapter includes the timeline for data collection, treatment reliability, examination of the results, and the summarization of the answers to the RQ. This chapter also includes descriptive statistics, statistical analysis organized by the RQ and/or hypotheses, and findings that reflected any additional statistical tests of hypotheses that emerged from the analysis of main hypotheses.

Data Collection

The LoTi Digital Age Survey, an online survey, was used in this research. The survey focused on teacher attitudes and instructional practices using digital tools and resources that collectively had the greatest influence on student achievement and success in the classroom (Learning Quest, Inc. 2013). The LoTi Digital Age Survey generated a customized set of resources and strategies for each participant based on the LoTi, H.E.A.T., and digital age best practices frameworks (see Chapter 2 for a discussion of each framework). Each set of resources/strategies, in essence, represents a personalized PD growth plan for each individual targeting digital age literacy, classroom pedagogy, and student achievement. The survey took approximately 15 to 20 minutes to complete.

Data collection occurred in two batches. The first batch of 35 completed surveys were collected between February and May 2018. Because teachers from different districts were invited to participate, it was imperative to reach the teachers before they left for the summer break. Email reminders were sent followed by phone calls to school principals. The principals promised to contact the teachers and pass on the information. There was a stretch when there were no inputs from teachers. At the end of the summer of August 2018, there was another push through emails and phone calls, and 45 completed surveys were collected.

I observed that some teachers were hesitant to take the online survey because of the time-consuming procedure of signing in and taking the online survey. After consultations with my mentor and subsequently with the provider of the survey, it was decided that the sign-in procedure had to be relaxed. I used Survey System (https://www.surveysystem.com/sscalc.htm#one) to calculate the sample size for this study, which was 80 teachers from the intended sample size of 100, from the population of 320 mathematics teachers.

Descriptive and Demographic Characteristics

The study was conducted in five school districts (> 50,000 students) in a large suburban area in the western United States. More than 80% of students in this area are economically disadvantaged. Nearly 40% of students have limited English proficiency. Students in the district speak more than 40 different languages at home. The districts have approximately 3,100 noninstructional staff and 2,400 teachers, with 98% of teachers meeting the federal requirement of highly qualified. More than 50% of teachers in the districts have 10 or more years of experience teaching.

The initial portion of the survey gathered demographic and descriptive data pertaining to participants' years of teaching experience and description of the teacher's classroom's digital infrastructure. The selection criterion to participate in this study was to be a mathematics teacher in a Title 1 high school ; there was no question to ascertain their subject taught and grade levels taught. The teachers' years of teaching experience ranged from less than 5 years to more than 30 years. Teachers with 10 to 20 years' experience had the highest representation in the survey. Demographic information for the sample can be found in Table 3. Table 4 shows some demographic data of the participants, including race, gender, and age.

Table 3

Years of Teaching

Response	Number of staff	Percent of total
Less than 5 years	20	25%
5 to 9 years	13	16%
10 to 20 years	31	39%
More than 20 years	16	20%

Note. *N* = 80.

Table 4

Demographic Data

Demographic data	*N*	Percentage
Race		
African American	13	16%
Asian	8	10%
Hispanic	20	25%
White	35	44%
Other	2	2.5%
Two or more races	2	2.5%
Gender		
Male	31	39%
Female	49	61%
Age		
21-30	15	19%
31-40	28	35%
41-50	20	25%
51 or over	17	21%
Prefer not to answer	0	0%

A comparison of this study's demographic data with the county's demographic data from a major school district indicated that the average teaching experience in the county was 12 years, compared to most teachers in this study (31) having 10 to 20 years teaching experience. Race demographics were closely aligned: African American: study (16%) vs. county/district (12%); Asian: study (10%) vs. county/district (10.8) White: study (44%) vs. county/district (7.7%); Hispanic: study (25%) vs. county/district (14%). Gender- female: study (61%) vs. county (73.4%); Male: study (39%) vs. county (26.6% ; https://dq.cde.ca.gov/dataquest/ and http://www.cde.ca.gov/ds/sd/df/). Based on the study sample of 80 teachers, the county/district teacher population of 1,693, and the closely aligned demographic percentages, the study sample appears to be representative of the population.

This study's population size was 320 mathematics teachers. The sample size of mathematics teachers in Title 1 high schools invited to participate was 100 teachers. The number of teachers who agreed to participate and complete the survey were 80, which is 80% of the of those recruited. This discrepancy may have occurred due to constraints of grading periods in various districts, staff development, scheduling, and mandated state testing. Many teachers expressed interest in completing the survey but were unable to due to competing priorities and other responsibilities.

The sample of 80 participants is representative of the population of mathematics teachers in Title 1 high schools, in area comprehensive high schools. Thus, part of the demographics of this sample is that they all taught high school mathematics, and another demographic was that all the teachers were high school teachers from ninth to 12th grades.

Results

In order to grasp a better picture of the factors that may play a role in the integration of technology and increased usage in the classroom, the data analysis determined if the integration of technology in the classroom was based upon the relationship between teacher's attitudes about professional growth and leadership, digital age work and learning, digital-age learning experiences and assessments, digital citizenship and responsibility, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools.

An analysis of the quantitative data generated by the LoTi Digital-Age Survey was evaluated by the online LoTi Connection software and presented scores for the demographic questions, group LoTi. I examined these data, and although it appeared pertinent and appropriate to the participants' respective school districts, they were not relevant to my RQ. Data from the survey participants were gathered by LoTi Connection and transmitted electronically to me for analysis. The data were imported into SPSS Statistics for further analysis and to address the RQ. I derived the subscale scores from the survey data gathered by LoTi Connection. Assuming the dependent variable (level of technology integration) was a continuous measurement scale, then a single multiple regression model was appropriate. In this research, the sample of teachers were selected by convenience. Shapiro-Wilk's test (p = .093) indicated the differences passed the test for normality (p < .05 ; Shapiro & Wilk, 1965).

RQ: What is the relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration?

H_0: There is no statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

H_a: There is a statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

Based on the results of this online survey, the median level of technology innovation is a Level 2: Exploration, with 37.5% of respondents falling in this category. Table 5 displays the LoTi framework.

Table 5

Level of Teaching Innovation (LoTi) Framework

LoTi level	Description	*N*	Percent
LoTi 0: Nonuse	The instructional focus may vary; does not support or promote purposeful learning aligned to academic standards/expectations.	8	10.0%
LoTi 1: Awareness	The instructional focus is exclusively direct instruction. Digital and/or environmental resources are either (1) non-existent or (2) used by the classroom teacher to enhance teacher presentations.	22	27.5%
LoTi 2: Exploration	The instructional focus emphasizes content understanding and supports mastery learning and direct instruction. Students use digital tools and resources to generate multimedia products that showcase content understanding.	30	37.5%
LoTi 3: Infusion	The instructional focus emphasizes student higher order thinking. Students use digital resources to solve teacher-directed problems related to the content under investigation.	14	17.5%
LoTi 4a/4b: Integration	The instructional focus is on students engaging in exploring real-world issues and solving authentic problems using the available digital and/or environmental resources, to answer student-generated questions that dictate the content, process, and/or products.	0	0.0%
LoTi 5: Expansion	The Instructional focus emphasizes global student collaboration to solve world issues, using digital tools and	0	0.0%

LoTi level	Description	*N*	Percent
	resources for authentic problem-solving opportunities beyond the classroom.		
LoTi 6: Refinement	The instructional curriculum is entirely learner-based involving the content, process, and product of instruction.	1	1.3%

To measure the relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration, comparative analyses of the independent variables and LoTi levels were examined and compared. The confidence interval gives an estimated range of values which is likely to include an unknown population parameter, the estimated range being calculated from a given set of sample data (Cumming et al., 2012). Confidence level is constructed at a confidence level, such as 95%, which means a researcher can be 95% certain contains the true mean of the population being researched.

A multiple regression is used to predict a continuous dependent variable based on multiple independent variables (Laerd Statistics, 2023). Furthermore, multiple regression permits the researcher to determine the overall fit of the variables and the comparative impact of each of the independent variables to the total variance. The multiple regression helps to determine how much of the variation in the dependent variable is explained by the independent variables. A multiple regression for the RQ was conducted using SPSS

Statistics to predict LoTi (dependent variable) from subscale scores (independent variables) of Subscale1Mean, Subscale2Mean, Subscale3Mean, and Subscale4M (Table 2).

To check for relationships among the responses from the survey, the Durban-Watson statistic for the analysis indicated 2.311 (see Figure 1). According to Laerd Statistics (2023), the Durbin-Watson statistic can range from 0 to 4, with value of approximately 2 indicating no correlation between residuals. This analysis value is slightly above 2, which can denote that there is independence of residuals, as assessed by Durbin-Watson statistic of 2.300.

Figure 1

Model Summary: Durban-Watson

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.684[a]	.468	.439	.875	2.300

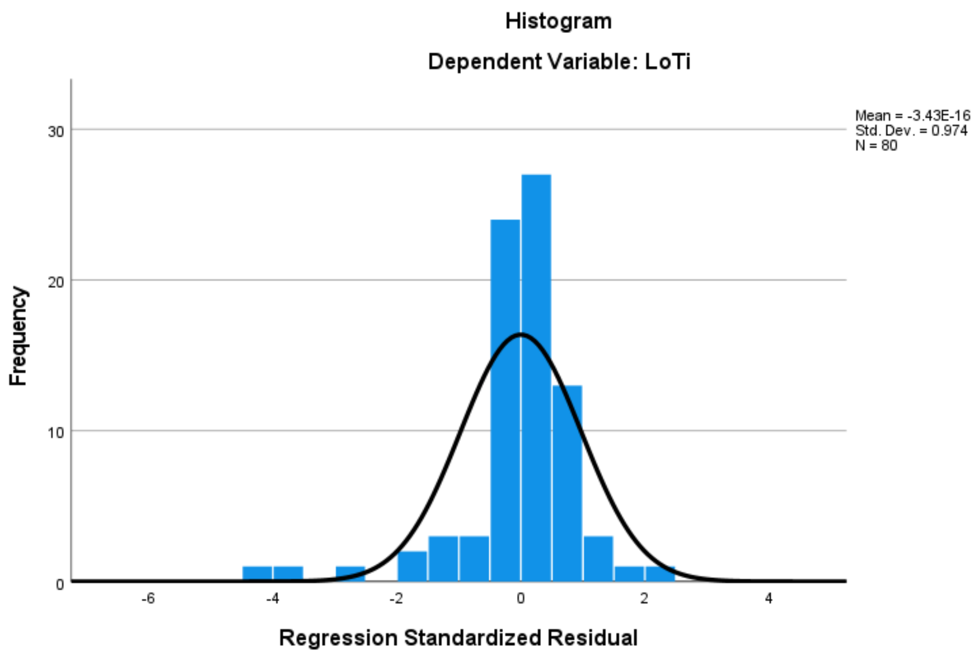
a. Predictors: (Constant), SubScale4MEAN, SubScale3MEAN, SubScale1MEAN, SubScale2MEAN

b. Dependent Variable: LoTi

To check for normality, the residuals need to be normally distributed. According to Laerd Statistics (2023), two common methods are normally used in SPSS Statistics to check for normality. A histogram with superimposed normal bell curve and a P-P Plot (Figure 2) can be used to check for normality. The mean and standard deviation should have values of approximately 0 and 1, respectively.

Figure 2

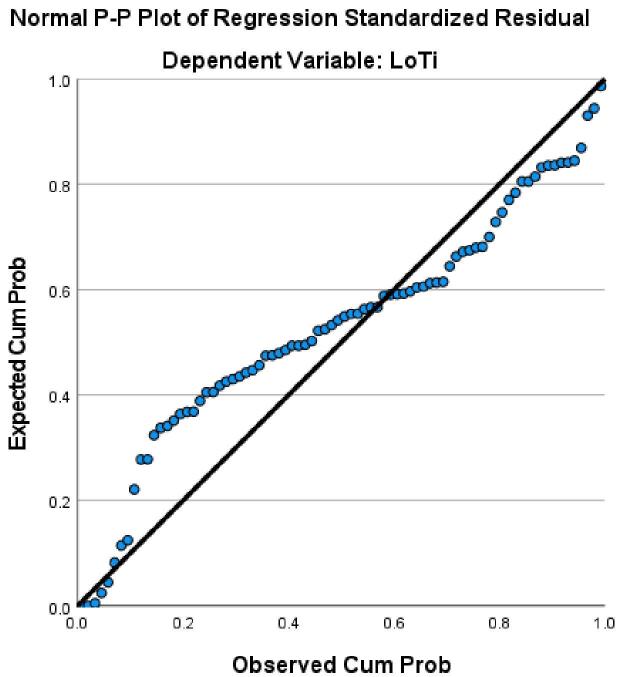
Histogram



The second method is the Normal Q-Q Plot of the Studentized residuals in Figure 3.

Figure 3

Normal Q-Q Plot of Regression Standardized Results



Based on normal bell curve of the Histogram (Figure 2) and the close but not perfect alignment of the points along the diagonal line (Figure 3), both distributions were approximately normally distributed to indicate that the residuals were close enough to normal for the analysis, to satisfy the tests for normality. In interpreting the results of the SPSS Statistics analysis, Laerd Statistics (2023) highlighted that there were three main objectives to achieve, including defining the share of the variation in the dependent variable supported by the independent variables. The second objective is the ability to predict the dependent variable values based on new values of the independent variables. The third objective is to determine how much the dependent variable changes for a one-unit change in the independent variables.

After running the multiple regression procedure and testing that my data met the assumptions of a multiple regression, SPSS Statistics generated information that I used to determine whether the multiple regression model is a good fit for my data. The first output to consider is the multiple correlation coefficient (*r*) found in the Model Summary table in Table 6, which is the scores predicted by the regression model (or the predicted scores) and the actual values of the dependent variable (LoTi scores). According to Laerd Statistics (2023), *r* is a measure of the strength of the linear association between these two variables and can give an indication of model fit. The value of linear association range from 0 to 1, with higher values indicating a stronger linear association. The value of my testing indicated 0.684, which implies a moderate level of association.

Another method of assessing model fit is the coefficient of determination or r^2. According to Laerd Statistics (2023), this is a measure of the proportion of variance in the dependent variable that is explained by the independent variable, over and above the mean model. The value of r^2 is presented in the "r Square" column in the Model Summary table (Table 6). The r^2 is equal to .468. This means that the addition of all my independent variables into the regression model explained 46.8% (0.468 x 100 = 46.8%) of the variability of my dependent variable (LoTi scores) compared to the mean model. This is considered to be a moderate starting measure to understanding results (Draper & Smith, 1998). The *r*-squared value of 46.8% also indicates that a moderate amount of variance in the dependent variable is explained by the independent variables, thus there is a moderate data fit for the model.

On the Model Summary (Figure 1), the adjusted r^2 is 0.439 or 43.9%, which is another measure that corrects for the positive bias of the r^2 so as to provide a value that would be expected in the population. r^2 for the overall model is 46.8% with an adjusted r^2 of 43.9%, a moderate size effect according to Cohen (1988).

The statistical significance of the overall model, containing all independent variables is presented in Figure 4.

Figure 4

ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	50.512	4	12.628	16.478	<.001[b]
	Residual	57.475	75	.766		
	Total	107.988	79			

a. Dependent Variable: LoTi

b. Predictors: (Constant), SubScale4MEAN, SubScale3MEAN, SubScale1MEAN, SubScale2MEAN

The "Sig" value is <.001, which means that $p < .001$. If $p < .05$, then this is a statistically significant result. Accordingly, the addition of all independent variables lead to a model that is statistically significantly better at predicting the dependent variable than the mean model. This also implies that there is a statistically significantly better fit to the data than the mean model. The result is reported as follows: $F(4, 75) = 16.478$, $p < .001$. Table 2 sub scales means statistically significantly predicted LoTi, $F(4, 75) = 16.478$, $p < .001$.

A multiple regression was run to predict LoTi from survey questions (Table 2). There was linearity as assessed by partial regression plots and a plot of studentized residuals against the predicted values. There is independence of residuals, as assessed by a Durbin-Watson statistic of 2.300. There is homoscedasticity, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. There is no evidence of multicollinearity, as assessed by tolerance values greater than 0.1. The assumption of normality is met, as assessed by a Q-Q Plot. The multiple regression model statistically significantly predict LoTi $F(4, 75) = 16.478$, $p < .001$, adj. $R^2 = .468$.

Based on my findings, there is a statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration. The percentage of variance that was accounted for by the equation or coefficient of determination, in my findings, the R-squared is equal to .468. This means that the addition of all my independent variables into the regression model explained 46.8% (0.468 x 100 = 46.8%) of the variability of my dependent variable (LoTi scores) compared to the mean model. This is considered to be a moderate starting measure to understanding results (Draper & Smith, 1998).

Summary

The purpose of this correlational quantitative study is to investigate if there are statistically significant and meaningful relationships among teachers' attitudes about professional growth and leadership, digital age work and learning, digital-age learning experiences & assessments, digital citizenship and responsibility, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools. This study's population of mathematics teachers in Title 1 high schools consisted of 100 teachers. The number of teachers that completed the survey were 80, which is 80% of the study population.

Multiple regression analysis is conducted on the RQ to predict the strength of the dependent variable LoTi from the sub scales. The multiple regression model statistically moderately predicted LoTi from the sub scales. All independent variables added statistically moderately to the prediction, with $p < .05$. Regression coefficients and standard errors were also calculated using SPSS Statistics. The corrected correlation coefficients showed that the significance <.001 were less than .05, which meant that there were statistically significant differences between the dependent variable of LoTi level and the sub scales or independent variables. Based on my findings, there is a statistically significant and meaningful relationship between teachers' attitudes toward digital-age work and learning, attitudes about professional growth and leadership, attitudes about digital citizenship and responsibility, attitudes about digital age learning experiences and assessments, and their level of technology integration.

Chapter 5 will present objective interpretations, analyses, and clarifications of the data collected for this quantitative study. Analysis and interpretation of the findings in the context of the theoretical framework will be presented. Recommendations for future research and implications for social change will be presented.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this correlational quantitative study was to investigate if there were relationships among teachers' attitudes about professional growth and leadership, digital age work and learning, digital-age learning experiences and assessments, digital citizenship and responsibility, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools.

The nature of this study was a quantitative correlational survey research method. Skilling and Stylianides (2020) defined quantitative research as research that explains phenomena according to numerical data that are analyzed by means of mathematically based methods, especially statistics. This study used an empirically validated quantitative survey with multiple-choice Likert scale response items. Data came from the LoTi Digital Age Survey (Appendix A) developed by an educational consortium: Learning Quest, Inc. This instrument was chosen because it had been tested for both reliability and validity of the whole instrument (see Stoltzfus, 2009). It also accurately measured levels of teacher's attitude and perception in integrating technology into the classroom.

I conducted this study because there appeared to be a dearth of research to address technology integration PD for Title 1 low SES school mathematics teachers. Research by Wager and Foote (2013) and Anthony and Clark (2011) were among the few that dealt with this topic. These studies illuminated teachers' dilemmas and coping strategies in their efforts to integrate technology in mathematics classes in Title 1 low SES schools. The problem addressed in this research study was to better understand the relationships among teachers' attitudes about professional growth and leadership, digital age work and learning, and digital- age learning experiences and assessments, and their level of technology integration.

The descriptive analyses in this study addressed the representativeness of the study sample. When I compared my sample of 80 mathematics teachers with the population, the result showed that the sample was reasonably representative of the population. Results of multiple regression analysis for the RQ revealed a statistically moderate and meaningful relationship between teachers' attitudes toward digital-age work and learning and their level of technology integration. The statistical analysis for the RQ also indicated a statistically moderate and meaningful relationship between teachers' attitudes about professional growth and leadership and their level of technology integration.

Furthermore, the multiple regression analysis for the RQ indicated a statistically moderate and meaningful relationship between teachers' attitudes about digital citizenship and responsibility and their level of technology integration. This indicates that there is a statistically moderate and meaningful relationship between teachers' attitudes about digital citizenship and responsibility and their level of technology integration.

The multiple regression analysis for the RQ indicated a statistically moderate and meaningful relationship between teachers' attitudes about digital age learning experiences and assessments and their level of technology integration. *R*-squared , also known as the coefficient of determination, is the statistical measure that indicates the proportion or variance in the independent variable that the independent variables were able to influence. In my findings, the r^2-squared was equal to .468. This means that the addition of all my independent variables into the regression model explained 46.8% (0.468 x 100 = 46.8%) of the variability of my dependent variable (LoTi scores) compared to the mean model. This is considered to be a moderate starting measure to understanding results (Draper & Smith, 1998).

In this chapter, I analyze and interpret the findings from the statistical evaluations performed. This chapter also includes discussions of the limitations of the study and suggests recommendations for further research, implications for positive social change, description of recommendations for practice, the potential impact of the study findings on all appropriate stakeholders, and the conclusion of the study.

Interpretation of the Findings

The analysis of the data was conducted in Chapter 4; therefore, this section provides an interpretation of the trends seen in the data collection and data analyses. The RQ results appear consistent with research by Baturay et al. (2017) and Mitchell (2021), who found a positive relationship among teachers' attitudes toward digital-age work including computer-assisted education and their level of technology integration. The strength of the relationship in this study between teachers' attitudes toward digital-age work and learning and their level of technology integration is comparable to the relationship in the two studies.

Granziera and Perera (2019) suggested that beliefs about teaching and technology, established classroom practices, and reluctance to change are related to teachers' use of technology. The RQ finding in this research appears to align with the result of research by Atabek (2020), which suggested that attitude and self-efficacy seem to play a determinant role in teachers' acceptance and actual use of technologies in the classroom. More positive attitude towards educational technology may prepare teachers to better implement educational technology in learning environments (Abbitt, 2011). Abbitt (2011) further suggested that attitudes towards "improving oneself in using technology in education" was the strongest predictor of self-efficacy for using educational technology and modelling digital age work and learning.

Conversely, the RQ finding is inconsistent with research by Bakar et al. (2018), Gibson et al. (2014), and Li (2007) which suggests that attitude towards using technology is a barrier to technology integration for teachers. My study disconfirmed the results of Bakar et al. (2018) and Li (2007) because the researchers observed that teacher's educational technology anxiety affected self-efficacy, slow pace of adoption, and attitude towards using technology and technology integration in their classrooms. Research by Bakar et al. (2018) did not sustain the role of PD in the self-efficacy of teachers in their integration of technology in their classrooms.

The result revealed a positive correlation between the LoTi levels and teachers' attitudes about professional growth and leadership and their level of technology integration. This is consistent with research by Baldwin (2011), who showed that teachers who spend more time in PD are more likely to use technology frequently, to implement 21st century instructional practices, and to have students using technology as part of integrated classroom instruction.

The findings on my RQ support research by Karlin et al. (2018) that successful implementation of education technologies depends upon extensive, high-quality teacher PD, professional growth, and ongoing support. These include site-based technical support and leadership feedback to teachers, hands-on modeling instruction, and continuous articulation of new technology introduction, technology integration, and student achievement (Kormos, 2022; McComb & Eather, 2017; Torff, 2018). The strength of the relationship in this study between the LoTi levels and teachers' attitudes about professional growth and leadership and their level of technology integration is similar to the relationship in these studies.

The result revealed a positive relationship between teachers' attitudes about digital citizenship and responsibility and their level of technology integration. The findings suggested that teachers integrate technology in their classroom instruction because they are inclined to keep abreast of educational technology, improve their digital citizenship and responsibility, and improve their proficiency. This confirms research by Ertmer et al. (2012), who found that teachers with student-centered beliefs were more inclined to develop and use curriculum that align to student-centered instruction irrespective of the technological barriers.

My RQ results also appear consistent with research by Šumak et al. (2017), who observed that technology training that focuses on helping teachers develop their technology skills, regardless of past experiences, with effective learning, increases their acceptance and utilization of technology. Because studies by Martelli (2017) revealed that digital citizenship as a multidimensional and complex concept is a relatively new approach, my study complements and adds to the knowledge base of the relationship between teacher's attitudes about digital citizenship and their LoTi.

Moreover, my findings appear to extend the study by Choi et al. (2018), who advocated the need for policy makers to engage teachers as responsible, informed, and engaged digital citizens in a globalized and networked society, by offering PD and other resources that can assist teachers to increase and improve their level of technology integration. Further the study supports my research with the idea that a meaningful relationship exists between teachers' attitudes, self-efficacy towards the effective use of digital technologies, and further developing roles and responsibilities of a digital citizen.

The findings revealed a positive relationship between teachers' attitudes about digital age learning experiences and assessments and their level of technology integration. The result suggests that teacher's experiences from PD, peers, PLCs, and other effective resources avail teachers that opportunity to improve and increase their level of technology integration. My findings aligned with research by Stewart (2019) and Gutierez and Kim (2017), which revealed that PDs can lead to organizational improvements in the areas of collaboration, providing the means for continuous improvement for teaching and student learning, and shared data-driven strategic decisions. This also aligned with the study by Lee et al. (2018), who suggested that teachers' digital-age learning experiences can lead to constructive structures and strategies that would accelerate technology integration and alignment with curriculum.

My findings in the RQ also support Meeuwse and Mason (2017), who found that PD provides opportunities for teachers to increase experience, improve attitudes, and examine their own teaching strategies in order to positively implement technology integration. Accordingly, there appears to be a meaningful relationship between teachers' digital-age learning experiences, including PD, seminars, other learning opportunities, and an increase in the level of technology integration. Further, Kopcha et al. (2020) supported the idea that proposing activities that align with the principles of effective PD learning experiences may be a critical step toward long-term changes in teacher perceptions, attitudes, and practice. Thus, teacher PD is vital in the management of technology integration in teaching and learning.

Theoretical Framework

This quantitative study was premised under the social cognitive learning theory (Bandura, 1991) and provided a framework for understanding stages of teacher's adoption of technology. In this context, teachers, through modeling and observing others, adopt a particular innovation, and, over time, may be more inclined to consider adoption themselves. Accordingly, social learning not only influences the decision whether to adopt technology into the classroom but expands the possibilities to include technology integrated curriculum and student-centered learning classroom environment. According to Bandura (1986), ‘‘ Within the model of triadic reciprocality, action, cognition, and environmental factors act together to produce changes’’ (p. 521).

The component self-efficacy beliefs refer to the extent and confidence to which individuals engage in activities that they believe they can control, as well as factors that guide their actions in attaining a specific goal (Perera & John, 2020). Bandura (1989) advanced that self-efficacy beliefs serve as an important “set of proximal determinants of human motivation, affect, and action” (p. 1176). Specifically, in this study, self-efficacy referred to the individual teacher’s judgement of their competencies to consolidate knowledge and understanding, from participating in PD to attain proficiency in technology integration in the classroom. According to Iqbal et al. (2021), the cognitive approach focuses on making knowledge meaningful and helping learners organize and relate current information to prior knowledge in memory.

The findings of PD and technology integration for mathematics teachers from this study aligned with social cognitive theory, as it involves an environment of collaboration and inquiry. The findings are immersed in a learning-oriented and progressive growth approach that uses each teacher’s knowledge, beliefs, and practical experiences to construct meaning and understanding that can be beneficial to all stakeholders for sustained improvement.

The findings of PD and technology integration for mathematics teachers of this study interpreted through the context of the theoretical framework was built upon a constructivist foundation. PD sessions and activities are constructivist in nature because they are built on learning and sharing ideas and experiences, to arrive at a common purpose , including improved student learning outcomes, common lesson plans, solving problems, and improved school environment. Findings from the RQ reflect a constructivist underpinning where teachers undergo training on a concept or skill, boost their professional growth and leadership, increase their digital-age learning experiences, and practice what they learned to improve their technology integration. The attitudes of teachers towards technology had a meaningful and moderate relationship toward technology integration in their classroom. As teachers participate more in PD and increase their digital-age learning experiences, the more likely teacher's attitudes improve in the implementation of technology integration.

The social cognitive theory relates to this study through an understanding of how teachers through modeling and observing others adopt a particular innovation. Based on this adoption and with consistent trials and applications, these teachers may be motivated to increase and incorporate the application on a daily basis in classroom instruction. This relates to findings from the RQ. Moderate and meaningful relations were observed as teachers agree that participation in PD leads to professional growth and leadership and improved digital citizenship and responsibility and is more likely to increase technology integration.

Limitations of the Study

The first limitation of this study is the generalizability of the findings , which may be limited because the participants were selected because of ease of accessibility. I used only high school mathematics teachers, and there were time constraints and limited financial resources. Data in this study were collected from local comprehensive high schools in school districts located within a specific area in the state of California. The findings of this study are limited to only those situations similar to the participants within this particular setting. This limitation was evident at the onset of this study and was not minimized throughout the study. The intercorrelation of the sub scales has a positive impact on the results of the study. The sub scales appeared to sustain the study's outcomes, indicating that PD provides opportunities for teachers to increase experience, improve attitudes, and examine their own teaching strategies in order to positively implement technology integration. The intercorrelation of the subscales further indicate a positive relationship between teachers' attitudes toward digital-age work and learning and their level of technology integration.

The second limitation of this study pertained to perceptions and attitudes. A general reliance upon teacher perceptions and attitudes within the scope of this study was a limitation because perceptions may lead to multiple sources of teacher bias and may change over time. The third limitation was data collection. The data set collection was dependent upon the participants' inclination and integrity to cooperate and contribute to the study. To minimize this limitation, anonymity of respondents was sought. The fourth limitation was researcher bias. This refers to objectivity and researcher bias because I am a teacher and employed in one of the school districts. Such limitations were evident through the study but were addressed by complete disclosure throughout the study.

The fifth limitation of this study was the LoTi instrument. The use of this measurement tool is only one indicator of teacher's perceptions and attitudes towards integrating and implementing technology in the classroom. While I suggested that the LoTi is a good predictor, I also recognize that other instruments might be successful for this purpose.

The sixth limitation of this study was the generalizability of the RQ. The quantitative data were limited to public high school mathematics teachers and may not be comparable to teachers from private high schools and teachers of other subjects. Future research should build upon these findings to determine if the views of the participants in this study differ from teachers in high socioeconomic districts, in other parts of the state and county.

Recommendations for Further Research

The first recommendation for further study is to replicate the study to further investigate the integration of technology in core subjects like Language Arts and science. Constantine et al. (2017) conducted research on science teachers and how teachers' beliefs affected their technology integration in their classrooms. Ufnar and Shepherd (2019) conducted PD research on science teachers. Gore and Rosser (2022) researched a pedagogy-focused approach that cut across grades and subjects, enhanced by effective PD.

The second recommendation is to replicate the study with middle and elementary school teachers. Results from this study on high school mathematics teachers indicate that the sample Title 1 low SES high school math teachers' technology integration reveals a moderate relationship between teachers' attitudes about professional growth and leadership. Bowman et al. (2022) surveyed middle and high school teachers and showed that values facilitate the impact of PD on technology integration, to enhance their knowledge and skills in the utilization of technology as cognitive tools to support students' learning. More innovative studies need to be introduced in the middle and elementary schools to prepare both teachers and their students to improve 21st century learning skills and using technology as a learning cognitive tool.

The third recommendation is to replicate the study with larger sample size of more than 100 Title 1 low SES high school mathematics teachers. Effective technology

PD (tech-PD) has the potential to impact and shape teacher technology integration practices. This study of 80 Title 1 low SES high school mathematics teachers concentrated on suburban areas. This researcher recommends replicating the study to other areas and include more than 100 teachers. The more teachers that are involved, the more generalizable the findings will be for large schools and school districts.

The fourth recommendation is to investigate relevant topics that Title 1 low SES high school teachers need, aligned with types of PD based on their instructional technology beliefs. Studies need to be conducted that will investigate topics that are relevant to teachers as it relates to giving teachers resources to implement technology into their daily teaching skills. 21st century teaching and learning skills demand effective alignment of technology into the curriculum and teaching skills. Research by Karlin et al. (2018) contend that effective technology PD needs to consider individual teacher needs and preferences.

The fifth recommendation is to replicate the study to further investigate the integration of technology in high SES high schools versus low SES high schools. Other areas that can be studied between low and high SES schools include skills level, needs, teacher beliefs, barriers to access, wants, PD resources, technology use and integration, and school leadership. The sixth recommendation is to replicate the study to compare urban and suburban school districts to determine if the independent variables including participation in PD activities, individualized knowledge of specific technology programs, and level of technology implementation versus the dependent variables including the perceptions, attitudes, and beliefs towards technology integration in the classrooms would produce a significant result on Title 1 low SES high school math teachers' specific types of technology use that improve students' cognitive engagement.

The seventh recommendation is that further studies need to be conducted to ascertain Title 1 low SES high school math teachers' proclivity in using mobile technology and its integration into classroom teaching strategies.

Implications

Teachers need to keep pace with these technologies and work hard at integrating these technologies into their classroom lessons, because technology provides unique challenges and benefits to the teaching and learning of mathematics. (Hill & Uribe-Florez, 2020). Technology is part of social change as it is consistently changing (Burton (2018), Francom (2020), and Norton et al., (2019). According to Bowman et al., (2022), Backfisch et al., (2021), Yildiz Durak (2021), and Young, et al., (2019), educators should engage in consistent PD to improve their skills in technology.

This study promotes positive social change as it benefits teachers, administrators, school districts, the community, and students. This research sought to contribute to an overall conceptual understanding of the nature and the importance of facets of social capital in affecting the knowledge sharing in Title 1 low SES high school math communities. The study contributes to social change by partially filling a gap in literature by synthesizing teachers' attitudes towards digital-age work and learning, professional growth and leadership, digital citizenship and responsibility, and digital-age learning experiences and assessments, and their level of technology integration.

This study findings may inform educators about their technology integration strengths and deficiencies. With a stronger understanding of technology integration practices, awareness of innovative strategies may increase teacher participation in technology PD workshops which will subsequently produce technology-literate teachers that will be more effective in producing technology-literate students, ready for the 21st century education demands. Other practical contributions of this study include helping school leaders to find ways to effectively integrate computers in their classrooms, including incorporating student-centered curriculum.

This study addresses a gap in the research base required to address which variables can predict teachers' attitude and propensity to utilize and integrate technology into their classroom and curriculum. Findings from this study may partially fill the gap to include teachers in low SES schools being empowered with future staff development strategies, better quality training, providing resources, and assisting these schools provide productive and collaborative environments to facilitate teachers' improved use of technology in the classroom. This study's findings of mathematics teacher's use of PD to improve their technology integration in their classrooms add to the overall literature, including other research being conducted to achieve school-wide technology implementation and integration into the classroom. Positive social change will be amplified when there are benefits in the fields of educational technology, instructional technology, and productive teacher PD.

The implications are that teachers and other stakeholders in the education spectrum have a responsibility to work together to achieve a common goal of more robust educational technology integration in classroom instruction. According to Johnson (2021), it was imperative for educators to promote higher order thinking while achieving high levels of technology performance because a technology-rich learning and teaching environment has a positive outcome on students' higher order critical thinking skills.

Theoretical implications for positive social change are predicated on the Social Cognitive Learning theory (Bandura, 1991), which provides a framework for understanding stages of teacher's adoption of technology. Social learning not only influences the decision whether to adopt technology into the classroom but expands the possibilities to include technology integrated curriculum and student-centered learning classroom environment. This system aligns with positive social change because teachers acquire and adopt skills that enable them to integrate technology into their lessons, which in turn challenges and prepares their students to excel in the new technological frontier. The student-centered learning environment challenges students to improve and utilize higher order critical thinking skills in their learning process. This creates positive social change as it prepares both teachers and students to succeed and excel in the ever-changing technological paradigm.

Recommendations for Practice

The first recommendation for practice is that school districts should lessen the pressure and intimidating presence of technology by presenting technology in a non-threatening manner (Ertmer, 1999), and allow teachers to "play around and get a feel" of the technology and get acquainted before introducing the specific program. This recommendation support findings from the RQ of this study which indicate that increased self-efficacy and positive attitudes toward digital-age work and learning share a meaningful relationship to technology integration by Title 1 low SES high school math teachers.

The second recommendation for practice is that diverse uses of technology should be incorporated that challenge and build up critical thinking skills in any technology development training for math teachers. This recommendation support findings of the RQ which reveal a statistically significant relationship and likelihood that math teachers' attitudes about digital citizenship and responsibility, moderately affect their integration of technology use in their classrooms.

The third recommendation for practice involves providing several types of PD for math teachers that lead to greater technology integration including online PD, interactive technology workshops, PLC workshops, and college affiliated credit courses. This recommendation support the findings of the RQ which reveal a strong likelihood that math teachers' attitudes about professional growth and leadership had a moderate and meaningful relationship to their integration of technology.

The fourth recommendation is that school districts should provide objective evidence of policies and procedures designed to alleviate the uncertainties of technology integration and the development of best practices for technology integration practices, for math teachers. This recommendation supports the findings of the RQ which reveal that math teachers have a positive and meaningful attitude about digital-age learning experiences and assessments that school districts could further develop and align with best practices. When school districts provide objective policies that align with Title 1 low

SES high school math teachers' beliefs, attitudes, and digital-age learning experiences, these teachers will more likely implement and integrate technology.

The fifth recommendation for practice is that school districts should offer and monitor PD with real-time software that tracks math teacher's technology usage and student achievement, and regularly evaluate the software's efficacy through collaborative efforts of both math teachers, school personnel, students, and other stakeholders. This recommendation supports findings from the RQ of this study which indicate that self-efficacy and outcome expectation share a significant and meaningful relationship to technology integration by math teachers. An effective collaborative system between Title 1 low SES high school math teachers, school districts, and students, will provide a robust system that will enhance teaching and learning. This is consistent with prior research because the practice of PDs was seen as an intentional strategy for system-wide change (Gutierez & Kim, 2017), and increases the efficacy of teachers and administrators (Kent, 2019; Rotermund et al., 2017).

The sixth recommendation involves districts assisting their math PLC teachers with assimilation of strategies learned at PD sessions by scheduling blocks of time to study, model, reflect, and plan for integration of technology. This recommendation supports findings from the RQ which reveal statistically moderate and meaningful relationship between professional growth and the level of technology integration. Findings from this study support the idea that math teachers implement technology integration regardless of the amount of PD they receive, therefore districts should continue to provide workshops and resources for Title 1 low SES high school math teachers for effective collaboration.

Conclusion

The purpose of this correlational quantitative study is to investigate if there were relationships among teachers' attitudes about professional growth and leadership, digital age work and learning, digital-age learning experiences and assessments, digital citizenship and responsibility, and their level of technology integration for high school mathematics teachers in Title 1 low SES schools.

Findings in this study supported by specific data in the LoTi survey by teachers, suggest that teachers' attitudes about digital-age work and learning, professional growth and leadership, digital citizenship and responsibility, and digital-age learning experiences and assessments, participation in PD, and their level of technology integration is a moderate and positive relationship.

With a constructive and well-articulated PD in educational technology, teachers can teach their 21st century learners in an environment that integrates teaching objectives that depend on the technology that the students use in everyday life. Teachers who engage in productive PD trainings and implement learned material in their classrooms, increase their students' overall success and improve their cognitive abilities. A competent technological integration in today's society means overcoming the barriers that mitigate teachers' integration of technology into the classroom for effective learning to take place.

Teachers' attitudes towards educational technology and its impact on their professional growth, experiences, learning, and leadership appears evident in the meaningful relationships between these subscales and technology integration as established in this study. The findings of this quantitative study can provide data for continued discussion on this topic and also strengthen the research literature on PD and technology integration in public high school mathematics classrooms.

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Appendix A: LoTi Digital Age Survey

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LoTi Digital Age Survey for Dissertation Studies

Version 1.11

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3

DEMOGRAPHIC Questions

Subject Specialty:
Which category best describes your primary subject area (secondary) or specialty (elementary)?

- ❑ *Math*
- ❑ *English/Language Arts*
- ❑ *Science*
- ❑ *Physical Education/Health*
- ❑ *Social Studies*
- ❑ *Library/Media*
- ❑ *Fine Arts*
- ❑ *Administration*
- ❑ *Elementary (multiple subjects)*
- ❑ *Intermediate (multiple subjects)*
- ❑ *Secondary (multiple subjects)*

Grade Level:
Which category best describes your primary grade level?

- ❑ *Pre-K*
- ❑ *Kindergarten*
- ❑ *1st Grade*
- ❑ *2nd Grade*
- ❑ *3rd Grade*
- ❑ *4th Grade*
- ❑ *5th Grade*
- ❑ *6th Grade*
- ❑ *7th Grade*
- ❑ *8th Grade*
- ❑ *9th Grade*
- ❑ *10th Grade*
- ❑ *11th Grade*
- ❑ *12th Grade*
- ❑ *Elementary (multiple grade levels)*
- ❑ *Intermediate (multiple grade levels)*
- ❑ *Secondary (multiple grade levels)*

Years Teaching:
How many years of experience do you have in education?

- ❑ *Less than Five Years*
- ❑ *Five to Nine Years*
- ❑ *Ten to Twenty Years*
- ❑ *More than Twenty Years*

Age:
What is your age group?

- ❑ *Twenty-one to Thirty*
- ❑ *Thirty-one to Forty*
- ❑ *Forty-one to Fifty*
- ❑ *Over Fifty*

Gender:
What is your gender?

- ❑ *Male*
- ❑ *Female*

Highest Level Of Education:
What is your highest level of education?

- ❑ *Bachelor's Degree*
- ❑ *Master's Degree*
- ❑ *Educational Specialist Degree*
- ❑ *Doctoral Degree*

Hardware Access:
What is the Student to Digital Device (e.g. laptops, tablets, handheld devices) ratio in your classroom?

- ❑ *No hardware access*
- ❑ *One teacher or student workstation*
- ❑ *Ten to one student/digital device ratio*
- ❑ *Four to one student/digital device ratio*
- ❑ *Two to one student/digital device ratio*
- ❑ *One to one student/digital device ratio*

Educator Digital Device Frequency:
Approximately how often do you use digital devices (e.g. laptops, handheld devices, document cameras, interactive white-boards) to do your job as an educator?

- ❑ *Daily*
- ❑ *A Few Times a Week*
- ❑ *A Few Times a Month*
- ❑ *A Few Times a Year*
- ❑ *Never*

Home Digital Device Use:
Do you have access to digital device (e.g., laptops, handheld devices) at home?

- ❑ *Yes*
- ❑ *No*

Home Computer Use:
Do you have a personal computer at home?

- ❑ *Yes*
- ❑ *No*

Hours Digital Device Staff Development:
How many hours of digital device-related staff development have you received over the past five years?

- ❑ *Daily*
- ❑ *A Few Times a Week*

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DEMOGRAPHIC Questions

Content-related Digital Device Staff Development:
Which statement best describes the content of your digital-device related staff development?

- ❑ *No staff development*
- ❑ *Specific digital device skills training (e.g., training on specific Web 2.0 applications interactive boards)*
- ❑ *Curriculum integration staff development (e.g., how digital devices can be effectively integrated into instruction).*
- ❑ *A combination of digital device skills training and curriculum integration staff development*

Guidance For Digital Device Integration:
From which individual(s) do you mostly seek primary guidance, information, inspiration, and/or direction relating to the integration of digital devices and resources into your instructional setting?

- ❑ *Students*
- ❑ *Classroom Teachers (e.g., Other Colleagues, Mentors, Peer Coaches)*
- ❑ *School/District Specialists (e.g., Media/Technology Specialist, Instructional Specialist)*
- ❑ *Other (e.g., Building Administrator, College Professor, Vendor, Conference Speakers)*

Greatest Obstacle:
What do you perceive as your greatest obstacle to expanding your use of digital devices and resources in your instructional setting?

- ❑ *Access to Digital Tools (e.g., computers, PDA's, interactive boards)*
- ❑ *Time to Learn, Practice, and Plan*
- ❑ *Other Priorities (e.g., Statewide Testing, New Textbook Adoptions)*
- ❑ *Lack of Staff Development Opportunities*

Digital Device Sharing Sessions:
Do you participate in formal or informal digital device sharing sessions, such as faculty meetings, inservice training, lunchtime discussions, before or after school meetings, professional learning communities, or common preparation time within your instructional setting?

- ❑ *Yes*
- ❑ *No*

NET-S:
How familiar are you with the National Education Technology Standards for Students (NETS-S)?

- ❑ *Have never heard of the NETS-S*
- ❑ *Have heard of the NETS-S, but have received no formal staff development*
- ❑ *Have received limited staff development on the NETS-S*
- ❑ *Have received extensive staff development on the NETS-S*

NETS-T:
How familiar are you with the National Education Technology Standards for Teachers (NETS-T)?

- ❑ *Have never heard of the NETS-T*
- ❑ *Have heard of the NETS-T, but have received no formal staff development*
- ❑ *Have received limited staff development on the NETS-T*
- ❑ *Have received extensive staff development on the NETS-T*

NETS-A:
How familiar are you with the National Education Technology Standards for Administrators (NETS-A)?

- ❑ *Have never heard of the NETS-A*
- ❑ *Have heard of the NETS-A, but have received no formal staff development*
- ❑ *Have received limited staff development on the NETS-A*
- ❑ *Have received extensive staff development on the NETS-A*

Teacher Computer Use (TCU):*
How often are you (the teacher) using digital tools and resources during the instructional day?

0 ❑ *Never*
1 ❑ *At least once a year*
2 ❑ *At least once a month*
3 ❑ *At least once a week*
4 ❑ *At least once a day*
5 ❑ *Multiple times each day*

Student Computer Use (SCU):*
How often are your students using digital tools and resources during the instructional day?

0 ❑ *Never*
1 ❑ *At least once a year*
2 ❑ *At least once a month*
3 ❑ *At least once a week*
4 ❑ *At least once a day*
5 ❑ *Multiple times each day*

** required question*

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SURVEY Questions

0 Never

1 At least once a year

2 At least once a semester

3 At least once a month

4 A few times a month

5 At least once a week

6 A few times a week

7 At least once a day

Q1: I engage students in learning activities that require them to analyze information, think creatively, make predictions, and/or draw conclusions using the digital tools and resources (e.g., Inspiration/Kidspiration, Excel, InspireData) available in my classroom.

Q4: Students in my classroom use the digital tools and resources to create web-based (e.g., web posters, student blogs or wikis, basic webpages) or multimedia presentations (e.g., PowerPoint) that showcase digitally their research (i.e., information gathering) on topics that I assign more than for other educational uses.

Q5: I assign web-based projects (e.g., web collaborations, WebQuests) to my students that emphasize complex thinking strategies (e.g., problem-solving, decision-making, experimental inquiry) aligned to the content standards.

Q6: I provide multiple and varied formative and summative assessment opportunities that encourage students to "showcase" their content understanding in nontraditional ways.

Q8: I use the digital tools and resources in my classroom to promote student creativity and innovative thinking (e.g., thinking outside the box, exploring multiple solutions).

Q10: My students identify important real world issues or problems (e.g., environmental pollution, elections, health awareness), then use collaborative tools and human resources beyond the school building (e.g., partnerships with business professionals, community groups) to solve them.

Q12: I promote, monitor, and model the ethical use of digital information and technology in my classroom (e.g., appropriate citing of resources, respecting copyright permissions).

Q13: I use different digital media and formats (e.g, blogs, online newsletters, online lesson plans, podcasting, digital documents) to communicate information effectively to students, parents, and peers.

Q14: My students propose innovative ways to use our school's advanced digital tools (e.g., digital media authoring tools, graphics programs, probeware with GPS systems) and resources (e.g., publishing software, media production software, advanced web design software) to address challenges/issues affecting their local and global communities.

Q15: I model and facilitate the effective use of current and emerging digital tools and resources (e.g., streaming media, wikis, podcasting) to support teaching and learning in my classroom.

Q16: Our classroom's digital tools and resources are used exclusively for classroom management and professional communication (e.g., accessing the Internet, communicating with colleagues or parents, grading student work, and/or planning instructional activities).

Q17: The digital tools and resources in my classroom are used by me during the instructional day and *not* by my students.

Q18: I use different technology systems unique to my grade level or content area (e.g., online courseware, Moodle, WAN/LAN, interactive online curriculum tools) to support student success and innovation in class.

Q19: I employ learner-centered strategies (e.g., communities of inquiry, learning stations/centers) to address the diverse needs of all students using developmentally-appropriate digital tools and resources.

Q20: Students' use of information and inquiry skills to solve problems of personal relevance influences the types of instructional materials used in my classroom.

Q21: My students participate in collaborative projects (e.g., Jason Project, GlobalSchoolNet) involving face-to-face and/or virtual environments with students of other cultures that address current problems, issues, and/or themes.

Q22: My students use the available digital tools and resources for (1) collaboration with others, (2) publishing, (3) communication, and (4) research to solve issues and problems of personal interest that address specific content standards.

Q23: I model for my students the safe and legal use of digital tools and resources while I am delivering content and/or reinforcing their understanding of pertinent concepts using multimedia resources (e.g., PowerPoint, Keynote), web-based tools (e.g., Google Presentations), or an interactive whiteboard.

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SURVEY Questions

0 Never
1 At least once a year
2 At least once a semester
3 At least once a month
4 A few times a month
5 At least once a week
6 A few times a week
7 At least once a day

Q25: My students model the "correct and careful" (e.g., ethical usage, proper digital etiquette, protecting their personal information) use of digital resources and are aware of the consequences regarding their misuse.

Q26: I participate in local and global learning communities to explore creative applications of technology toward improving student learning.

Q27: I offer students learning activities that emphasize the use of digital tools and resources to solve "real-world" problems or issues.

Q30: I prefer using standards-based instructional units and related student learning experiences recommended by colleagues that emphasize innovative thinking, student use of digital tools and resources, and student relevancy to the real world.

Q31: I seek outside help with designing student-centered performance assessments using the available digital tools and resources that involve students transferring what they have learned to a real world context.

Q32: I rely heavily on my students' questions and previous experiences when designing learning activities that address the content that I teach.

Q36: My students use the classroom digital tools and resources to engage in relevant, challenging, self-directed learning experiences that address the content standards.

Q37: I design and/or implement web-based projects (e.g., WebQuests, web collaborations) in my classroom that emphasize the higher levels of student cognition (e.g., analyzing, evaluating, creating).

Q38: My students use the digital tools and resources in my classroom primarily to increase their content understanding (e.g., digital flipcharts, simulations) or to improve their basic math and literacy skills (e.g., online tutorials, content-specific software).

Q40: My students use digital tools and resources for research purposes (e.g., data collection, online questionnaires, Internet research) that require them to investigate an issue/problem, take a position, make decisions, and/or seek out a solution.

Q41: My students collaborate with me in setting both group and individual academic goals that provide opportunities for them to direct their own learning aligned to the content standards.

Q42: I promote global awareness in my classroom by providing students with digital opportunities to collaborate with others of various cultures.

Q43: My students apply their classroom content learning to real-world problems within the local or global community using the digital tools and resources at our disposal.

Q45: My students and I use the digital tools and resources (e.g., interactive whiteboard, digital student response system, online tutorials) primarily to supplement the curriculum and reinforce specific content standards.

Q46: Problem-based learning occurs in my classroom because it allows students to use the classroom digital tools and resources for higher-order thinking (e.g., analyzing, evaluating, creating) and personal inquiry.

Q47: My students use all forms of the most advanced digital tools (e.g., digital media authoring tools, graphics programs, probeware with GPS systems, handheld devices) and resources (e.g., publishing software, media production software, advanced web design software) to pursue collaborative problem-solving opportunities surrounding issues of personal and/or social importance.

Q48: I advocate for the use of different assistive technologies on my campus that are available to meet the diverse demands of special needs students.

Q49: I promote the effective use of digital tools and resources on my campus and within my professional community and actively develop the technology skills of others.

Q50: I consider how my students will apply what they have learned in class to the world they live when planning instruction and assessment strategies.

Appendix B: Permission for Use of the LoTi Framework

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September 5th, 2013

Permission For Use of the LoTi Framework

To: Walden University
Dissertation Review Boards

Please accept this letter as notification that Nate Abba is hereby granted permission to utilize the LoTi Framework and corresponding Digital-Age Survey to collect data for his doctoral dissertation study. Nate is permitted to use the Digital-Age Survey and the LoTi Framework for purposes of the study only. In addition, Nate has permission to review all available LoTI Digital-Age results on the individuals taking place in his study.

The guidelines for using LoTi Connection copyrighted material as part of this dissertation study are as follows:

1. Permission to reprint the LoTi Framework is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
2. Permission to reprint selected results including graphs and tables in the Appendices of the study is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
3. Permission to reprint selected questions from the Digital-Age Survey in the Appendices of the study is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
4. LoTi Connection holds the right to restrict usage of any intellectual property if LoTi Connection finds that the content is being used in an inappropriate manner.

Sincerely,

Dennee Saunders

Dennee Saunders
Assistant Executive Director

Appendix C: LoTi Digital-Age Quick Scoring Device

LoTi Digital-Age Quick Scoring Device to obtain a LoTi Score

Use this Quick Scoring Device to calculate the "High Score" and "High Level" numbers for scoring, then use the calculated values on the LoTi Digital-Age Survey Calculation Key to obtain a final LoTi Score from the 37-question LoTi Digital-Age Survey.

	DCR	Level 1/2	Level 3	Level 4a/4b	Level5/6	PCU	CIP
	Q12 ________	Q4 ________	Q1 ________	Q27 ________	Q10 ________	Q13 ________	Q6 ________
	Q19 ________	Q16 ________	Q5 ________	Q30 ________	Q14 ________	Q15 ________	Q20 ________
	Q25 ________	Q17 ________	Q8 ________	Q31 ________	Q21 ________	Q18 ________	Q32 ________
	Q42 ________	Q23 ________	Q37 ________	Q36 ________	Q22 ________	Q26 ________	Q41 ________
	Q48 ________	Q38 ________	Q40 ________	Q43 ________	Q47 ________	Q49 ________	Q50 ________
		Q45 ________		Q46 ________			
STEP1: Add for Raw Scores							
STEP 2: Divide to find Averages		/ 6	/ 5	/ 6	/ 5	/ 5	/ 5
High Score							
High Level		1	2	3	4	**PCU**	**CIP**

STEP 3: Record the largest High Score that was calculated (e.g., 6.2) = [ ] **= High Score**

STEP 4: Record the High Level that corresponds with the High Score from STEP 3 (e.g., 2) = [ ] **= High Level**

Appendix D: Research Data Dictionary

Research Data Dictionary

Item	Variable Name	Data Type	Description	Codes	Notes	
A	Group ID	Character	abba			
B	Survey Date	Numeric	Date survey was taken			
E	District	Character	District of service			
F	School	Character	School of employment			
G	Loti	Numeric	Levels of Teaching Innovation	Level 0: Non-Use Level 1: Awareness Level 2: Exploration Level 3: Infusion Level 4: Integration Level 5: Expansion Level 6: Refinement		
H	PCU	Numeric	Personal Computer Use	PCU Level: 0-7	Intensity level	
I	CIP	Numeric	Current Instructional Practices	CIP Level: 0-7	Intensity level	
J	Access	Numeric	Access to technology	0 = no 1 = yes		
K	Survey Type	Character	LoTi Digital			
L	SCU	Numeric	Student Computer Use	0 = Never 1 = At least once a year 2 = At least once a month 3 = At least once a week 4 = At least once a day 5 = Multiple times each day		

M	TCU	Numeric	Teacher Computer Use	0 = Never 1 = At least once a year 2 = At least once a month 3 = At least once a week 4 = At least once a day 5 = Multiple times each day		
N	H	Numeric	Higher Order Thinking	H Score: 1-6		
O	E	Numeric	Engaged Learning	E Score: 1-6		
P	A	Numeric	Authentic Connections	A Score: 1-6		
Q	T	Numeric	Technology Use	0 = Never 1 = At least once a year 2 = At least once a month 3 = At least once a week 4 = At least once a day 5 = Multiple times each day 6 = A few times a week 7 = At least once a day		
R	SAMR	Numeric	SAM-R Model developed by Dr. Ruben Puentedura	Levels: 1 = Substitution 2 = Augmentation 3 = Modification 4 = Redefinition		
S	RR	Numeric	Rigor & Relevance Framework	Quadrant : A - E		
T	DoK	Numeric	Webb's Dept of Knowledge	Levels: 1 - 4		
AA - BK	Q1-50	Numeric	Survey Questions	0 = Never 1 = At least once a year 2 = At least once a semester		

				3 = At least once a month 4 = A few times a month 5 = At least once a week 6 = A few times a week 7 = At least once a day		
BL	Student Resource Use	Numeric	Student Resource Use	Levels: 1 - 5		
BM	Teacher Resource Use	Numeric	Teacher Resource Use	Levels: 1 - 5		
BO	Communication	Character	Communication	Agree, Strongly Agree, Disagree, Strongly Disagree, No Opinion		
BP	Digital Infrastructure	Character	Digital Infrastructure	Various		
BQ	Digital Model	Numeric	Digital Model	1 = No Blend 2 = Blended		
BR	Greatest Obstacle	Character	Greatest Obstacle	Various		
BT	Grouping Strategies	Character	Grouping Strategies	Agree, Strongly Agree, Disagree, Strongly Disagree, No Opinion		
BU	Guidance for Digital Resources	Character	Guidance for Digital Resources	Various		
BW	Personal Beliefs	Numeric	Personal Beliefs	0 = No Opinion 1 = Agree 2 = Somewhat Agree 3 = Strongly Agree 4 = Disagree 5 = Somewhat Disagree 6 = Strongly Disagree		
BX	Personal Feedback	Character	Personal Feedback	Agree, Somewhat Agree, Strongly Agree, Disagree, Somewhat Disagree, Strongly Disagree, No Opinion		
BY	Personal Readiness	Character	Personal Feedback	Agree, Somewhat Agree, Strongly Agree, Disagree, Somewhat Disagree, Strongly Disagree, No Opinion		
BZ	Personal Support	Character	Personal Support	Agree, Somewhat Agree, Strongly Agree, Disagree, Somewhat Disagree, Strongly Disagree, No Opinion		
CA	Professionalism	Character	Professionalism	Agree, Somewhat Agree, Strongly Agree, Disagree, Somewhat Disagree, Strongly Disagree, No Opinion		
CC	Standard Based Learning	Numeric	Standard Based Learning	Levels: 0 - 5		
CH	Vision	Character	Vision	Agree, Somewhat Agree, Strongly Agree, Disagree, Somewhat Disagree, Strongly Disagree, No Opinion		
CI	Voice	Character	Voice	Agree, Somewhat Agree, Strongly Agree, Disagree, Somewhat Disagree, Strongly Disagree, No Opinion		
CJ	Years Teaching	Numeric	Years Teaching	0 = Less than Five Years 1 = Five to Nine Years 2 = Ten to Twenty Years 3 = More than Twenty Years		