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Teachers' Participation in Learning by Design Activities, Their Technological, Pedagogical and Content Knowledge, and Technology Integration in an Inner City School

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Walden University
2018

Abstract

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by

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MEd, The City College of New York, 1999

MA, University of Miami, 1978

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Students at an inner city school have low test results despite making progress. The study examines the problem that technology plans implemented by the Board of Education could not improve student achievement. Educational policy recommends to increasingly sustain teaching by educational technology. Therefore, this research examines the teacher knowledge necessary for technology integration in classes, and the ways this knowledge can be fostered. The theoretical framework of this study integrates 2 prominent theories of instructional science: learning by design (LBD) and technological, pedagogical, and content knowledge (TPACK). The relationship between LBD, TPACK, and technology integration in the classroom was examined. The assumption was made that LBD and TPACK predict technology integration, and that TPACK mediates the relationship between LBD and technology integration. A correlational study was carried out with a sample of $N = 109$ in-service, secondary, mathematics teachers from an inner city school. The data were collected using a previously validated questionnaire survey and initially analyzed by multiple regression analysis. However, the measured variables displayed nonlinear relationships, suggesting that, while TPACK partially mediates the LBD-TI relationship as hypothesized, technological knowledge had a saturation effect on TI, and thus high scores of both LBD and TPACK decreased TI. The study shows at a theoretical level how teachers can benefit from LBD experiences resulting in TPACK and how likely they combine technology with teaching. For the practice of teacher leadership, this study will suggest effective forms of professional development, thus improving teaching quality and enabling positive social change.

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Dedication

This study continues the memory of my parents Agnes Anduze-Bruner and Curtis Bruner. They loved learning so much and did not mind sharing their knowledge with others. Not one day passes when I do not think of them and the joy they received from discovering life through literature, listening, and discussion. I miss them for their talks and laughter. This study is also dedicated to my family, Angela, Yolanda, Jürgen, Andrew, Maximilian, and Ellington. Their faith in me was of great support and encouragement.

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Behind the blood, sweat, and tears of every doctoral candidate are those souls who helped to make a long-standing desire happen. I would like to acknowledge-

Dr. Nicolae Nistor, who never lost his subtle humor, patience, and dedication to the pursuit of knowledge. He performed truly as a bridge over troubled waters.

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Section 1: The Problem

Introduction

The third largest school district in New Jersey, New Jersey District (NJD; pseudonym), is confronting economic, social, and educational crises. NJD has the highest unemployment rate nationally and a high crime rate that prevents the establishment of new businesses (Department of Labor, 2013). The lack of new business or expansion of existing businesses contributes to the city's economic decline. Furthermore, the city faces childhood poverty rates double those of the United States (United States Department of Labor [USDOL], 2012).

The district has a burgeoning student population whose academic attainments show deficiencies. There are 29,000 students from prekindergarten to 12th grade (Board of Education, 2013). The level of scholastic achievement places the district on a lower half of state academic growth (United States Department of Education [USDOE], 2012). As the state annually raises the requirements of passing scores, students struggle to meet minimal grades. Absenteeism and poor academic performance often result in low graduation rates, which tend to add to the underemployment and unemployment statistics (USDOE, 2012). As part of the remedial process, the district incorporated technology to enhance student achievement, test performance, and acquisition of 20th century skills. Its other goal was to solve the problem of deficient student achievement in mathematics (USDOE, 2012).

Definition of the Problem

Local Problem

In 2007-2010 and 2010-2013, the Board of Education implemented two technology plans to improve student learning, test performance, and technology skills. In addition, technology coordinators (TC) assisted the professional development in technology. The goal was to support and encourage teachers' technological acceptance. Each school, in particular those with low student test scores, received allocations for school-based technology coordinators. In the description of duties, the school district followed guidelines (NJD, 2007) from the International Society for Technology in Education (ISTE). The district found that student academic gains and test scores in mathematics were marginal. Students have shortcomings in the areas of numeracy and geometry (NJ DOE, 2012). Additionally, they have difficulty with word problems. Hence, as the content matter becomes more complex, students cannot connect concepts with applications (NCTM, 2013). Subsequently, they fall behind statewide and nationally. The decline in achievement occurs in Grades 6 through 8. Figure 1 provides the demographic distribution of the district.

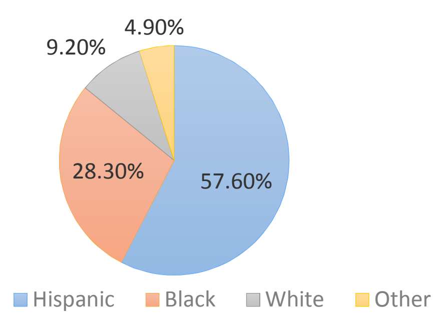

Figure 1. Demographic distribution of the public school district.

The district put several remediation plans in place. In many instances, remediation improved performance, but there were not enough tutors or aids to meet student demands. In 1991, the State of New Jersey assumed control of the Board of Education. It cited as just cause poor student achievement, low graduation rates, corruption, and general mismanagement. During New Jersey State's 23-year takeover, student test performance in math and scholastic achievement remained marginal. Test results for a 7-year period showed that students continued to fall behind their statewide norms (Board of Education, 2013). In summary, the technology plans suggested by ISTE and implemented by the Board of Education to improve student achievement and performance proved ineffective. This problem is examined in the following subsections.

Larger Population

American educational reform emphasizes vast changes in the quality of instruction and teacher accountability. Declining student performance in reading and the sciences (USDOE, 1998-2000) raised an awareness of the country's educational deficits. Thus, Congress legislated the No Child Left Behind Act (2002, 2005). By 2010, additional legislation sought improvement through the Race to the Top (RTTT) Act. The second law was intended to make teachers more accountable for student learning.

Table 1

NJASK, Subtest Mathematics Seven-Year Results Proficiency and Advanced Proficiency Levels (2007 to 2013)

Grade	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011	Year 2012	Year 2013
8th	39.7%	40.9%	46.8%	42.3%	40.8%	40.0%	45.7%
State Results	68.4%	67.7%	71.8%	69%	71.5%	80.7%	69.3%
7th	46%	39.2%	36.4%	46.0%	45.0%	45.8%	46.9%
State	66.3%	64.3%	45.8%	64.3%	73.7%	71.0%	63.5%
6th	57.1%	45.6%	43.5%	43.5%	51%	55%	56.8%
State	79%	72.2%	71.2%	72.1%	77.4%	78.8%	79.1%

Note. Adapted from NJDOE, State Summary, Subset Mathematics, Grades 6 through 8.

In both parts (quality of instruction and improvement in student learning), state, norm-referenced tests were the instruments of assessment. Support for professional development for teachers became an important third goal (RTTT, 2010). Professional development budgets received strong fiscal funding. The chief objective was to establish technology-rich environments in American classrooms to bring them up to 21st century standards. Hence, technology integration and teacher professional development, in particular technology competency, are at the forefront of American educational reform (NCLB, 2002, 2005; RTTT, 2010).

Research shows that teachers' use of computers and peripherals enhances student learning, and the enhancement results in higher test scores (Linden, 2008). Rivera (2008) and Watson and Watson (2011) cited as proof districts with underperforming students who made progress using technology. Furthermore, the ISTE maintained that teachers and students need technology to be competitive in 21st-century skills (ISTE, 2013a).

Instructional improvement and technology were at the center of professional development for teachers, especially mathematics and reading (Bos, 2009; Campbell & Jane, 2012).

Technology professional development extends constructivist strategies and practices for teaching. It is an overarching and unwritten component of educational reform (Jimoyiannis, 2010; Keengwe & Onchwari, 2011; Mishra & Koehler, 2006). However, in the process of universal attempts to reach all, this teacher-training vehicle often omits reinforcement of constructivist philosophy. Many in-service teachers need the reinstitution of constructivist pedagogy (Gerard, Varma, Corliss, & Linn, 2011; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010). It is a prerequisite for technology professional development. Teachers acquire creative, pedagogical strategies through meaningful discussions and practices. Hence, they meet the need for and commitment to technology. On the other hand, without constructivist involvement, participants internalize technology professional development through traditional lenses. They develop superficial ideas and responsibility for technology integration.

Consequently, professional development with constructivist foundations helps teachers to understand technology integration in a professional setting (Martin et al., 2010). Groff and Mouza (2008) developed a workable inventory matrix for teachers to make up for training deficits. They constructed the model to explain why teacher lack creativity in technology. The matrix is also an assessment tool. Principals fared no better. Gerard, Bowyer, and Linn (2008) and Sorensen, Shepherd, and Range (2013) found that administrators needed as much training as teachers. As instructional leaders, they have to guide teachers in making the appropriate change. Their role as technological leaders is to model and urge risk taking. They are listeners who support the engagement in technology projects.

In school environments with technological settings, technology coordinators have primary functions (ISTE, 2013b). They are the keepers of the vision for integrating technology into the curricula (ISTE, 2014). They help plan and put into action the Board of Education's mission. They are the communication bridge between staff and administration. They model technological behavior such as modifications and implementations of learner-friendly software programs. Technology coordinators drive the investment in recency in technology (Tondeur, Cooper, & Newhuse, 2010). They are constructivists (Kolodner, Crismond, Gray, & Putambekar, 1998) who use learning by design (LBD) strategies to encourage teachers to problem solve. They also support teachers' reflection on technology through individual educational philosophy. Another responsibility of the technology coordinator is follow-up or one-to-one professional development sessions. Finally, they know that listening to staff often leads to professional development ideas grounded in teacher input. In addition, attentive listening establishes a trust bond between the coordinator and teachers. This effect often serves as a road to teacher efficacy. Hence, technology coordinators are the hub of all activity around successful technology integration, and they are technology leaders (Hutchison & Reinking, 2011). Barron, Dawson, and Yendol-Hoppey (2009) contended that teachers and ancillary staff members must rely on the technology coordinator if they are to prepare students for 21st-century skills. ISTE (2013) argued that school-based technology personnel accelerate the changeover from traditional to digital learning. They are on site to answer critical questions and promote technology integration. These are decisive paths, as many teachers in urban areas tend to be technology wary (Mouza, 2011).

The use of technology for instruction requires practitioners to analyze the academic and cognitive needs of students. They combine this information with technology to develop creative venues for student academic advancement. Thus, they should know and practice technological, pedagogical, and content knowledge (TPACK) at every teaching level. By default, technology coordinators become instigators and supporters of LBD activities, which in turn become important TPACK-sustaining devices. Hence, it is important to investigate the effects of LBD activities on TPACK for teacher technology integration.

Rationale

Gap in Practice

The gap in practice occurs when teachers do not sufficiently integrate technology into the classroom, and they do this with little training or distinct knowledge (Mouza & Karchmer-Klein, 2013). Consequently, students do not acquire 21st century skills, and there is marginal evidence of sustained academic improvements (Badia, Barberà, Guasch, & Espasa, 2011; Kim & Hannafin, 2011; Vanderlinde & van Braak, 2010). Hence, the Board of Education attempted to reduce the gap in practice by introducing technology into the classroom (NJD, 2007). Another, cost-effective form of professional development was LBD activities, which is another form of teacher-generated professional development.

Evidence of the Problem from the Professional Literature

In the larger context, the Board of Education's problem is shared with that of its inner city counterparts. The district's significant poverty indices (USDOE, 2012; US DOL, 2012) and small tax bases do not support economic growth. Furthermore, high unemployment adds to a negative condition for school systems (Li, 2010; Machin, McNally, & Meghir, 2010). The NCLB Act (2006) recognizes the plight of these cities and supports the use of technology for students' educational benefits. The United States and New Jersey Departments of Education show increases in technology usage. In contrast, standardized test scores underline the marginality of academic advances via technology (NJ Department of Education, 2008; US Department of Education, 2011). Increasingly, severe budget cuts preclude the participation of supportive, strategic, technological personnel (Corn, 2010; Lei, 2010; Wahl, 2000). Such staff members guide the development of teachers, administrators, and students in the complex acquisition of technological knowledge. Researchers in the field addresses this issue.

Reliable and valid research supports the possible benefits of teaching with technology (Banister & Reinhart, 2010; Hossain & Wiest, 2013; Johnson, 2008). Moore (2011) used Bruner and Olson (1977) to support the argument that when students learn through technology, they acquire knowledge through text and learning strategies as they navigate technology for information. In addition, Moore stated that identifying what technology to use for information gathering, knowing how to use the technology, and knowing how to interact with the information provided are parts of the learning process. In other words, for teachers to carry out the process of teaching with 21st century skills, they need the mentoring and functions of the technology coordinator. Thus, computer, teacher, and coordinator interchangeably serve as a random access memory that enhances student cognition (Moore, 2011). Lowther et al. (2008) conducted a longitudinal, qualitative study of a statewide technology program, which provided full-time, school-based technology coordinators. Twenty-six schools, 927 teachers, and 12,420 students were the target population. Lowther et al. showed that teachers with the school-based technology coordinator had significantly higher efficacy in using technology as a teaching tool than the controlled group. They showed a buy-in to the technology and they were willing to take more risks. Although scores on standardized testing remained marginal, the teachers remained confident. The findings also showed that the role of the technology coordination was a significant factor. Concurrently, Sugar and Holloman (2009) investigated the leadership characteristics of technology coordinators and their importance to schools. In the mixed-method study, the respondents evaluated the technology coordinator as a leader and expert in technology. Sugar and Holloman showed the respondents perceiving the coordinator as an expert leader in technology. The respondents also thought the technology leaders were vital to the school building. The implications are that this position functions as a cohesive touchstone through which faculty members develop camaraderie and a willingness to learn outside of conventional methods. These psychological attitudes benefit the implementation of technology-rich classrooms (Shah, Foster, & Betser, 2013; Teo & Noyes, 2011; Thoonen et al., 2011; Tondeur et al., 2010).

Waring (2010) conducted a case study on the belief system of a technology coordinator in a school setting. The subject of the study practiced and modeled the TPACK framework. This approach influenced the instructional staff. Thus, at a school-level, technology coordinators positively affect staff attitudes. Subsequently, instruction improves in the classrooms. Kumar, Rose, and D'Silva (2008) evaluated secondary math, science, and English language teachers in Malaysia. They found that teachers' attitudes and perceptions of practicality toward technology and computer compatibility had a significant correlation with computer use. It is the task of the technology coordinator to mentor teachers until attitudes of indifference, reluctance, and concern become views of acceptance and ultimate innovation (ISTE, 2013b).

Researchers have highlighted a universal technology problem faced by school districts which is to drop school-based positions. The literature does acknowledge the technology coordinator as a primary factor in developing technology-rich classrooms. However, it continues to show that teachers do not embrace the technology, and the scarcity of resource personnel does not help. However, means of establishing an interdistrict collaboration that would offer alternatives for replacing technology coordinators are missing from the literature.

Little research has been conducted on the impact of LBD activities on TPACK through professional development are scarce. As far back as 2004, Hofer, Chamberlin, and Scott, in support of Moursund (1992), advanced the need for technology professional development. However, their study did not provide information about teacher-generated professional development. In another example, Sugarman and Holloman (2009) studied the impact of instructional technologists as coaches. Sugarman and Holloman explored teacher observations of a technology coordinator as a leader, but did not review professional development and LBD activities. There is an apparent relationship between LBD activities and professional development leading to technology integration. Hence, there is a need for the present study.

Rationale for Choosing the Problem

The rationale for selecting this problem is that many American school districts use technology to improve students' academic deficits. There is the tendency to view the new paradigm as a cure-all (Corn, 2010; Jianhong et al., 2010; Tassey, 2013) without in-depth teacher training (Roschelle et al., 2010). As a result, technology integration success has mixed results. In inner cities, the results are less than marginal. Accordingly, it is essential to know and understand exactly where the problem lies and to find possible solutions. Furthermore, continuing fiscal cuts cannot sustain the technology as currently practiced, which underscores that finding solutions is critical.

The district wanted to improve the learning environments. It is successful in raising teacher awareness of different technology professional developments of hard- and software for education. Through its technology plan implemented in 2007, it wanted to transform traditional teaching and learning processes to student-centered experiences. Its goal was to improve test scores and student academic success. In addition, the plan called for job-embedded or in-class coaching, professional development workshops and planning meetings (NJD Technology Department, 2007) to expand instructional and staff expertise in 21st century skills. The district recognized the critical role of technology professional development; however, it neither stated nor implied content matter and pedagogy embedded in applications of technology. This concept is inherent in technology training (Koehler & Mishra, 2011). However, it did include school-based technology coordinators (TC) in the plan from 2007 through 2010. The Board of Education followed the general trend in American school districts, which is to use technology integration for student academic and test-score improvement.

Researchers have produced documents of mixed results on testing, student cognition, and teacher acceptance of technology (Bos, 2011; Bowers & Stephens, 2011). In particular, researchers of technology in underperforming schools have shown that students do gain (Angeli, 2008; Dror, Schmidt, & O'Connor, 2011; Na Li, Kang-hao Hung, & Chun-hao Chang, 2010). Nonetheless, there is little documentation on sustaining these gains. Additionally, researchers confirmed that teachers favor technology integration; however, research on teacher creative use of content with technology does not have much documentation (Andiliou & Murphy, 2010). District-commissioned surveys have shown that teachers want technology integration (NJD Technology

Department, 2007). The Board of Education has spent $26.9 million dollars on technology in a 7-year period. Nevertheless, student achievement and test scores have had marginal success (NJDOE, 2007-2013). Dwindling fiscal support and escalating computer costs (Demski, 2010; Ringstaff & Kelley, 2002) have forced the budget-wary district to make decisive personnel adjustments. Subsequently, schools lost technology coordinators, and centrally located technology integration specialists took their places (Tomasini, 2012). The logic is that one position can serve multiple schools in one training session. The sessions are generic in nature, and not all teachers can attend. Dierkes (2012) argued that this form of professional development is not beneficial to teachers.

The Board of Education exhibits fiscal caution; however, in the future, student academic growth and teacher technological efficacy may not show progress. For example, at the time of the budget cuts, students were beginning to demonstrate improvement in math skills and proper use of technology. Teachers showed improvement in combining content knowledge with technological and pedagogical skills (NJD, 2010). In addition, during the years 2007 to 2010, student test scores slightly improved. However, without the technology coordinator to assist and meaningful professional development, teachers' growth will stagnate. Thus, costs will escalate, and student gains will decline. When the budget deleted these school-based positions, they created a negative impact on teacher training and subsequent student achievement.

According to ISTE (2014), technology coordinators function as curriculum specialists and bridges between administrators and teachers. They are also the originators of unique professional development as they customize face-to-face training for teachers. They address technological issues and on-the-spot problem solving. They instigate problem-based projects and teacher reflection. The psychological and fiscal costs of losing school-based technology coordinators are high. Most importantly, the rate of development in technology integration diminishes.

Table 2

Professional Development Calendar, Mathematics, 2013-2014

Audience	Subject	Facilitator
All math teachers	IFL Math, Algebra Studies	IFL*
6th Grade Teachers	IFL Strategies for Learning	IFL
IFL Math, Algebra	Algebra 1-IFL Strategies	IFL
IFL 6th grade Strategies	IFL Strategies	IFL
Math 8th grade	Equation, linear functions: Solving linear equation in one variable	IFL
Math 7th grade	Proportional Relations	IFL
IFL Math 6th	Solving one-variable equations and inequalities	IFL
IFL Math Algebra	Algebra 1- Solving problems using linear and exponential models	IFL
All Math teachers,	NJK Test Core Design and Administrative Featured	D**
Math - 6th grade	Locating, ordering & finding distance between positive & negative integers	IFL

*Institute for Learning, University of Pittsburgh; **District Office

ISTE (2013b) posited that professional development and LBD activities are vital to the health and success of any educational institution. They are especially important in urban schools where teachers may be wary of technology (Mouza, 2011). Hence, the technology coordinator is a cost-effective and critical item in school budgets (Anderson & Dexter, 2005; Hofer, Chamberlin, & Scot, 2004; Lin & Chiou, 2008). Their physical presence and approachability give psychological support to teachers. The elimination could have an adverse impact on technology integration and subsequent student progress.

When matching student scores and academic gains against their previous years' scores, it is apparent that growth is taking place. However, students' benefits remain behind their noneconomically depressed counterparts. Modest test scores for 6 years are indicative of a serious problem. Without the necessary skills for entry-level jobs and limited career choices, a student will not be competitive in the 21st century. Consequently, while being fiscally prudent, the Board of Education also generated a two-part conundrum.

The first is a lack of school-based technology coordinators to impart the creative process of LBD and subsequent TPACK development. A gap exists between technology professional development and dedicated implementation of technology in classrooms. This combination must also be flexible to individual adult needs, and thus it enables efficacy (Archambault & Crippen, 2009; Hardy, 2010). From its actions, it appears that the Board of Education views technology as a means of ending poor student performance, without considering influencing forces. Of these, teacher fluency in TPACK and administrative understanding of professional development (Sorensen et al., 2013) posed a significant concern. Thus, the board assumes that teachers can raise test scores and student academic progress without the guidance of school-based technology coordinators.

The second is that the Board of Education wants technology integration. However, it has not defined technology integration to include content and pedagogical practice. Thus, these two areas have had a negligible impact on advancing technology-rich classrooms. Plans become action with goals that lack a definitive understanding of technology integration via the technology coordinator participation. The school-based LBD activities are valuable assets. Without them, sustainable TPACK and technology integration may be minimal (Dexter, 2011; ISTE, 2013a; Reinhart & Rathsack, 2013).

Against this background, the intent of this study is to examine the effects of teachers' participation in professional development and of their knowledge of technology, pedagogy, and content (TPACK) on technology integration in the classroom.

Definitions

Educational technology: Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources. As a field, educational technology emphasizes communication skills and approaches to teaching and learning through the judicious use and integration of diverse media (Association for Educational Communication and Technology, 2011).

Learning by design (LBD): LBD emerges from the constructionist theory that emphasizes the value of learning through creating, programming, or participating in other forms of designing. The design process creates a rich context for learning. LBD values both the process of learning and its outcomes or products. The essence of LBD is in the construction of meaning. Designers (learners) create objects or artifacts representing a learning outcome that is meaningful to them (Han & Bhattachary, 2001).

Technology coordinators (TC): Those professionals who help educators advance technology use in schools (ISTE, 2014). There are more than four titles for this position.

Technological, Pedagogical, *and Content Knowledge (TPACK)*: Identifies the nature of knowledge required by teachers for technology integration in their teaching, while addressing the complex, multifaceted and situated nature of teacher knowledge. At the heart of the TPACK framework, is the complex interplay of three primary forms of knowledge: content (CK), pedagogy (PK), and technology (TK). As must be clear, the TPACK framework builds on Shulman's idea of pedagogical content knowledge (Koehler, 2009).

Technology-rich classrooms: Student and teacher use of technology in the gathering and application of knowledge to enhance problem-solving skill (Kereluik, Mishra, Fahnoe, & Terry, 2013; Mishra & Koehler, 2006).

Significance of the Problem

The importance of this study is that this district shares issues with many inner city school districts. For instance, cities manage severe budget cuts when educational reform demands more school accountability. Additionally, increasing student test scores with technology that teachers are reluctant to use. The last, although there are more, is encouraging new business to the city while coaxing the fleeing businesses to remain. Thus, the degree to which the Board of Education solves its problems could be prototypical for other inner city schools. For instance, the Board of Education is using technology to bring students into the 21st century. While technology will drive current and future trends, the administrators will have to reflect upon the underpinnings of its true technological mission. For example, the immediacy of raising test scores is for the present, and it is a stopgap to problem solution. However, its longevity is uncertain. Furthermore, advancing test scores does not ensure successful competition in global markets. On the contrary, instructing students how to use computers for creative problem solving is a lasting 21st century skill. Mastery of this skill will serve careers and everyday living well into the next century. Continued with these and other technological skills is contingent upon LBD strategies leading to TPACK.

Research Questions

Investigations have suggested that TPACK is essential for technology integration in the classroom (Mishra & Koehler, 2006), and that this knowledge can be acquired by participation in LBD activities (Kolodner et al., 1998). However, empirical findings on the effects of LBD and TPACK on technology integration are still insufficient to establish these approaches as effective solutions of the technology integration problem described above. I used the following research questions to determining technological development alternatives for this school district:

Research Question 1: To what extent do LBD and TPACK predict technology integration in the classroom?

Research Question 2: Does TPACK mediate the relationship between LBD and technology integration in the classroom?

In the subsequent literature review I will provide details on the LBD and TPACK concepts, present actual evidence of their effects, and describe the associated measure instruments.

Review of the Literature

Search Criteria

In my research, I used the Walden University Library system, EBSCO, ERIC; and educational public archives on a state, local, and national level. Professional organizations such as the International Society for Technology in Education, the National Council of Teachers of Mathematics, and the Society for Information Technology and Teacher Education have extensive libraries housing published papers open to its membership. Their archives became another opportunity for information gathering. The McKinsey Global Institute, in Palo Alto, California presented an excellent source for understanding technology and its impact on globalization. The National Science Foundation newsletter was also an invaluable source of information concerning technology. For in-depth searching, I used terms significant to technology. They were *technology coordinator*, *technology specialist*, *self-efficacy*, *digital learning*, *technology-rich classrooms*, *technology fluency*, *21st century skills*, *technology professional development*, *collaboration in technology*, and *virtual learning*. The list proved to be ever changing and voluminous. I chose those terms that frequently occurred. I found many of the terms in professional journals focusing on technology in education.

From the extensive professional journals I used, there were many from which to select. The most preeminent were those journals from professional organizations. The *Journal of Research on Technology Education* and the *Journal of Digital Learning in Technology Education* were good sources of information. I also found very useful The

National Council of Teachers of Mathematics' journals: *Mathematics Teaching in Middle School* and *The Journal of Research in Mathematics Education*. Other useful journals were *International Journal for Technology in Mathematics Education; Journal of Research in Technology Education; Journal of Computer Assisted Learning*; and the *Journal of Computers in Mathematics and Science Technology*. The most preeminent were those journals from professional organizations: *The Journal of Research on Technology Education* and the *Journal of Computers in Mathematics and Science Technology*.

Theoretical Foundation

The theoretical framework that guided this research encompasses two theories. They are TPACK (Mishra & Koehler, 2006) and LBD (Kolodner et al., 1998; Kolodner, 2009). Both theories take into consideration the challenges teachers face in the delivery of instruction. TPACK gives the theoretical basis for individual, teacher accomplishment in using technology as an instructional tool. LBD offers a theoretical platform for groups to analyze solutions relative to learning.

The development and workings of a technology-rich classroom require that teachers have excellent skills and competencies that facilitate student learning. Accordingly, there are many TPACK teacher prerequisites (Mishra & Koehler, 2005). They must have in-depth knowledge of the subject, which includes the most difficult and easy aspects of the content. They must know how to impart the knowledge so that optimum learning occurs. For example, teachers must understand how students learn, and they must know their students, or rather what students bring into the classroom. Teachers must also know how to manipulate software and combine it with content knowledge. For instance, in mathematics, the abstract concept of “X” is teachable using spreadsheet applications. Another example is the teaching of an area using the properties of a word processor. The teacher must also recognize the correct machinery for use in a lesson and how to integrate different equipment for optimum lesson delivery. The teacher must also be a technician able to identify and repair problems with machinery. To reach this level of instructional performance, teachers must excel in the integration of technology, pedagogy, and content knowledge.

The literature review has seven sections. The theoretical foundations comprise the first two. The remaining five sections are TPACK, LBD, TPACK interaction with LBD, teachers and technology, professional development, TPACK interaction with the technology coordinator, and LBD interaction with the technology coordinator. The sections are illustrative of the complex enormity of technology integration in classrooms. Furthermore, the division gives the reader a sound foundation for understanding the subtleties that affect the human experience as it navigates a formidable 20th-century tool.

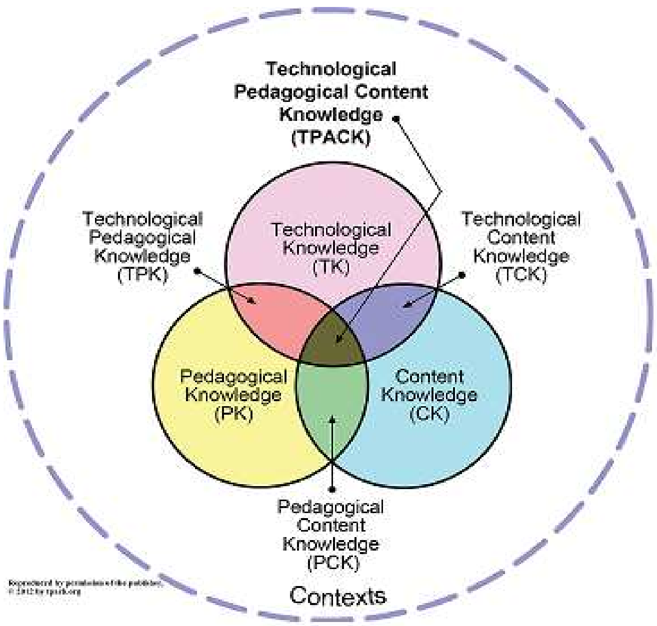

Figure 2. Technological, pedagogical, and content knowledge Venn diagram (reproduced by permission of the publisher, © 2012 by tpack.org).

Technological, Pedagogical, and Content Knowledge (TPACK)

In tandem with LBD, TPACK forms a stable framework from which to investigate what teachers do to configure technology-rich classrooms. Schools, districts, administrators, and pedagogues realized that technology integration did not meet their anticipated results (Ewing-Taylor, Pennell, & Brackett, 2013; Hill, 2009; Zhao, 2011). A primary source of contention was that, traditionally, practitioners used content and pedagogy as distinct units in instructional planning. Thus, students were not receiving the full benefit of teaching via technology. Shulman (1986) advanced the position that preservice teachers should have training in combining content and pedagogical knowledge. Shulman argued that unless educators combined teaching strategies with the subject matter, students could not completely grasp information. Furthermore, Shulman argued that teachers must have knowledge of the plan that students bring with them to the classroom. The process worked in tandem with epistemological theories (Shulman, 1993), which helped the teacher. Thus, the whole child is part of the planning process. Shulman termed the new paradigm pedagogical content knowledge (PCK). With technology as an added dimension to learning, Mishra and Koehler (2005) combined PCK with technology. In 2005, they advanced the theoretical argument of TPACK. TPACK is a conceptual combination of seven domains in which teachers integrate technology in the classroom. Mishra and Koehler (2005) argued that to have a solid command of technology integration, teachers must have competency in technical knowledge. They must also have breadth and depth of content knowledge combined with deep expertise in pedagogical knowledge. Additionally, they held that the strategy of teaching with technology was no longer one-size-fits-all pedagogical approaches. Thus, they must be masters of all avenues relative to learning. Furthermore, teachers must have a profound knowledge of content supported by knowing when and how to deliver information (Koehler & Mishra, 2005). Thus, the seven domains interact to ensure optimum instruction using technology. Additionally, depending upon the knowledge of the student, practitioners may use combinations of the TPACK domains to facilitate learning for the assessment of TPACK, quantitative descriptive survey research summarizes data from pre-established or self-established surveys (Lodico, 2010). Additionally, it depicts patterns in the data necessary to the investigation (Creswell, 2008). Of equal importance is that it can assess or project educational outcomes (Creswell, 2008). For example, Graham et al. (2009) developed a content-specific survey instrument to measure the effects of TPACK in the curricula. The goal of the study was to measure teacher efficacy and confidence in using TPACK. It began the groundwork for measuring the impact of TPACK constructs on content knowledge. Through its reliability and validity, the authors expanded the study to include educational assessment from 2011 through 2012. Thus, stable and consistent results of descriptive quantitative descriptive research are a match for the investigation.

Learning by Design

LBD (Kolodner, Crismond, Gray, Holbrook, & Puntambekar, 1998; Kolodner, 2009) is a theoretical framework that posits that students can solve problems themselves. Within this construct, students use a combination of design and redesign methods based on investigation and exploration. The inability to reach a solution results in repetition of the entire process. LBD has its basis in case-based reasoning (CBR; Kolodner, 1993; Riesbeck & Schank, 2013), which suggests that project goals come from the application of existing and acquired knowledge. Through discussion of ideas and collaborations in experiments, participants use iterative and analytical investigations for problem-solving (Kolodner, 2009). Its pedagogical model has two cycles in the design and redesign format (See *Figure 3*). During the first period, the facilitator helps students with clarification and understanding of the task or project (Kolodner et al., 1998). Additionally, the facilitator may model for the group. In the second cycle, students investigate, explore, and experiment with different designs. Each cycle has a period of construction or testing of solutions, and students examine the process or product. Thus, through a constructivist lens, students learn and aquire information.

Originally intended for middle school students, LBD has become an integral part of professional development sessions for teachers (Darling-Hammond & Richardson, 2009). In this research, it provides a robust theoretical framework because of its range in several areas, which is essential to adult education. For example, the use of collaboration for goal setting and problem solving is intrinsic to the nature of the adult learner (Knowles, 1970). In these surroundings, adults design artifacts and a common language that enhances reflection (Schön, 1987), as well as a further understanding of task analysis. It is a fusion of problem-based learning and case-based reasoning (Kolodner, Hmelo, & Narayanna, 1996), which assists adult discovery learning (Knowles, 1970). Furthermore, adults are independent learners who want to find solutions without external help (Barrows, 1996; Savery & Duffy, 2001). In this study, LBD serves as part of the theoretical framework that drives the evaluation of teacher efficacy in technology. It also makes the research sensitive to the effect of the association between the technology coordinator (facilitator) and progress in teacher technology integration.

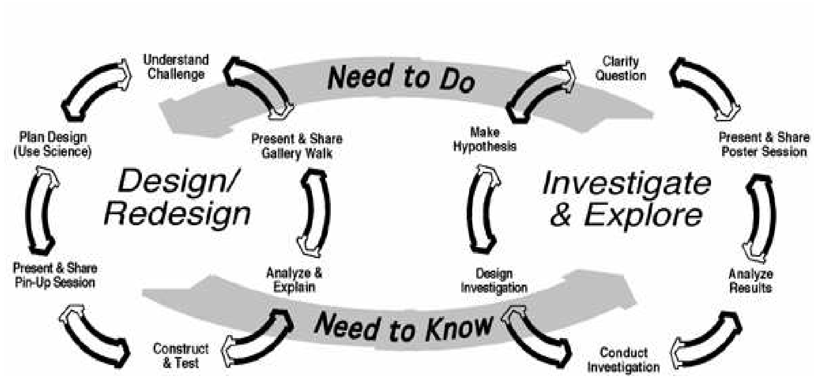

Figure 3. Learning by design process (Kolodner, 2011).

TPACK Interaction with LBD

The engagement of LBD and TPACK as theoretical frameworks strengthens this correlational study as they are organizing models (Creswell, 2008; Lodico, 2010). The two structures offer a diverse platform from which to conduct a study. For instance, a prominent activity of LBD encourages group interdependence leading to problem solution (Kolodner, 2009; Puntambekar & Kolodner, 2005). Thus, it is in tandem with 21st century skills (Blackmore, 2010; Snyder & Wenger, 2010). It presents TPACK as a theory that customizes individual accomplishments and needs (Graham, Borup, & Smith, 2012; Koehler & Mishra, 2011). Together they provide a theoretical synthesis that this research uses to analyze what teachers did via LBD and TPACK, as a group and individually, to enhance technology integration. The frameworks also provide a common language for practitioners to begin a dialogue (Mishra & the Deep-Play Research Group, 2012). It enables barriers to technology to fade and for practitioners to share information. In addition, the contexts suggest a meeting place for teachers to explore and attain deeper subject knowledge. It does so by supporting a junction between content knowledge and pedagogical expertise. This also brings the challenge of “thinking out of the box.” Consequently, theories drive the research in the selection and construction of instrumentation. The study uses the theories to identify language tools, attitude changes towards technology, and collaborative procedures that teachers used.

The binding thread is the technology that provokes practitioner creativity in learning as a student. Thus, the theories guide this study in examining the impact of technology coordinators on teachers as learners. It is critical, as many school districts no longer budget technology coordinators for facilitators. Instead, generic technology professional development replaces school-based technology coordinators. Therefore, the frameworks form a channel to describe the degree of progress teachers make with and without technology coordinators. This study recognizes that there is insufficient literature in the field on the impact of technology coordinators on teachers as learners. The academic use of technology in the classroom depends upon teacher sensitivity to technology, which includes recognition of the efficacy of and comfort level in the seven constructs of TPACK. The constructs or domains are technological knowledge, technological content knowledge, technological pedagogical knowledge, pedagogical knowledge, pedagogical content knowledge, content knowledge, and technological pedagogical content knowledge (Mishra & Koehler, 2006). Although measured as a total construct, results do not often show as competencies in individual domains. Archambault and Barnett (2010) conducted a factor analysis study to examine TPACK. Their survey instrument contained 24 items. They constructed a questionnaire to measure each domain of the TPACK framework. From within the United States, 596 teachers responded. The analyzed data suggested that TPACK is a sound organizational structure; however, teachers had difficulty in separating the two domains. The respondents had difficulty in differentiating between pedagogical knowledge (PK) and content knowledge (CK). Hence, if teachers did not know the difference, how could they use TPACK in the classroom? These constructs are mutually inclusive of each other. Investigations show that teachers have strengths in two or three domains. In contrast, they have weaknesses when integrating TPACK into curricula (Archambault & Barnett, 2010; Kinzie & Delcourt, 1991; Niess, 2001). Thus, there is a criticism of the original intent of the framework. However, TPACK gives an excellent starting point for attempts at producing technology-rich classrooms. At the same time, it provokes discussion and reflection that lead to stimulating activities often found in LBD groups.

Lu, Johnson, Tolley, Gilliard-Cook, and Lei (2011) conducted an investigation to establish technology integration courses for preservice teachers. Their premise was that content and pedagogy drive technology integration. However, teachers' beliefs and attitudes toward technology are conditioning factors in establishing these classrooms. Subsequently, psychological, cultural, academic, and technological skills combined to make cogent mindsets toward learning with technology. They argued that LBD was the conduit for TPACK.

Thirty-nine students participated in the Lu mixed-method study. They used the LBD activities that included design/redesign and investigate and explore (Kolodner et al., 2003). The authors used the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009). They conducted a *t* test to compare the constructs of TPACK with the pre and post surveys. A matching of reflection journals with the seven constructs of TPACK was part of the analysis. The finding of their study suggested that while LBD may not improve content knowledge, teacher understanding, and use of TPACK improved with LBD activities. Although preservice teachers were the target population, the implication exists that LBD and TPACK are significant vehicles for teacher adaptation of technology-rich classrooms.

Neville (2010) conducted a qualitative study of how teachers used LBD strategies for instruction. Mined data came from the collection of lesson plans, interviews, curriculum planning sessions, student work, audio and video recordings, teaching observations, and artifacts. The analysis of the data (Neville, 2010) showed that teachers or practitioners must have prerequisite conditions for effective LBD (Neville, 2010). These areas included four of the seven constructs of TPACK (Neville, 2010). Among the four were (a) profound content knowledge, (b) pedagogical knowledge, (c) pedagogical content knowledge, and (d) technology knowledge. Thus, the study underscored the need for LBD and TPACK to work in tandem.

Teachers and Technology Integration

The constructs of TPACK are the foundation of technology-rich classrooms (Lowder & Lowder, 2013; Mouza & Karchmer-Klein, 2013). Thus, they are the successful building blocks for student learning with technology (Mishra, 2012). The mandated use of technology (NCLB, 2006) has compelled teachers in the 21st century to integrate technology into classrooms. Teachers began using technology as an instructional tool (Hughes, 2013; Kumar et al., 2008). Technology in the classroom includes three critical areas: teachers and technology, technology professional development, and technology coordinators.

It is an understatement to say that teacher acceptance of any paradigm changes directly affects the learning environment. This finding becomes apparent as machine usage and other forms of technology continue to grow. Wachira and Keengwe (2011) noted that while access to technology has increased, surveys from American teachers show a drop in the use of technology. Of equal importance and in support of the Wachira and Keengwe study, Hutchison and Reinking (2011a) conducted a national survey on teacher perception and beliefs about technology integration. The sample consisted of 1441 literacy teachers. The results showed low levels of technology integration, which indicates that the domains of TPACK were not in play.

The domain of technology knowledge (TK) dictates that teachers who are technology proficient have favorable student learning outcomes (Dawson, Ritzhaupt, Liu, Rodriguez, & Frey, 2013; Graham et al., 2009; Lubin & Ge, 2012). It occurs because TK provides teachers with the capabilities of knowing how machines work and when they should use technology for a particular content area. TK also presents a creative bridge to reach all students at their individual cognitive levels. Increased application of technology is a direct representation of the interest level of teachers and their belief in technology integration. Simsek (2011) used the Computer Anxiety Scale (Oetting, 1983) and Murphy's Self-Efficacy Scale (1989) to measure student and teacher perceptions of technology in selected Turkish elementary and secondary schools. The author found that secondary students had higher self-efficacy than teachers did. Simsek attributed the variance to elevated student use of computers for many reasons. Simsek also noted that students were apt to try alternatives usages. On the other hand, teachers' use of computers was self-restricted to storage and communication. Simsek also referred to the lack-of-the-time element. They were unable to explore the technology because of work overload. Interestingly, among the teachers, there was a high correlation between self-efficacy and use of the Internet. However, Simsek also noted that teachers had high self-efficacy in using the Internet. The cause was the impact on stopgap information gathering as opposed to using the information for research and correlation purposes.

The integration of TPACK framework, in particular pedagogy and content knowledge (PCK), allows for teacher exploration of technology in targeted areas of knowledge (Moore, 2011). Hence, teachers can create a different dimension content, and they can reexamine their methods of delivery (Angeli & Valanides, 2009). This process gives teachers a stronger appreciation of the interface between pedagogy, content, and their tendency to change one another. Thus, teachers develop the inclination to take more risks, and their self-efficacy expands (Polly, Mims, Shepherd, & Inan, 2010). The results of the Simsek (2011) study are illustrative of a global trend.

In Ghana, Buabeng-Andoh (2012) investigated public school teachers' perceptions and practices of technology. The author found a high correlation between competency and information communication and technologies (ICT) use. However, there was not a statistically significant correlation between perception and ICT application. That is, teachers appeared not to recognize the positive impact of technology on student cognition. Earlier, Johnson (2008) added to the dialogue with a study on cognition processing and human behavior as a result of student technology interfacing.

McMahon (2009) suggested that students in a technology-rich classroom had better cognition and skills application than those who were in traditional classrooms. Further analysis revealed that teacher knowledge and implementation of ICT was minimal because perceptions and beliefs had not changed. Thus, the barriers to implementation remained (Nikolopoulou & Gialamas, 2013). In the Holden and Rada (2011) study, the findings substantiated earlier results by Kinzie and Delcourt (1991). They purport that teachers made use of technology according to their beliefs in pedagogy and student cognition. Thus, program implementation could not be successful until teacher beliefs became part of the process. McMahon (2009) suggests that training and professional development programs become part of the curricula in teaching colleges.

Ertmer and Ottenbreit-Leftwich (2010) also argue that teachers must be willing to see that technology or ICT is an important resource. It brings added dimensions to the classrooms. Kirkscey (2012) also noted that teachers who experienced connectivity with technology also developed a greater sense of commitment. It is conceivable that all of these issues become part of preservice and in-service teacher training. If teacher-training institutions integrate TPACK in the curricula, teachers will have experience in constructing lessons (Abbitt, 2011; Kutluca, Gokalp, & Ziya Gokalp, 2010). Thus, they will know how to use various machines and for different purposes (Mishra, 2009). Subsequently, teachers become active participants, and students become self-efficacious (Arnone, Small, Chauncey, & McKenna, 2011).

Although these studies are inconclusive, they do amplify critical areas in educational technology implementation. They highlight the gap between teacher acceptance and understanding of technology. This difference may account for the ineffectiveness of actual technological pedagogy. They show that teachers lack adequate preparation and ongoing training for implementation. They underscore the lack of time for technology exploration. Consequently, failure to address these disparities will perpetuate barriers to technology integration. A significant portion of the literature carried the implication that teacher input and involvement at every level was necessary for program success. As opposed to preparing for tests, it is apparent that districts should acknowledge teacher perceptions and beliefs about technology before, during, and after expansion of technology into the curricula (Groff & Mouza, 2008; Hughes, 2013; Liu & Szabo, 2009; Yang et al., 2013). The literature also highlighted the need for a bridge between traditional and 21st century teaching.

Prior to the advent of technology, American instruction was evolving toward making the learner the focus of classroom activity. However, technology hastened a paradigm change in teaching for 21st century skills. These skills include collaborative learning and communication, the teacher as facilitator, creativity, critical thinking, problem solving, decision-making, and learning. As the technology changes rapidly, the traditional mode of teacher-centered classrooms must change to accommodate the demands of a student-centered classroom and support 21st century learning. This demonstrates the importance of TPACK and its individual constructs that encompass the student-oriented instruction. They are a means of moving away from long-established venues and into 21st century learning. Ertmer et al. (2012) noted that teachers with student-centered beliefs were amenable to technology integration. Thus, the impact upon their students was successful. The Aud et al. (2012) report on education in America supports these findings.

From the literature, it is apparent that school systems are experiencing jagged degrees of technological success. Inan and Lowther (2010) and Tamim et al. (2011) argued that teacher preparation for 21st century skills must include technological approaches to pedagogy and content. Unless this preparation takes place, technology integration in classrooms will lack consistency. Furthermore, many student assessment gains appear to be unsustainable (Tamim et al., 2011). The literature presents a scarcity of studies illustrative of administrative attempts to rectify the problem.

The absence of such studies speaks volumes for future progress in technology integration. It is significant to add that pressure to increase test scores may be a contributing factor for teacher technology- reticence. Teaching to the test or using valuable weeks for test preparation (NJ Department of Education, 2008; The City School District, 2011) precludes explorations and creative quests in technology (Clarke-Midura & Dede, 2010). In their study Allsopp, McHatton, and Cranston-Gingras (2009) found that experience with technology integration increased the subjects' efficacy.

Furthermore, as their level of competency increased, the students became more prone to take risks with technology. In addition, their attitudes toward technology became more confident. The teachers cited the modeling and mentoring of the faculty that aided them. This study supported the Kumar, Rose, and D'Silva (2008) study in which teacher mentoring and professional development had a definite bearing on teacher attitude towards computers. Kirkscey (2012) supported the findings of previous investigations of small technology integration. However, Kirkscey's results also showed two important factors: (a) as the teachers became more competent and efficacious in technology; the integration process advanced; (b) teachers wanted additional training and implementation in technology applications. Thus, the literature implies that teachers can be successful in creating a technology environment. However, hardware and software are not the primary tools that would also include efficacy building and innovation. Just as students need information and encouragement in the acquisition of knowledge, practitioners require adult-centered learning environments to navigate technology. Howard (2011) argued that teachers will take risks using technology if they understand the benefit to students and themselves. One means of technology accommodation via TPACK is the use of professional development.

Professional Development

It is important to analyze teacher technology professional development (TPD) through the lens of TPACK. Mouza (2011) posited that professional development embedded in TPACK helps teachers understand the overt and finite impact of technology in education. The findings of Doering, Veletsianos, Scharber, and Miller (2009) advocated the same findings. These authors worked with teachers receiving professional development in online programs and classroom use of the program. The teachers received training in TPACK prior to their work on the participation.

The exponential growth of electronics in the classroom places additional pressure on teachers to understand the transition from traditional to technology classrooms. They will give students two significant benefits. One is creativity in the use of technology. The other is the self-efficacy that generates creativity (Albion, Jamieson-Proctor, & Finger, 2010; Archambault & Crippen, 2009). Equally important, administrative and political expectations for teacher use of technology to raise test scores has intensified (Means, 2010). Technology professional development (TPD) schedules have dramatically multiplied to meet these demands. However, Ewing-Taylor (2013) noted the Board of Education based TPD is somewhat lacking in content and meeting teacher needs. O'Hara, Pritchard, Huang, and Pella (2013) underscored the necessity for TPACK-based TPD to aid teachers in adapting to technology. Additionally, as districts practice creative funding for technology (Oliff, Mai, & Leachman, 2012), teachers will have to draw upon their technological skill in the classroom to accomplish learning (Martin et al., 2010).

School districts have turned to professional development for support, development, and assessment in technology-related instruction as a means of offsetting budget reductions. Reigeluth (2010) maintained that technology purchases and usage should be cost-effective entities, which would absorb fiscal decreases. Lei (2010) argued that school systems should rethink the effect of technology on student achievement before making acquisitions. In support of Lei’s position, Demski (2010) explored the suggestion that second-hand technology is a strong contender for school purchases. Nevertheless, technology in schools is replacing traditional learning tools, and teachers continue to need preparation to interface with new and old demands (Roy, Vanover, Fueyo, & Vahey, 2012). Teacher professional development often appears as a strategy that helps teachers understand and practice delivery of information to learners. It is a widely-practiced and expensive discipline in the United States (USDOE, 2012). The results have had varying results: Some are positive, and some are marginal. For example, Hill (2009) argued:

> The professional development "system" for teachers is, by all accounts, broken. Despite evidence that specific programs can improve teacher knowledge and practice student outcomes, these programs seldom reach real teachers on a large scale. To use a shopping metaphor, these research-proven programs offered by university faculty or nationally recognized providers are "boutiques" serving a handful of fortunate teachers while leaving many more to shop at the Wal-Marts of the professional development world. Most teachers received uninspired and

often poor-quality professional development and related learning opportunities. (p. 470)

Notwithstanding, and with minimal results, professional development continues as a mainstay in American schools. The demand for educational reform has propelled it center stage in continuous teacher education. Most technological professional development (TPD) occurs at school sites. Within these environs, teachers and administrators attempt to improve instruction through mentoring, collegial coaching, and study teams. However, Tondeur et al. (2012) held that TPD must occur at the preservice teacher level. They contend that under-exposure and under-use of technology begin at teaching colleges. In an earlier study, Allsopp, McHatton, and Cranston (2009) not only laid the foundation for TPACK training at teaching colleges, but they also called for understanding preservice teachers' attitudes toward technology. Their argument was that TPD must take the beliefs of teachers into consideration when planning sessions. The tendency carries over to in-service teachers, and it has a negative impact on technology integration. Kereluik, Mishra, Fahnoe, and Terry (2013) amplified these findings. However, they also maintained that content and domain knowledge (technology, pedagogy) were critically important in helping students to learn. Consequently, it is also important to begin using the TPACK framework in teaching institutions. Zhao (2011) argued that broad knowledge of disciplines integrated with the domains become critical, creative tools for preservice and subsequent in-service students and teachers. In the classroom, students will model their teachers by assuming higher thinking order skills.

The TPACK (Koehler & Mishra, 2006) framework underscores the complexity of learning and the need for teacher training to integrate content, curricula, and technology into a formidable teaching tool. Hence, in-service teachers will no longer have high technology underuse (Kutluca, Gokalp, & Ziya Gokalp, 2011). Gray, Thomas, and Lewis (2010) also reported the underuse of technology in classrooms. They used surveys from the National Center for Education Statistics (NCES, 2008-2009). The response concluded that while the majority of teachers had computers in the classroom, fewer than 50% of teachers and students used the computers during the instructional class time (Gray et al., 2010).

A TPACK background provides a platform for dialogue on problems encountered in the classroom. It also brings to the sessions a desire to share information. Such topics could include cross-discipline formats, students as researchers, and intercultural student collaboration for problem solving. Thus, with TPACK, teachers bring higher order skills that make TPD significant. However, a prerequisite for meaningful TPD is the involvement of teacher-learners in planning stages.

Many results of previous surveys of teacher perception on TPD convey dissatisfaction. They cited poor planning, little regard for teacher technology ability, and minimal concern for content diversity (Bai & Ertmer, 2008; Casey, 2013; Curwood, 2011, 2013). They addressed the need for TPACK integration in school (Agyei & Voogt, 2011; Ewing-Taylor et al., 2013; Jimoyiannis, 2010b; Krauskopf & Forssell, 2013; Mishra & Koehler, 2005). Interestingly, 61% of the teachers reported that training by school staff was beneficial (Gray et al., 2010). That same percentage also reported that professional development helped to prepare them for technology integration (Gray et al., 2010). These findings alluded to teacher frustrations that result in the underuse of technology. It is also an inability to master electronic instruction. The major significance of this study was that over 50% (Gray et al., 2010) of the respondents had favorable attitudes toward professional development. The literature is explicit in noting that teachers have an idea of the complexities of technology in learning. However, they can understand its benefits only if they help develop training sessions. This participation includes suggestions and implementation of ideas and follow-up sessions.

Gunn and Hollingsworth (2013) completed a 3-year longitudinal study of a district-wide TPD plan in Canada. Their goal was to observe the shift to 21st-century skills. They found that with increased professional development, teachers developed efficacy and took risks in applying the software. Teachers participated in extensive TPD exposure, which was TPACK-based. Subsequently, they began to develop technology-rich classrooms. Curwood (2013) supported these findings. Curwood also suggested that technology in the classroom would have success if professional development were a major proponent. In the process, LBD (Kolodner et al., 1998) projects were integral parts of professional development sessions. The literature implies that school districts should make commitments concerning ongoing professional development that has teacher input. Such an action would be effective in developing positive teacher attitudes.

Ewing-Taylor, Pennell, and Brackett (2013) conducted a yearlong study on technology needs of teachers. The findings show the respondents expressed negative attitudes toward professional development. They felt that the quality of the meetings was not beneficial. They also were skeptical about the availability of sessions. This attitude may have developed from top-down management in which teachers are not participants. Cordingley (2008) raised the issue of school-based continued professional development and its usefulness. Basing the conclusions on results of other studies, the author held that teachers' goals differ from schools' goals, and thus tension arises. Furthermore, the studies show that the tensions continue to exist. Perhaps Schibeci et al. (2008) were alluding to these tensions by advancing the argument that professional development (ideas and content) should originate with teachers. Additionally, they contended that administrative awareness of teacher attitudes and experiences play a role in any professional development design (Schibeci et al., 2009). Valanides and Angels (2008) constructed a professional development program driven by technological pedagogical knowledge (TPK). The results supported the findings of Mouza (2011) in that professional development can prepare teachers in-service and preservice for technology integration. The results also supported the findings of Richardson (2012) that teachers were confident about their knowledge of technology and pedagogy of content matter; however, their classrooms were neither student-centered nor illustrative of their knowledge base. Because students and teachers were not creative, there was no authentic use of computer tools. Hence, the inference that although teachers professed knowledge of TPK, they needed extensive training. Findings such as these have led to the search for a professional development model of technology integration, which would be TPACK-based.

In searching for a professional development model, Tearle and Golder (2008) conducted a study at a British teaching college. Their findings showed that the institution provided minimal content-driven professional development. The lack of resources in this vital area was typical of primary and secondary TPD. Thus, preservice teachers did not receive a baseline measure for TPACK. Figg and Jaipal (2013), Roy, Vanover, Fueyo, and Vahey (2012), and Simpson and Bolduc-Simpson (2013) upheld these findings.

The literature showed that sincere and dedicated TPD has taken place. The recognition of the value of teacher-learner input and searching for the ever-elusive TPD model illustrate that progress is occurring. However, survey results and findings indicate the need for sincere TPACK-based TPD. Particular attention should rest with technological pedagogical knowledge (TPK) and pedagogical content knowledge (PCK). Attention to these areas would increase teacher self-efficacy (Abbitt, 2011). A greater shift to student-centered from teacher-centered designs is a direct result of teacher self-efficacy. Fortunately, practitioners are beginning to realize that this shift does help teachers change their beliefs and attitudes toward technology. Teachers require continuous TPACK-based professional development to be effective change agents. This process transcends formal sessions and enters the arena of face-to-face and informal professional development. However, it requires the skill and knowledge of technology coordinators whose participation is vital to elements in technology development.

TPACK and Teacher-Technology Integration

The classroom implementation of TPACK becomes a difficult and somewhat slow matter without the assistance of a technology coordinator (TC). The formation of technology-rich classrooms must face several hurdles before they become learning centers. For example, teachers' technology wariness impedes progress. Among the contributing factors are modest preparation for technology and technological misconceptions that result from inadequate training (Albion et al., 2010; Bull, 2010; Kereluik, Mishra, Fahnoe, & Terry, 2013). Adding to the problem is the inability of the teacher to grasp the meaning of technology and its impact on student learning (Hutchison & Reinking, 2011; Koehler & Mishra, 2011). In many instances, teacher inclination to accept and explore technology ends in frustration and reticence. As they begin to accept TPACK, they facilitate the change from traditional to 21st century teaching.

Teachers can use the domains of TCK and PCK as reference points. The flexibility of TPACK gives them interchangeable roles, which allows positive progress in teacher technology integration. Their repertoire includes formal and informal professional development, which they can integrate machines, pedagogy, and content for student benefit.

Thus, teachers become change agents (Abbitt, 2011). They help other teachers with efficacy (Lin & Chiou, 2008), and integration of technology becomes effective.

Sugar and Holloman (2009), while acknowledging the many roles of technology coordinators, argued that leadership skills are worth developing. In their mixed-method study of 37 teachers, Sugar and Holloman found that problem-solving facilitation and resource management helped to develop leadership qualities in teachers. Riel and Becker (2008) allowed that administrators should foster teacher technology leadership. It is conceivable that such collaboration between teacher and administrator would include networking with other schools, attending workshops and webinars, and joining communities of practices. The teachers would include district and building administrators in teacher assessment, professional development assignments, and review of future purchases.

There are limited studies on the impact of technology coordinator impact on teachers and learning (Buckenmeyer, 2011; Hofer, Chamberlin, & Scot, 2004; Reinhart & Rathsack, 2013). However, the emerging themes from the literature capture the need for a universal understanding of roles assumed by the technology coordinator. The most important role of the TPACK technology coordinator is helping teachers to understand, use, and take risks with technology. Through modeling TPACK, teachers become sensitive and accepting of technology. The literature shows examples of teachers who have made progress under technology coordinators (Doering et al., 2009); patience is tantamount to achievement, and teachers can be highly successful. Reinhart and Rathsack (2013b) noted that the TC and TPACK increase the quality of TPD. The reflection constructs of LBD aid in teacher recognition and acceptance of ever-changing technologies. They act as inhouse reference manuals for building personnel. They instigate LBD projects, via encouragement, collaboration, and risk-taking (ISTE, 2013).

The task of the technology coordinator is to make a traditional classroom into a learning environment in which technology-sensitive teachers and students gather, disseminate, and manipulate information. The TC uses LBD constructs to create new paradigms of learning. These new models are central to 21st century thinking (Bhattacharya, Mach, Moallem, & Barton, 2011; Voogt, 2010). Thus, the TC uses the LBD constructs of analysis and explanation (Kolodner, Crismond, Gray, & Putamber, 1998) to identify challenges embedded in the problem. The process often occurs through TC facilitation of teacher discussion, reflection, and sharing of a priori knowledge.

LBD and Teacher-Technology Integration

The design and redesign constructs of LBD enable teachers to plan and construct solution designs for technology integration (Lu et al., 2011). Inherent in all of these constructs are collaboration and iterative research that produce incidental and deliberate learning processes. Fessakis, Tatsis, and Dimitracopoulou (2008) investigated using LBD as a tool to establish blogs in geometry learning. They compartmentalized online forums, Wikis content, learning management (simple) Html, and management systems into LBD tasks. These initiatives established blogs through which students were able to learn geometry. The results found that students advanced in learning geometry when LBD and experienced technology specialists guided the learning activities. Thus, teacher use of

LBD developed another use of technology in the classroom. At the same time, the study added to the literature on pedagogical technology.

In their research, Yelland, Cope, and Kalantzis (2008) conducted a qualitative study to show how LBD supported and encouraged the teachers to establish the research, innovation, and reflection for teachers. The study focused on 30 upper primary and junior secondary teachers. By investigating how and when students learn through LBD activities, results showed that teachers were able to think of planning and instruction in many, different, new ways. Also, the investigation showed how LBD enables teachers to understand how learning is a social process in which teachers and students can participate. Another participation of teachers in LBD and TC is the examination and conceptualization of pedagogical needs as they relate to curriculum standards.

The extensive use of design revision, collaboration, and evaluation is part of the experiential process. Through LBD, teachers apply these methods to academic programs, planning, and instruction. Du Plessis and Webb (2011) conducted a study of sixth- grade students and teachers. The goal was to understand how students and teachers used LBD to create a hypermedia project. The results found that students reacted positively to planning before implementation of designs. Students also benefitted from the reiterative processes, which enabled them to improve their strategies.

A school that promotes LBD activities for problem solution and generation is a powerful learning instrument for teacher adoption of technology in learning. LBD activities represent a constant reminder of the goals for technology-rich classrooms.

When teachers initiate LBD activities, they develop psychological reinforcement of technology and its uses. By sharing knowledge through LBD modeling or undertakings, the teachers generate an environment in which they learn, incidentally or deliberately. Thus, students, teachers, and technology coordinator create an ambiance of learning with and through technology.

Research Questions and Hypotheses

The NETS Standards for Technology in Education (2014) is a guidebook for states, school districts, and professional development training courses. However, it also incorporates the principles of LBD and TPACK as meaningful vehicles for teachers and administrators. In essence, TPACK is essential for technology integration. From the entire TPACK, this study focused on the categories that have to do with technology (TK, TPK, TCK, TPACK), not directly with the required knowledge of the traditional teacher (PK, CK, PCK). The latter was less relevant for technology integration than the former; besides, it could imply a personal evaluation of the teachers, which was an issue to avoid. In this sense, there was set of research questions (RQ) addressing the effects of TPACK on tech integration. As stated in the theoretical framework, TPACK came to fruition via LBD; therefore, a further set of RQs addressing the effects of LBD on teacher TPACK was necessary. The following research questions and hypotheses formed the core of the methodology.

Research Question 1

Does teacher participation in LBD activities predict their TPACK?

Hypotheses:

H1.1₀. Teacher participation in LBD does not predict their technological knowledge.

$H1.1_1$. Teacher participation in LBD does predict their technological knowledge.

$H1.2_0$. Teacher participation in LBD does not predict their technological content knowledge.

$H1.2_1$. Teacher participation in LBD does predict their technological content knowledge.

$H1.3_0$. Teacher participation in LBD does not predict their technological pedagogical knowledge.

$H1.3_1$. Teacher participation in LBD does predict their technological pedagogical knowledge.

$H1.4_0$. Teacher participation in LBD does not predict their technological pedagogical content knowledge.

$H1.4_1$. Teacher participation in LBD does predict their technological pedagogical content knowledge.

Research Question 2

Does teacher TPACK predict technology integration in their mathematics classes?

Hypotheses:

$H2.1_0$. Teachers' technological knowledge does not predict technology integration in their mathematics classes.

H2.1$_1$. Teachers' technological knowledge does predict technology integration in their mathematics classes.

H2.2$_0$. Teachers' technological content knowledge does not predict technology integration in their mathematics classes.

H2.2$_1$. Teachers' technological content knowledge does predict technology integration in their mathematics classes.

H2.3$_0$. Teachers' technological pedagogical knowledge does not predict technology integration in their mathematics classes.

H2.3$_1$. Teachers' technological pedagogical knowledge does predict technology integration in their mathematics classes.

H2.4$_0$. Teachers' technological pedagogical content knowledge does not predict technology integration in their mathematics classes.

H2.4$_1$. Teachers' technological, pedagogical, content knowledge does predict technology integration in their mathematics classes.

Research Question 3

Does TPACK mediate the relationship between teacher participation in LBD activities and technology integration?

Hypotheses:

H3.1$_0$. Teachers' technological knowledge does not mediate the relationship between their participation in LBD and technology integration.

$H3.1_1$. Teachers' technological knowledge does mediate the relationship between their participation in LBD and technology integration.

$H3.2_0$. Teachers' technological content knowledge does not mediate the relationship between their participation in LBD and technology integration.

$H3.2_1$. Teachers' technological content knowledge does mediate the relationship between their participation in LBD and technology integration.

$H3.3_0$. Teachers' technological pedagogical knowledge does not mediate the relationship between their participation in LBD and technology integration.

$H3.3_1$. Teachers' technological pedagogical knowledge does mediate the relationship between their participation in LBD and technology integration.

$H3.4\ _0$. Teachers' technological pedagogical content knowledge does not mediate the relationship between their participation in LBD and technology integration.

$H3.4_1$. Teachers' technological pedagogical content knowledge does mediate the relationship between their participation in LBD and technology integration.

Implications

The school district had the same issues as other inner cityschool districts. Bolstering marginal student academic achievement with technology barriers was a significant trait they shared. Hence, the implications of the findings of this study were important to inner cities and the educational communities. Teachers' instructing students how to use computers for creative problem solving is a lasting 21st-century skill. Mastery of this skill would serve careers and everyday living well into the next century.

Continued progress with these and other technological skills was contingent upon LBD strategies leading to TPACK. In the absence of technology coordinators who advance these concepts, inner city districts would develop equal alternatives.

For example, the outcome of this study will be a policy statement to act as a guidance mechanism to build centers of collaboration for the expansion of knowledge. It will help the district to lay the groundwork for collective knowledge that benefits all. Shared knowledge should be a global process that allows the exploration and questioning of current information and methodologies. These paths will give rise to new ways of thinking found in professional learning communities.

The policy statement will help to identify tools and concepts that are peculiar to the district. At the same time, it will encourage and support teacher understanding of educational changes vis a vis technology (TPACK enhanced goals). Hence, the district will be able to improve content pedagogy through subsequent teacher efficacy and learning. The rationale for recommending a policy statement is that it is teacher grounded. It builds a sense of community for its stakeholders (Nistor, Daxecker, Stanciu, & Diekamp, 2015). Most importantly, it is participatory leadership, and it allows leadership to rise in accomplishing given situations.

Escalating purchasing and maintaining costs in technology translated into new and creative ways of using technology in classrooms. Cases in point were the different ways of thinking about professional development content, and teacher time allocations must have different perspectives. Giving teachers more time to participate in TPACK-based LBD projects would be a cost-effective venture. The implications were that administrators must proactively incorporate meaningful technological growth sessions with careful planning and include TPACK. The other implication was that teachers could express their needs and wants through LBD projects. In other words, administrators should allow those who know best to participate in the planning.

Summary

Underperforming students and low test scores were a large part of the educational crisis in this district. After instituting several remedial programs, the district developed a technology plan, which included remediation and acceleration. Thus, technology became the primary means for overall student improvement. The plan included professional development to accommodate the transition from traditional classrooms to technology-driven environments. However, budget cuts phased out school-based technology coordinators, and although some remained in their positions, the remainder received assignments to central locations. The problem became maintaining teacher technological growth with minimal professional development, which were the sources of TPACK and LBD activities. There were two considerations for choosing this problem.

The apparent lack of TPACK classroom practice was a convincing factor in the selection process. Many inner city school districts, as well noninner city districts, use technology as remediation and acceleration agents without incorporating technology concepts in teacher training. TPACK is a major component in teacher technology preparation. Such training supports teacher understanding, which initiates meaningful and creative interaction with technology. Without this theoretical framework, teacher progression may tend to stagnate. Technology coordinators and professional development are significant change agents that implement TPACK through coaching. Hence, student learning vis a vis technology does not have the desired result without their involvement. The literature underscores this argument. The significance of this problem is that it is occurring throughout American schools, in particular those in inner cities, which is the other consideration.

Severe budget cuts were becoming the norm for American education. At this school district, with its burgeoning, the diverse student population was not an exception. Thus, it was incumbent upon administrators to explore alternatives for affecting technology integration. The implication was that the study could present a low-cost model for technology integration. The anticipated results offered an opportunity to explore other avenues for technology development. Should the district adapt these possibilities and produce technology-rich classrooms, it would set in motion a blueprint for success. Teachers become accepting and less wary of technology integration. Student achievement and improved test scores were part of the blueprint. Accordingly, the district would establish a technology professional development plan (NJD, 2010-2013) for inner cities through sharing findings, ideas, and concepts. Hence, the construction of carefully designed and articulated guiding questions was important. They formed the skeletal framework for this study. Subsequently, exploration of the research questions could solve the problem of continued teacher progress in technology integration. Most studies concerned teachers and technological operations. Another area of information was technology versus student acquisition of knowledge. The literature review highlighted the gap in the informational studies. Through a quantitative, descriptive investigation, this study sought to add to that body of knowledge.

The theoretical framework was TPACK and LBD. Both provided a succinct platform from which to grasp the trends of the teaching staff in meeting its technology goals. It also contributed to an understanding that producing technology-rich classrooms remained an elusive, long-range accomplishment. The interplay of these dynamics gave dimension to the challenge; nevertheless, an unbiased study, clearly and deductively presented, gave breadth and depth to understanding the problem. A descriptive quantitative investigation was a good conduit for such an undertaking.

In the literature, there was a scarcity of studies on teacher participation in LBD activities leading to TPACK. One of the deficits stemmed from the lack of understanding of methods needed for technology integration (Mishra & Koehler, 2005). Another was supporting teachers in building student-centered technology classrooms (Lu, 2014). Figg and Jaipal (2013) contended that TPACK-practice workshops should drive professional development. From these sessions would come LBD activities, which generated research. Thus, it was a change agent meeting the demands of 21st century technological paradigms.

The implications of this study emphasized two themes. The first was that teachers must understand that technology is not going to disappear. Rather, it will assume a greater posture in classrooms. It became more complex in practice and demanding in collaboration. The second emphasis was that LBD and TPACK are formidable theoretical concepts, which led to teacher self-efficacy and student empowerment in learning.

The two concepts helped teachers to become proactive in setting their technological agenda. The proactivity was a result of teacher efficacy. From this setting, teachers would use the concepts to be flexible in thinking and goal setting. Teacher capacity for reflection becomes stronger than before. Eventually, through teachers' acting out of the concepts, a student would begin to model them.

Section 2 provides a discussion of the study's methodology.

Section 2: The Methodology

Introduction

As depicted in *Figure* , three research questions drove the study:

1. Does teacher participation in LBD activities predict their TPACK?
2. Does teacher TPACK predict technology integration in their mathematics classes?
3. Does TPACK mediate the relationship between teacher participation in LBD activities and technology integration?

In the following section, I will discuss the research design and method as well as give an overview of the population and the sampling. In addition, I will discuss the instruments and materials and give a synopsis of the variables. The segment on data collection and analysis gives a procedural accounting for the gathering, organizing, and analyzing of the data gleaned from the survey. The summation of this section will include the assumptions, limitations, scope, and delimitations of the study.

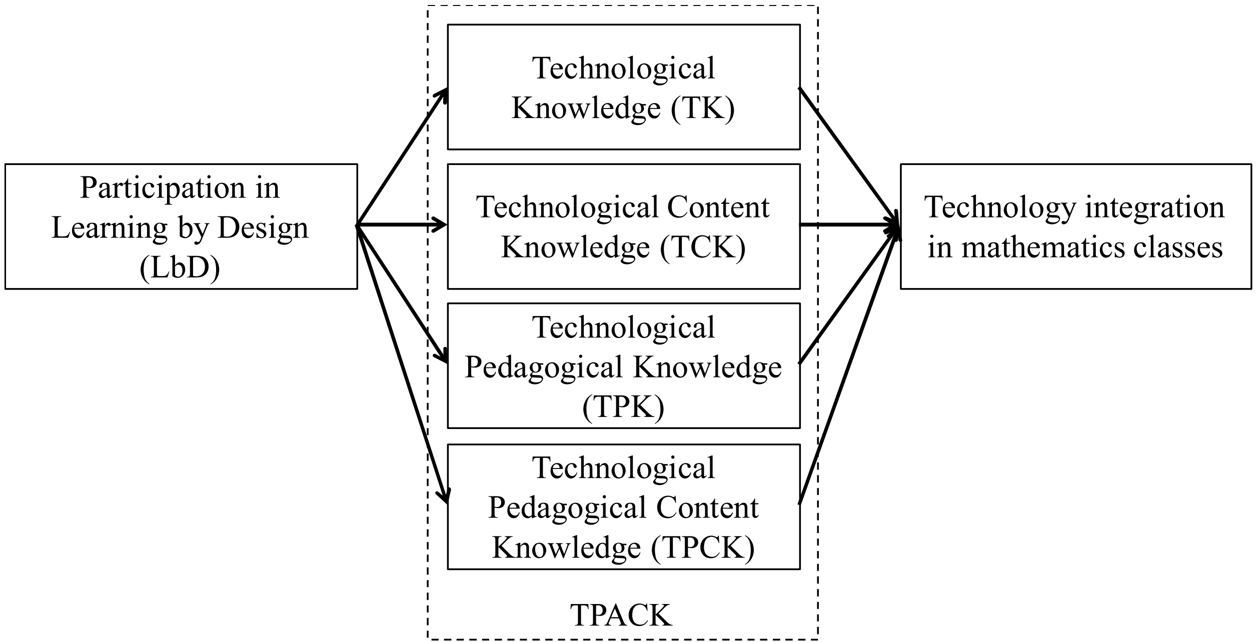

Figure 4. Research model.

Research Design and Approach

In this study, I addressed the problem through a research design strategy that is quantitative, correlational, and has a cross-sectional base. Quantitative research establishes patterns, variable causality, and the need for further analysis (Creswell, 2008). The correlational aspects allowed the measuring and examination of more than two variables and of the strengths of the relationship among these variables. The quantitative research design allowed me to analyze variables without using holistic systems (Lodico, Spaulding, & Voegtle, 2010), which would occur if I pursued a qualitative study. NJD administrative and instructional changes could not support observations, interviews, surveys, and other methods this approach required (Maxwell, 2012).

Mishra and Koehler (2006) hypothesized that teachers can enhance and enrich student learning and increase test performance through technology. Hence, it was plausible and appropriate that a quantitative approach would allow me to test the TPACK theory. The design allowed me to analyze different components of TPACK (technology, pedagogy, and content), and how teachers reacted to each one. I collected and examined the data on teacher perceptions of their participation in LBD, their TPACK, and their technology integration in mathematics classes. This analysis narrows the TPACK theory to an argument of rejection or confirmation. This line of reasoning puts forth the strongest defense for using the quantitative approach.

Setting and Sample

The setting for this study was a school district in Northern New Jersey, which is experiencing major fiscal cuts, as discussed in the problem statement section. NJD employs 2,862 teachers, and approximately 127 are secondary mathematics teachers. The district has two STEM-based schools. Teachers from these schools did not participate in the study which reduced the population to 109 teachers which were invited to participate in this study. This strategy produced parity and facilitated validity for the study.

The sampling participants were diverse in ethnicity. Hence, the demographic makeup included African American, Asian, Hispanic, and European American teachers. All participants were full-time mathematics teachers. I used archival data as an overview on the instructional staff. Teachers accessibility to technology was part of the criteria for participation. Additionally, teachers who worked with technology and software for instruction and had at least one session of technology professional development completed the selection criteria.

Variables and Instrumentation

The instruments I used was the TPACK questionnaire (Zelkowski, Gleason, Cox, & Bismarck, 2013) with subscales for participation in LBD, technology knowledge (TK), pedagogical knowledge (PK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), technological-pedagogical and content knowledge (TPACK), and technology integration (TI) in mathematics classes.

- *Participation in LBD*. This variable identifies respondents' participation in solving technology problems jointly with peers.
- *Technological knowledge (TK).* This variable identifies the respondent's technology knowledge. Its overarching goal is to capture the respondents' strengths and understanding of technology.
- *Pedagogical knowledge (TP).* This variable identifies the respondent's pedagogical knowledge. Its overarching goal is to capture the respondents' strengths and understanding of pedagogy.
- *Technological content knowledge (TCK).* This variable identifies the respondent's selection of appropriate technology to use with content matter, which also includes the placement of software.
- *Technological pedagogical knowledge (TPK).* This variable identifies respondents' ability to apply different instructional strategies for delivery of

content information using educational technology. It differs from technological content knowledge in that it requires creativity in combining content pedagogy and technology.

- *Technological-pedagogical and content knowledge (TPACK).* Categorically, this variable defines a teachers' knowledge base of strategies used for technology integration. In this study, TPACK is a moderating, dependent variable.
- *Technology Integration (TI) in Mathematics Classes*. This variable highlights teachers' use of technology as a teaching resource educational on a regular basis.

Technology integration in mathematics classes is the dependent, participation in LBD the independent, and TPACK the mediating variable. All variables from the TPACK constructs (TK, TP, TCK, TPK and TPACK) are dependent on participation in LBD, while in turn predicting technology integration in mathematics classes. Thus, they mediate the influence of participation in LBD on technology integration in mathematics classes. The instrument that measures the participation in LBD is a modified version of the published Zelkowski, Gleason, Cox, and Bismarck (2013) questionnaire with a seven-point Likert scale. The scale options are: *Strongly Disagree* - value of 1; *Disagree* - value of 2; *Somewhat Disagree* - value of 3; *Neutral* - value of 4; *Somewhat Agree* - value of 5; *Agree* - value of 6; and *Strongly Agree* - value of 7.

The theoretical discussions concerning the use of Likert response scales format focus on categorization. Jamieson (2004) and Kuzon, Urbanchek, and McCabe (1996) presumed the Likert response scales format as ordinal scales requiring analyzation as such. They argued that within the data, the Likert scales produce rank and order, which signifies ordinality. Therefore, nonparametric statistics is the analytical tool. Baggaley and Hull (1983), Maurer and Pierce (1998), and Vickers (1999) argued that Likert scales can be treated as interval data if the scale item is either five-point or seven-point. They argued that intervals are actual attributes of the data and parts of the labeling. Furthermore, Lubke and Muthen (2004) held that the results stemming from this kind of analysis are quite valid. Blaikie (2007) argued that in ordinal-level measurements, the intervals between ordinal categories need not be equal (Blaikie, 2007, p. 21). His premise rested upon the argument that not every respondent will interpret a choice the same way. Carifio and Perla (2008) supported Blaikie by highlighting many studies that show Likert response formats to be interval scales and that Likert response formats can produce empirically represented data and even ratio data logically and empirically (Carifio & Perla, 2007, p. 115). They surmised that scales are interdependent and subscribe to empirical data. Thus, they are open to parametric analysis.

My purpose for selecting Likert response format scale was to obtain a score that represented a numerical description of the participants' exposure to LBD and usage of TPACK to obtain classroom technology integration. The summation of their attitudes and beliefs toward technology integration would give a statistical analysis description (Trochim & Donnelly, 2008). Hence, a scoring instrument is a good fit. I also used the scaling to test the hypotheses of the study. In addition, the instrument had a unidimensional scaling system, which means that it was easier for understanding the constructs of TPACK and LBD. The instrument was a paper and pencil document requiring 45 minutes to finish.

Table 3

Variables, Hypotheses, Survey Statements, and Measurement Scales

Variable	TPDe	Hypotheses	Survey Statements	Measurement Scale
Participation in LBD activities	Independent	RQ1: $H1.1_0$, $H1.1_1$, $H1.2_0$, $H1.2_1$, $H1.3_0$, $H1.3_1$, $H1.4_0$, $H1.4_1$	Item# 29, 40, 41, 42, 46, 47, 49, 62, 64, 67, 68, 69	Continuous/ Interval
Technological Knowledge (TK)	Dependent/ Mediating	RQ2: $H2.1_0$, $H2.1_1$, $H3.1_0$, $H3.1_1$,	Item# 1, 2, 3, 4, 5, 6, 7, 8, 21, 22	Continuous/ Interval
Technological Content Knowledge (TCK)	Dependent/ Mediating	RQ2: $H.2_0$, $H.2_1$, $H3.2_0$, $H3.2_1$	Item# 11, 12, 13, 14, 27, 48, 50, 63, 65	Continuous/ Interval
Technological Pedagogical Knowledge (TPK)		RQ2: $H2.3_0$, $H2.3_1$, $H3.3_0$, $H3.3_1$	Item# 9, 10, 20, 23, 24, 25, 28, 43, 44	Continuous/ Interval
Technological Pedagogical and Content Knowledge (TPACK)	Dependent/ Mediating	RQ2: $H2.4_0$, $H2.4_1$, $H3.4_0$, $H3.4_1$	Item# 30, 32, 33, 34, 35, 36, 37, 38, 39, 51	Continuous/ Interval
Technology Integration	Dependent	RQ3: $H3.1_0$, $H3.1_1$, $H3.2_0$, $H3.2_1$, $H3.3_0$, $H3.3_1$, $H3.3_1$, $H3.4_0$, $H3.4_1$	Item# 15, 16, 17, 18, 19, 26, 31, 45, 66	Continuous/ Interval

Data Collection and Analysis

After receiving IRB approval (07-25-16-0263198) and approval from the Superintendent of New Jersey, I administered the paper survey (see Appendix F) to all secondary school math teachers at several school sites. The survey was given to 127 teachers, and 101 returned the completed survey, which is a response rate of 80%, which is relatively high in educational studies. I cleaned the data to remove corrupt or inaccurate information. I used the same criteria that Zelkowski et al. (2013) applied in their study, such as lack of engagement, zero variances in responses, manual inspection of surveys to identify unusual patterning, and completeness of the instrument. I analyzed the collected data using the IBM SPSS Statistics version 24. Additionally, I examined nonlinear relationships using WarpPLS version 6 (Kock, 2017).

Assumptions, Limitations, Scope, and Delimitations

The assumption is that participants selected answers according to their classroom practices. There is the assumption that participant answers reflected their honest opinions because I informed them of their anonymity rights. They also knew that they could withdraw from the study at any time.

The limitations of this study were the small sample population and sample size and the low return rate.

The scope of this study comprised a location in an urban district and secondary mathematics teachers. The rationale for this selection was that many urban districts have problems with technology integration, in particular mathematics classes. A middle/secondary school, with underachieving students, a technology program in place, and mathematics teachers with experiences in technology professional development present suitable subjects for study. Thus, data analysis from this study will be useful to other schools facing the same dilemmas.

Protection of Participants' Rights

Participants completed forms for permission to proceed. The forms included the following:

- Letter of Introduction about me and the copy of the
- Sample Data Use Agreement (Appendix B)
- Sample of Confidentiality Agreement (Appendix D)
- Letter of Cooperation (Appendix E)
- Sample Data Collection Coordination
- Sample Consent form

All participants received a cover letter. Letters of Cooperation from the District and Passaic Educators' Association-Teachers' Union identifying myself as the researcher, the goals of the study, and my contact email address accompanied the forms. Additionally, they received documents informing them of their rights, in particular the hold harmless withdrawal policy (Creswell, 2008). The respondents signed the required documents in the Welcome Packet for collection before receiving the survey.

The Office of the Deputy Superintendent has informed me that I would be able to administer and collect the survey for teachers (see Appendix F). Upon receipt of IRB approval (07-25-16-0263198), I contacted the deputy superintendent to make scheduling arrangements. At the administration of the survey, I identified myself. I also explained the purposes of the study, procedures, risks, and benefits associated with this study, and protection of identity, implications, and directions for the study. I also gave my email address and availability contact. Respondents personally received notification of any changes to the format or other relevant events affiliated with this research.

Respondents remained anonymous. All data gathered were exclusively for this study. I stored the data in a locked file cabinet in my study. I will retain the data for 5 years. Respondents might know me personally because I am a teacher at this site and have taught professional development on math concepts; however, I have no supervisory function over the other secondary math teachers that were invited to participate in this study. Respondents were informed that they could withdraw from the study at any time.

Data Analysis Results

Data Distribution Assessment and Factorial Analysis

A first examination of the collected data revealed significant deviations from the normal distribution, with both Kolmogorov-Smirnov and Shapiro-Wilk $p < .000$. A confirmative factorial analysis (see item loadings in Table 4) was performed to test the scale construction. As displayed in Table 8 items TPACK53, TPACK 59, and TPACK60 factored together, and items TPACK51, TPACK55, TPACKn1, TPACKn2, TPACKn3, and TPACKn5, also factored together. An examination of the item content revealed greater similarity in meaning amongst the items in each group than between items from different groups. Specifically, the items in the first group, in the following denoted TPACK1, are more generic in their scope than items in the second group, denoted in the following TPACK2, which are more specific and cover more narrow areas of expertise. Based on this understanding, the latent variable TPACK1 should concentrate on the *mastery* of technological, pedagogical and content knowledge, whereas the latent variable TPACK2 should describe the *width* of the same knowledge. The measure instrument in its final form including the resulting scales is provided in Table 4.

Testing the Research Model

From the relationships indicated in the research model (Figure 4), only LBD-TK and LBD-TPACK2 resulted in significant regression coefficients (i.e., $\beta = .42$, $p < .01$ for LBD-TK and, respectively, $\beta = .38$, $p < .01$ for LBD-TPACK2), which suggested that most relationships were non-linear. Therefore, all relationships were considered curvilinear and tested using WarpPLS. It was noted that this statistics package does not provide path analyses in complex research models, therefore partial mediation models were tested with results shown below in detail in Table 4 and Figures 5, 6, 7 and 8.

Table 4

Confirmative Factorial Analysis with Factor Loadings

Model	Predictor	Mediator	β	p	R^2	Criterion	β	p	R^2
Figure 5	LBD	TK	.42	< .01	.18	TI	.23	< .01	.18
	LBD	-	-	-	-	TI	-0,33	< .01	
Figure 6	LBD	TPK	-0,26	< .01	.07	TI	.28	< .01	.07
	LBD	-	-	-	-	TI	-0,3	< .01	
Figure 7	LBD	TCK	-0,21	.01	.04	TI	.19	.02	.16
	LBD	-	-	-	-	TI	-0,29	< .01	
Figure 8	LBD	TPACK1	-0,25	< .01	.06	TI	-	-	-
Figure 9	LBD	TPACK2	.38	< .01	.14	TI	-0,24	< .01	.18
	LBD	-	-	-	-	TI	-0,34	< .01	

Significant, direct, curvilinear relationships were found between the variables LBD, TK, TPK, TCK, TPACK2 and TI. TPACK1 was significantly related to LBD, but not to TI. The knowledge variables TK, TPK, TCK and TPACK2 were significant but partial mediators, meaning that the relationship between LBD and TI was partially direct, partially mediated by the knowledge variables. These relationships explained up to $R^2 = .18$ of the variance in TI, and up to $R^2 = .18$ of the variance in the knowledge variables TK, TPK, TCK, TPACK1 and TPACK2.

In Hypotheses 1.1, 1.2, 1.3, 1.4, and 2.1, 2.2, 2.3, 2.4-2, there was rejection of the null hypotheses. The data provided evidence supporting the alternative hypotheses. The null hypotheses 2.4-1 corresponding to the latent variable TPACK1 was accepted. The mediation hypotheses 3.1, 3.2, 3.3 and 3.4-2 were partially supported because the relationship TPACK1-TI was not significant. The corresponding mediation hypotheses 3.4-1 lost its meaning; therefore it was not part of the testing procedures. An overview over the hypotheses test results is in Table 8.

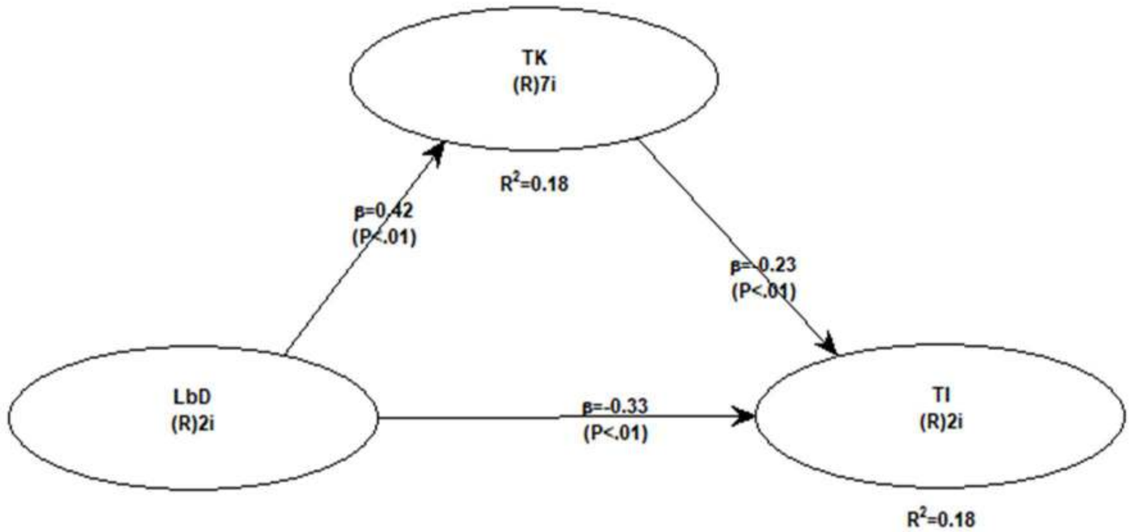

Figure 5. Relationship between LBD and TI with TK as a mediator.

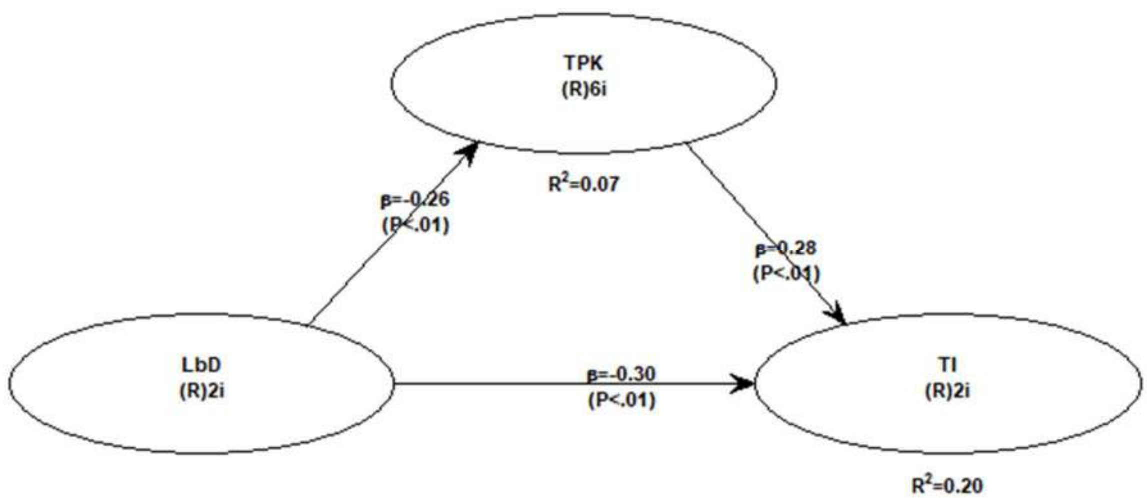

Figure 6. Relationship between LBD and TI with TPK as a mediator.

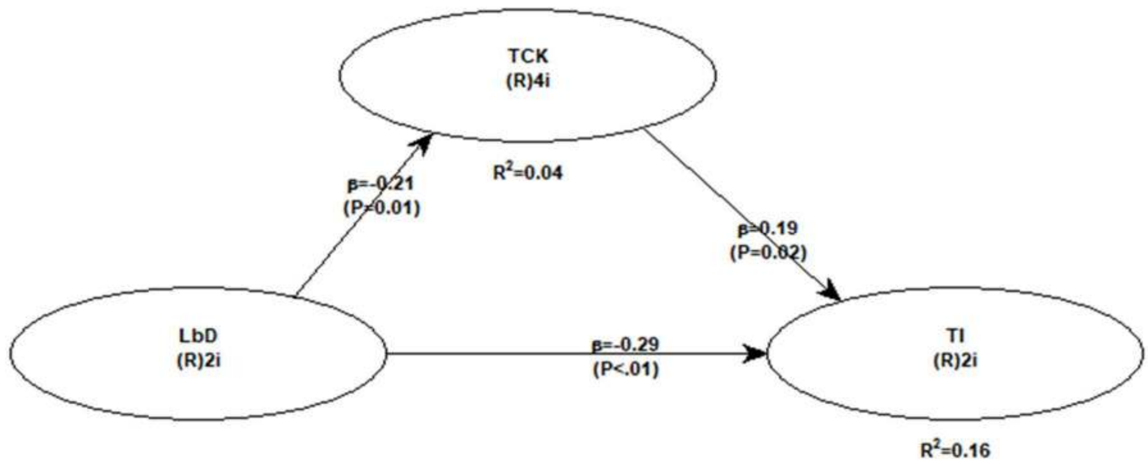

Figure 7. Relationship between LBD and TI with TCK as a mediator

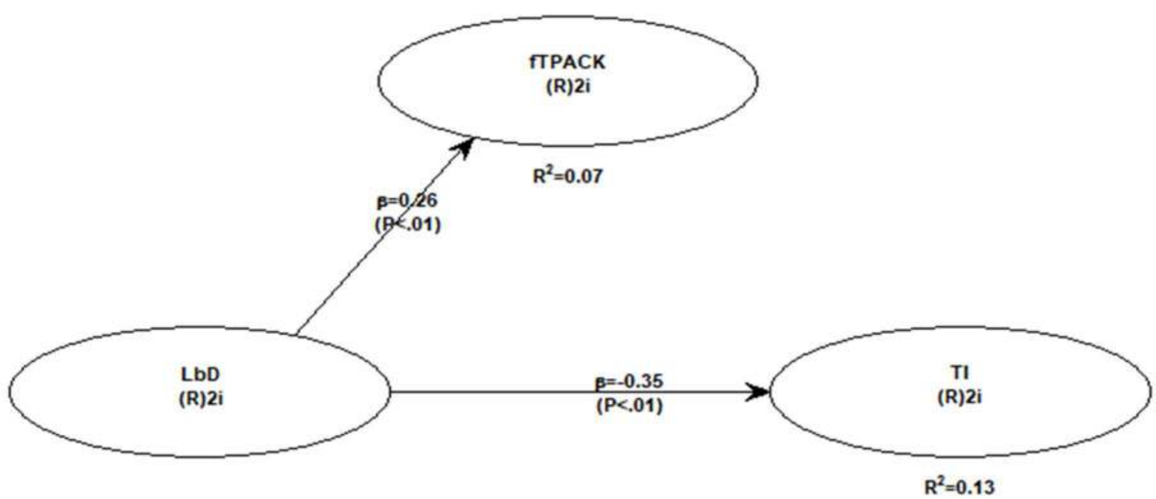

Figure 8. The TPACK 2nd order factor model.

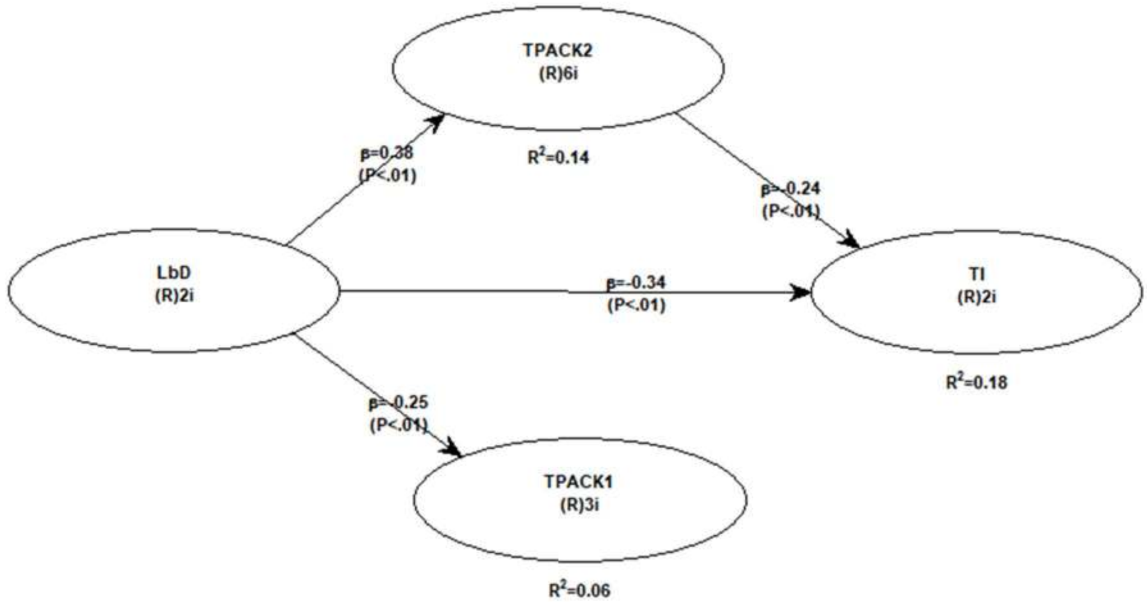

Figure 9. The TPACK model with two distinct factors (TPACK1 and TPACK2).

For a better understanding of the algebraic sign of the curvilinear correlation coefficients, and especially of the negative ones, the relationships between variables were plotted. For instance, linear or nearly linear relationships were found between the variables LBD-TK ($\beta = .42$, $p < .01$, $R^2 = .18$), as shown in Figure 10, and between LBD-TPACK2. U-shaped relationships were found between LBD and TI whereas the considered mediators did not substantially change the shape of the curve. Similar relationships were further found between
LBD-TCK, TCK-TI, LBD-TPK and LBD-TPACK1. A reversed U-shaped relationship was found between TK and TI (Figure 12). Finally, a strongly decreasing curvilinear relationship suggesting a saturation effect was found between TPACK2 and TI (Figure 13).

Table 5

Hypotheses Test Results

Hypothesis	Involved variables	Test result
$H1.1_0$	LBD-TK	Rejected
$H1.1_1$		Supported
$H1.2_0$	LBD-TCK	Rejected
$H1.2_1$		Supported
$H1.3_0$	LBD-TPK	Rejected
$H1.3_1$		Supported
$H1.4_0$-1	LBD-TPACK1	Rejected
$H1.4_1$-1		Supported
$H1.4_0$-2	LBD-TPACK2	Rejected
$H1.4_1$-2		Supported
$H2.1_0$	TK-TI	Rejected
$H2.1_1$		Supported
$H2.2_0$	TCK-TI	Rejected
$H2.2_1$		Supported
$H2.3_0$	TPK-TI	Rejected
$H2.3_1$		Supported
$H2.4_0$-1	TPACK1-TI	Accepted
$H2.4_1$-1		Not supported
$H2.4_0$-2	TPACK2-TI	Rejected
$H2.4_1$-2		Supported
$H3.1_0$	LBD-TK-TI	Rejected
$H3.1_1$		Partially supported
$H3.2_0$	LBD-TCK-TI	Rejected
$H3.2_1$		Partially supported
$H3.3_0$	LBD-TPK-TI	Rejected
$H3.3_1$		Partially supported
$H3.4_0$-1	LBD-TPACK1-TI	-
$H3.4_1$-1		-
$H3.4_0$-2	LBD-TPACK2-TI	Rejected
$H3.4_1$-2		Partially supported

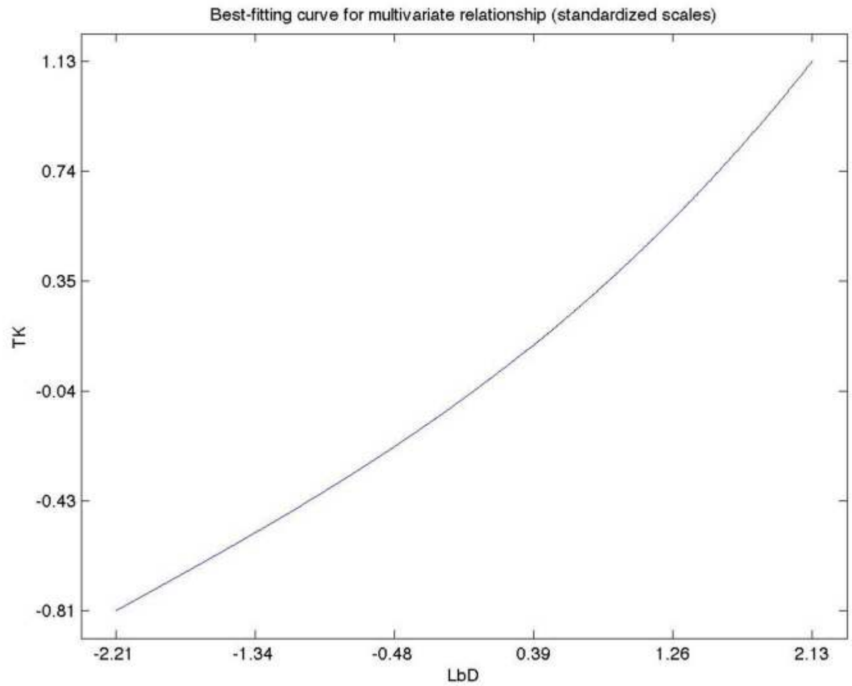

Figure 10. Relationship LBD-TK.

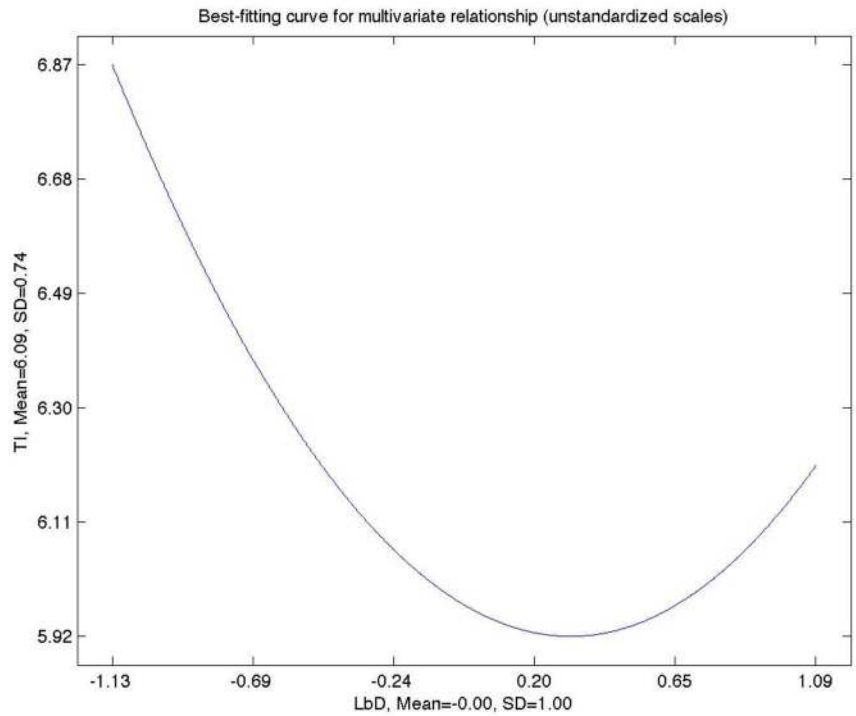

Figure 11. Relationship LBD-TI.

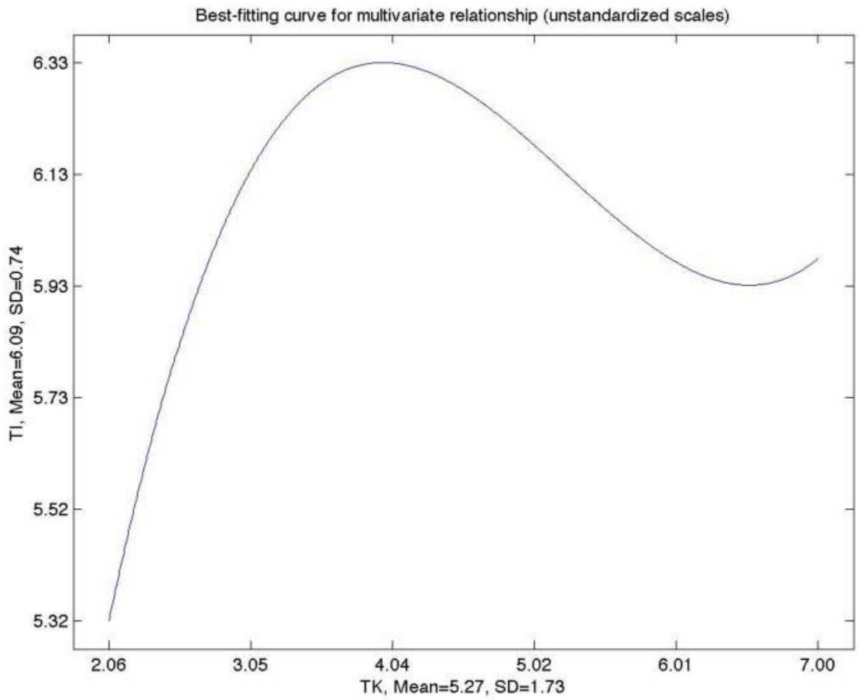

Figure 12. Relationship TK-TI.

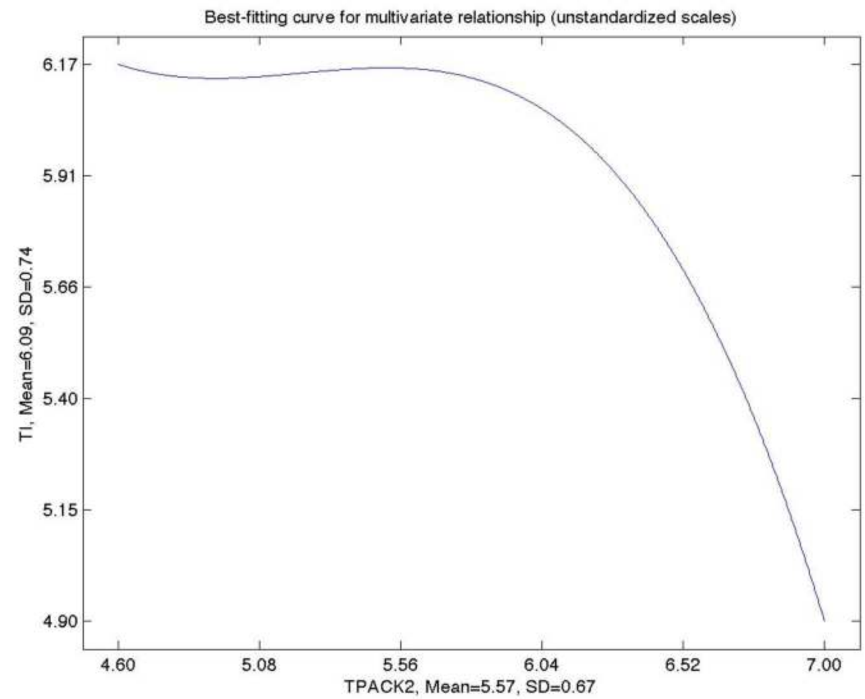

Figure 13. Relationship TPACK2-TI.

Summary and Discussion of Findings

The preceding findings show that, in general, LBD predicts technology integration. All examined knowledge variables (TK, TPK, TCK, and partially TPACK) are predictors of *technology integration.* The examined knowledge variables (TK, TPK, TCK and TPACK) mediate between LBD as predictor and *technology integration*. However, they also showed as dependent/predicted/outcome variable. When TPACK shows as two separate factors, TPACK1 (indicating knowledge width) and TPACK2 (indicating mastery), only TPACK2 mediates between LBD (the PCL component) and technology integration.

Of noted interest, the relationship between LBD and technology integration was curvilinear and U-shaped. This means that a small involvement in LBD activities may result in a decrease in technology integration. The results show that a change of focus to teacher and learner outcomes to be positive. Jaipal-Jamani et al. (2015) supported this finding. They implied that changing the emphasis from technical skills to how technology can meet content learning outcomes not only stems from an environment of LBD, but it also has positive results. Such an effect can occur, for instance, when technology is integrated in classroom teaching in a spontaneous, little reflected manner, thus comprising more or less meaningful applications of educational technology (Dong, Chai, Sang, Koh, & Tsai, 2015; Koh, Chai, Benjamin, & Hong, 2015). Acquiring applicative knowledge from LBD activities, and thus mastering the educational technology applications, may first increase teachers' critical thinking and eliminate unnecessary or ill-conceived applications, thus reducing the total amount of technology integration (Hung & Yeh, 2013). A higher involvement in LBD activities results in stronger applicative knowledge of educational technology and may thus increase the (meaningful) technology usage (Figg & Jamani, 2014).

The same applies for the relationship between involvement in LBD activities and knowledge of educational technology applications. While there is a simple, linear increase in knowledge of technology with the practical design activities, the TPACK combinations appear to decrease first with the design practice. This suggests that everyday knowledge and misconceptions, as well as illusions of knowledge, are probably eliminated. In consequence, the self-evaluation of TPACK knowledge turns more realistic and, hence, decreases. Only a stronger involvement in design practices may lead to a real increase in TPACK knowledge.

As for the surprising decrease in technology interpret integration, when teachers reach very high levels of mastery (TPACK2), this can indeed cause a saturation effect. In spite of utopic visions of the technology-rich classroom of the future (e.g., Mäkitalo-Siegl, Zottmann, Kaplan, & Fischer, 2010), educational technology will always have its limits, and parts of the educational process will always be carried out in the traditional way.

This study started from the problem of student underachievement, questioning the possibility of improving school performance by the use of educational technology, and by teachers' involvement in technology-based instructional design practice. Based on teacher surveys, the collected data support this assumption. However, the same data also suggest that teachers' professional development by design practice should aim not only at TPACK knowledge acquisition, but also at increasing teachers' critical thinking and eliminating technology applications based on everyday knowledge and misconceptions, thus strengthening the conceptual and theoretical roots of technology-enhanced instruction. These aspects are discussed more in depth in the project chapter of this doctoral thesis.

Conclusion

The intention of this study was to provide the district with cost-effective alternative solutions for its problem of continued teacher progress in technology integration. I used a quantitative, correlational design based on transsectional data, which verifies the research model. There are many solid avenues of research approach available. However, the design and approach fit this study. It can discover hidden effects and patterns. Additionally, research objectivity, data management, and generalizability are convincing parts of the process. As I wanted to describe the attitudinal and behavioral trends of this specific teaching population, I used survey research. Thus, the purpose of this study was to know what the teachers' experiences in LBD were and what they knew about TPACK.

The theoretical concept of LBD and the constructs of TPACK drove the study. They formed the foundation for constructing the variables and subsequent research questions. LBD activities and TPACK offer expansive pathways to technology integration. The former provides teachers with exploration and initiation of problem-solving techniques. The latter, through its constructs, gives teachers an awareness and competency in technology integration.

Professional development sessions were the setting. Mathematics teachers are the target population. Of that group, secondary mathematics teachers make up the sampling. However, teachers based in STEM-centered schools are not part of the sampling. Their exclusion provides a stronger case for the validity of the study. The sampling will complete a 60-item survey. It is a 7-point, Likert format scale. The instrument is an existing survey, which already has proven reliability and validity. However, as I made modifications to the instrument, I used Cronbach's alpha to measure the reliability of the modified version. SPSS v. 23 is the software that I used to analyze the collected data. I will use this program, to obtain descriptive statistics for the data. I built the scales as a mean value of items. The manipulation gave me a clearer understanding of the statistics, which represent the effects among the variables. I used multiple regression analysis to answer the research questions. However, as with all research projects, there will be concerns.

The study does not include the state or other district schools. Instead, the sampling comes from one school within the district. Its size may limit the generalizability goal of the study. The other concern is that the participants come from a target population of secondary mathematics teachers. Hence, the subject teaching matter is not cross-discipline. Again, this factor will affect the goal of generalizing to a larger population.

Implications and suggestions for future study will show that teachers are working through LBD sessions, originating on-site. This method will continue growth in technology and substitute for the loss of internal, technology professional development. This investigation is significant because many inner city schools are attempting to enhance student academic and test performance with technology, and they are sharing the same problems with those of this district.

Section 3: The Project

Introduction

Background of Existing Problem

As part of the remedial process, the district incorporated technology to enhance student achievement, test performance, and acquisition of 21st-century skills. Its other goal was to solve the problem of deficient student achievement in mathematics. The Board of Education implemented two technology plans to improve student learning, test performance, and technology skills. The goal was to support and encourage teacher technological acceptance leading to technology classrooms. Support for teacher-technology professional development became an important goal. Professional development budgets received strong fiscal funding. The chief objective was to establish technology-rich environments in American classrooms to bring them up to 21st-century standards. However, budgetary reductions did not support continued and diversified professional development programs in technology. Lack of these opportunities tends to retard teacher and student growth. This study addresses two issues confronting this school district. One is the continuation of teacher technology growth. The second is the maintenance of teacher-technology training as funding decreases. These are the focus points resulting from this study. They became the driving force and ultimate foundation behind a policy statement.

Description and Goals

The policy statement is in tandem with the New Jersey Professional Development Statute 6A:9C (Trenton, 2014). Hence, its recommendations are in keeping with the spirit of state law. Of importance, the recommendation developed from an analysis of the data that grounded its concepts in teacher responses. The goal of the project is to combine the quantitative results of the study to support sound strategies that ensure ongoing teacher professional development in technology. Its data-driven tenets provide a robust foundation for structuring and sustaining teacher-generated professional development workshops. Such strategies include developing inhouse technological professional development sessions as permanent units within each school building. Contrary to using costly external consultants, the policy recommends that all activities are teacher led. Teachers would have significant, participatory engagement in the design, implementation, and follow-up training activities. Driving the units are topics taken from LBD Activities that arise from TPACK-based problems. Using the technological talent of teachers and related personnel, participants meet to discuss, solve, and create building-specific technological challenges. That is, teachers advance the content matter of the professional development sessions through LBD activities geared to TPACK problem solving. Teacher/facilitators conduct the research and pragmatic schema for sessions. This concept is substantiated by the acceptance of hypotheses questions $H1.1_1$, $H1.2_1$. $H2._{1,}$ $H2.1_1$ (See Table 8). Furthermore, Brodie's qualitative study (2014) of professional learning communities noted that teachers are less inhibited to express their ideas in such surroundings. Thus, the study advances the goal of continuing teacher progress in technology.

These LBD undertakings also serve as identifiers for new problems. They provoke and nourish teacher collaboration, which tend to give rise to the creation of new knowledge and artifacts. The anticipation is that the actions channel and strengthen communities of participation (CoP), which will perform as learning centers as well as agents of change (Ambar Murillo de Oca, Nistor, Dascalu, & Trausan-Matu, 2014; Bridwell-Mitchell & Sherer, 2017; Brodie, 2013; Gellert, 2013). The Agyei and Keengwe (2014) study is also supportive of the study's outcomes. Hodges and Cady (2013) investigated communities of practice as continued learning resources. Their investigation was a two-year, longitudinal case study of middle school mathematics teachers completing a math course. Their findings showed that professional development led to the development of communities of practice. Also, teacher involvement at all levels increased the strength of the community. Although this study did not follow a longitudinal approach, its results were similar to those of Hodges and Cady (2013). However, the study also showed that the relationship between LBD and technology integration was curvilinear and u-shaped (see Figure 11); the study suggests that teachers should involve themselves in critical, robust readings and discussions of technology and mathematics (Dimmock, 2016). The linearity of the findings are the same as those of Beisiegel, Gibbons, and Paul (2016), who held that teachers can lose sight of mathematics pedagogy because of an overload in LBD activities in technology integration.

The study established a baseline profile of teacher experiences in LBD activities and experiences in practicing TPACK. For example, the data analysis showed curvilinear relationships between the variables LBD, TK, TPK, TCK, TPACK, and TI. The correlation between TPACK and LBD was significant. However, the relationship between TPACK and TI was small (Pamela, 2013; Shinas, 2013)**.** The results do show that LBD does bring about TPACK, which teacher experiences can support. However, the correlation between TPACK and technology integration was minimal. This suggests that LBD activities (necessary for TPACK) are not only vital but also integral bridges to technology integration. Of interesting notation is that Research Questions 3.1-4.2 were partially supported (See Table 8). This finding rendered the inability to test RQ3.4.-1 (See Table 8). Consequently, the impact on the policy statement was that TPACK had two identities. One dealt with the depth of knowledge that a participant had, and the other dealt with the mastery of knowledge. This finding underlines the policy statement formulation in the relationship between LBD activities in TPACK-problem solving. In support of this study, Handal et al. (2013) investigated the integration of TPACK in 280 secondary mathematics teachers.

The sampling involved teachers with varying years of experiences. The two-part, mixed-method study used a 5-point, Likert-TPD scale comprising of 30 items. The constructs measured were TCK, TPK, and TPCK. The second part consisted of qualitative information. The descriptive analysis of data included the mean, standard deviation, percentage, and Pearson correlation analysis (Handal, 2012). They added inferential statistics with two-tailed *t* test for independent sampling and one-way ANOVA (Handal, 2012). Their findings suggested that technology professional development courses be a core part of teacher training. In reference to this study, the results advocate less of an emphasis on technological skills and more in-depth, ongoing training on teacher technological knowledge. The Handal study supports this finding. Subsequently, teacher use of digital resources for learning as well as sharing of ideas and skills would be a direct result of LBD activities.

Teachers are aware of the benefits of technology in education (Dong et al., 2015; Kaliisa & Picard, 2017; Kearney, Schuck, Burden, & Aubusson, 2012). However, in contrast to their actual practice of using technology to promote learning, they have difficulty integrating tools, pedagogy, and content into classroom reality (Mishra & Koehler, 2007). Polly, Mims, Shepherd, and Inan (2010) noted that while teachers may attend technology professional development (TPD), they have difficulty ascribing to the TPACK framework. The authors suggested that teachers need other supportive environments outside of the TPD, which this study posits (Lu, 2014).

The results of this investigation show that TPACK assumes a dual role: mediator and predictor of predicted/outcome variables LBD and TI (See Figures 8 and 9). The predictor identity of TPACK variable pertains to the mastery of knowledge that the participants exhibited. The mediator identity of the TPACK variable highlights the depth of knowledge that the participants had (see Figure 8). Thus, this TPACK duality strongly suggests that the flexibility of a policy statement would be of major consideration. It also is dependent upon changes in the participant's teaching environment. Polly (2011) supported this particular finding of the study. This platform is also held by Gupta and Bostrom (2013); MacPhail, Patton, Parker, and Tannehill (2014); and Sack, Quander, Redl, and Leveille (2016). The next portion deals with the rationale for the project and its ramifications.

Rationale

This study addressed two issues confronting this school district. One is the continuation of teacher technology growth. The second is supporting technology training with decreasing fiscal support. After analyzing the data, this study advances a policy recommendation based upon teacher technology skills. The assumption is that using in-house talent diversifies the approach to solving technology issues. It also strengthens teacher and administration core understanding of technology as an ancillary instructional tool. It becomes a touchstone device.

Its tenets provide a robust foundation for structuring and sustaining teacher-generated professional development workshops, which in turn decrease the fiscal dependency on external hiring of consultants. Using the technological talent of teachers and related personnel, participants meet to discuss, solve, and create building-specific technological challenges. In actuality, through using LBD activities, communities of participation (CoP) permit teacher-technology growth. Accordingly, then, this process allows the school district to model social change

The policy recommendation engages teachers to identify and collectively develop solution simulations. Should the district adopt this policy, its stakeholders will inform and drive the professional development curricula. In addition, it provokes and nourishes teacher collaboration by supporting joint dialogue in problem solving. Hence, a tradition of stakeholder involvement is a valuable strategy to follow. Furthermore, targeting the digital divide solves problems. It also prepares students for the 21st century and beyond (Lawal, 2014; Raghuveer, Tripathy, Singh, & Khanna, 2014). Of importance, the policy statement recommendation developed from an analysis of the data that grounded its concepts in teacher responses. The policy recommendation is in tandem with the New Jersey Professional Development Statute 6A:9C (Trenton, 2014).

I chose this genre to address the problem because the school district shares issues with those of other inner city schools. Should the district successfully implement this policy statement, it will serve as a prototype for other inner city districts. My rationale is that, as an educator with more than 28 years of administrative and instructional experiences, I want to share my repertoire to a school sector in trouble. Another rationale is that the district does not have fiscal support as in prior years. Therefore, progress that teachers have made in technology integration may slow down. Additionally, the module is to serve as an in-house mechanism that provides ongoing technology professional development. Through LBD (Kolodner et al., 1998) activities, the module requires teachers to be charge of their own technological learning. Thus, my rationale has motivated me to offer the community, a policy recommendation that will ensure technology integration in classrooms

I firmly believe that teachers should play a significant role in finding solutions to their school-based problems. They should also have the responsibility to implement the design of their learning and discover new problems. Thus, the teacher-based policy statement amplifies their voices (Grindle, 2017), which reflects the values and norms to which they ascribe. The policy statement has wide latitude and flexibility for practitioners to be creative in professional growth. It gives teaches, parents, students, and administrators a definitive role by showing constraints and possibilities (Bowe, Ball, & Gold, 2017). Policy statements allow for compromise.

I also chose writing a policy statement as a project (acquiring TPACK through LBD activities) because it provides a flexible framework for total teacher involvement in some aspects of fiscal management. The data of the study show that the teachers have the resources and capabilities to maintain and sustain PD sessions. The subject matter varies because it is building-specific and not generic in nature. Thereby, it can sustain reiteration of content matter at low costs. Moreover, it assumes the identification of future problems with fluidity. Subsequently, it nullifies the need to hire outside consultants. Hence, it tends to nullify the problem of continuing technology PD. In summary, it is not only possible; it is also sustainable. This quality is an important feature for teachers to model and for students to witness (Weimer & Vining, 2017). The language of the policy statement will draw attention to this feature. Finally, and in support of this genre, teachers are a latent, creative source who would willingly support collaborative learning among themselves. The data finding analyses concerning Research Question 2: $H1.4_1$, (as in Simpson and Bolduc-Simpson, 2013; Tyler, 2013; Jaipal-Jamani, Figg, Gallagher, McQuirter, & Ciampa, 2015) support my position that LBD has the propensity to acquire TPACK through collaborative means, which is a major promulgation of the policy statement.

LBD leading to communities of participation gives the participants the power to do research in a collaborative environment, which is a 21st century tool. Hence, teacher efficacy becomes stronger as they encounter issues of greater difficulty. From this vantage point, they pass on to students new skills in critical thinking. TPACK is not only embedded in the process, but teachers and students learn together (Evans, Nino, Deater-Deckard, & Chang, 2015). Further, teachers should be more active in the development, implementation, and follow-up of their own technology professional development. The analysis of participant response to Research Question 2 showing the subsequent acceptance of alternative $H2.1_1$; $H2.2_1$; $H2.3_1$ as well as Nyikahadzoyi (2015) substantiate my findings. However, the same analysis of Research Question Two, $H2.4_0$ underlines the need for more clarification between Technological Content and Technological Pedagogy. The policy statement can address this issue. Acquiring TPACK through LBD activities is a good in-house tool for Technology Professional Development (Koehler & Mishra, 2011). Existing studies (Agyei & Keengwe, 2012; Evans et al., 2015;

McBroom, 2013; Stoilescu, 2015) support my findings. Subsequently, the selection of a policy statement as genre not only speaks to the district's problem, but it also brings awareness to social change.

Through this process, the school district models social change by targeting the digital divide. It provokes and nourishes teacher collaboration supporting joint dialogue in problem solving. It also prepares students for beyond the 21st century (Lawal, 2014; Raghuveer et al., 2014). The positive social change at local and nation-wide levels will be that teachers will enter actual partnerships with administrators vis a vis technological professional development. Furthermore, teachers, as those closest to the problem, will no longer have to depend upon external translations of their technological and pedagogical needs and visions. Thus, they will be able to speak and act for themselves. The implications include the recommendation that teachers demonstrate to students the art of collaboration as key to problem solving. They should model the importance of research and team problem solving. Most of all, they will present to students the philosophical value of becoming lifelong learners. The expectation is that the recommendations of the policy statement will have positive social change, locally and statewide.

Although they are not in order of importance, each in its own right represents a necessary stepping-stone toward positive social change. These important path marks toward social change include bridging the digital divide, practicing shared management, administrators and teachers as lifelong learners, and the community evolving as risk-takers for success. With the mastery of these path marks, the anticipated effect is that teachers begin to explore and employ creative avenues for technological learning for themselves and their students. Hence, the school site develops communities of participation.

Review of the Literature

Once seen as a possible cure for student academic improvement, technology is now a potential for assisting teachers in classrooms. Recently, researchers have explored concepts that contribute to growth in this area (Ewing-Taylor, Pennell, & Brackett, 2013; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). This review of the literature examines investigations that are appropriate to the problems experienced by this school district and the results of the study. At the same time, the analytical and comparative processes provided a meaningful platform of support for continued research.

Search Methodology

For my literature search, I returned to the Walden Library. There I found helpful personnel who were more than willing to aid me in my searches. Their assistance in providing studies I could not find was immeasurable. I also revisited the archives of professional organizations such as The National Council of Teachers of Mathematics and the International Society for Technology in Education (ISTE). As a member, I had free access to the archives and to their virtual librarians. ISTE was also a valuable source of papers delivered at conferences. There were topics that I could not ordinarily find in journals. I included a new resource, the Association for Supervision and Curriculum

Development (ASCD). This organization has a solid reputation for publishing scholarly articles on the administration of teachers.

Additional measures that I used to guide this project came from studies that advanced the importance of technology professional development (TPD) for teachers. These studies were a healthy mixture of different approaches, which offered significant dimensions of assessing the district's problems. The positions they advanced were compelling and thought provoking. Coupled with their bibliographical resources, I was able to gather quality resources for review. Furthermore, the bibliographies also had resources that were good for future studies. The demographics showed that all teachers were in-service, and the experience gap was of special interest to my study. I became sensitive to the importance of noting, descriptively, how this gap affected TPACK integration. Thus, I could address gender diversity recruitment in the project, if necessary. The challenging aspect of this review was to remain unbiased and to seek those studies that differed from mine in conclusions.

Important Terms

Keywords such as *technology professional development*, *LBD*, *TPACK*, *communities of participation*, *collaborative learning*, *professional learning communities*, and *educational technology* helped me in my search. They were excellent vehicles for the identification and discovery of new problems. Their analytical and comparative nuances provided a meaningful platform of support for continued research. These criteria formed a cohesive, influential touchstone in translating the findings as a policy recommendation.

The Review

The analysis of the data found that the variables LBD, TK, TPK, TCK, TPACK, and TI were curvilinear. Thus, their relationship or curvilinear disposition would change. If participants showed an increase in LBD then their TK would also show an increase. However, at a certain point, LBD would increase or remain stable, but their TK would decrease (See Figure11). A result would be stagnation in progress. Brodie (2013), as well as Gallagher, Griffin, Ciuffetelli, Parker, Kitchen, and Figg (2011), alluded to this possibility in their studies. They advanced the idea that CoP must include higher order and critical thinking platforms. Thus, LBD then becomes critical because it gives rise to CoP. Thus, professional development content must be stimulating and challenging to prevent teacher overload. The suggestions of the study's data analysis are that teachers can avoid saturation (See Figure 12) if they become risk-takers by becoming mentors and active problem solvers. Cheung, Lee, and Lee (2013) substantiated this suggestion. Polly and Drew (2012) and Schrum and Levin (2013) confirmed the study's finding of the participants' dual understanding of TPACK. This comparison confirms that the LBD reiterative process enables teachers to identify the distinction, thereby increasing technology integration. However, the caveat is to make certain that teacher satiety does not occur. This conclusion, to me, was a powerful lesson of using research and theory to support my selection of policy statement as genre. It becomes a flexible tool for combatting teacher boredom brought on by reiteration.

A comparison with other studies (Aldunate & Nussbaum, 2013; Jaipal-Jamani et al., 2015b) confirmed my findings. Exposure to LBD activities, serving as moderator variables, increases teacher-technology knowledge (TK; See Figure 5). The exposure to a variety of technology environments changes the attitudes and technology risk-taking inclinations of teachers. The settings include theoretical frameworks, software, hardware, and ongoing dialogues. Thus, they become predisposed to integrate cognition, content matter, and technology into the classroom. In addition, the mixed method research project of Kim, Kim, Lee, Spector, and DeMeester (2013) supports the findings of my study.

The authors investigated the role teacher beliefs have on cognition, pedagogy and their practice of teaching with technology. They found that lesson design and lesson implementation had a significant correlation to levels of technology. Notably, higher levels of teacher epistemology showed strong evidence of student-centered instruction. These teachers were also amenable to using technology for learning. Thus, the implication for TI and TPD is that teacher belief systems should be part of the planning process. This study is very critical to my project as it suggests that a mechanism for assessing teacher attitude toward learning with technology becomes part of the policy statement. Hence, the data will help guide this particular activity. For instance, this project is for in-service teachers with 1-30 years' experience, and a strong TPD parallel to years' experience enables successful participant involvement. Also, knowing and understanding the years' experience would help with the bonding process, which will lead to mentoring (Finger et al., 2013). The findings of a hermeneutical phenomenology study by Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012) supported the findings of the Kim study and those of mine. The analysis of the data revealed that Technological knowledge, technology Content Knowledge, and Technological Professional Development become collaborates in the LBD process by explaining or mediating the different levels of technology integration to teacher-participants. Thus, the partnership enables teacher-integration of technology (See Figures 5, 6, & 7). This finding also supports those of the aforementioned investigators, and they justify the selection of a policy statement as a genre.

Also in support of my study was that of Lu, Johnson, Tolley, Gilliard-Cook, and Lei (2011). The authors conducted a mixed-method study of in-service teachers' interaction with TPACK. The researchers' goal was to understand how teachers acquire TPACK. Their other goal was to aid teachers develop TPACK. They implemented an LBD model to facilitate teacher understanding and eventual technology acceptance. From the findings of their study, they advanced the argument that learning technology knowledge and skills does not ensure technology integration. They argued that unless a teacher understands and practices TPACK, technological support of student learning is a slow process.

Their findings suggested that LBD is an effective aid in acquisition of TPACK. They also found that in-service teachers were more receptive to understand and use TPACK. Most importantly, through LBD activities, teacher-efficacy grew, and they were willing to take additional risks. Hence, the process enhanced teacher-technology integration. The interesting finding was that teachers may have to reevaluate their teaching practices simultaneously with the content they teach (Tee & Lee, 2011). This study, coupled with the results of my investigation, underscored the need for a policy statement that helps to establish a mechanism involving, actively, new in-service teachers and teachers new to technology as participants. Furthermore, in the Lu et al. (2011) study, the teachers easily understood the theoretical framework of TPACK. In this this respect, their study was not only a good comparative document, but it also served as a touchstone tool. Aside from the substantiation of my study, both documents expanded my philosophy on social change.

This finding is integral to my study because district in-service teachers may need to attend courses in content matter, which is in keeping with Tee and Lee (2011). Based on this finding, my project will emphasize teacher continuing education in content matter. It will include items on teacher beliefs on continuing education. The investigators held that LBD can successfully increase participants' TPACK, thereby enabling technology integration, which was one of the purposes of my study.

An indirect goal of my investigation is to use its findings as a base for an ad hoc and continuing training module. PD has been cited in numerous studies (Landenberg et al., 2016; Walker, Rocker, Roberts haw et al., 2011; Wang, Myers, & Sandarac, 2012). Furthermore, the module is nongeneric, so that it would fill the needs particular to the building. Teachers would have input and requisition regarding their technological issues. It would be a cost-effective operation used by teachers and administrators. In addition to the studies previously mentioned, I used those investigations that were illustrative of the interconnectedness between research and theory. Thus, they were prototypical of this project's purpose.

In this study, the data analysis indicated that teachers need the constructs of TPACK to perform as mediator along with LBD for technology integration. However, previous studies have shown that preservice and in-service teachers cannot distinguish between CPK, TPK, and PK (Casey, 2013; Koh, Chai, & Tsai, 2013; Krauskopf & Forssell, 2013; Lu, 2014; Shinas et al., 2013). Chai, Ling Koh, Tsai, and Tan (2011) argued that a cluster analysis statistical approach would present, at a deeper level, teachers' perceptions on TPACK and its subconstructs. Hence, their results suggested that the policy statement should emphasize technological professional development design models. Such a development takes into consideration teacher perceptions of the relationships among the constructs. Furthermore, the process would highlight any teacher differences on TPACK constructs, which might affect their technology integration. I found these studies encouraging as they involved in-service teachers and their beliefs on learning and technology integration via TPACK. Furthermore, the participants were not unlike those of my study in that they have TPACK exposure and experience in TCK. This study guided my project in that I could embed activities for a wider range of participants. Hence, it motivated me to search for the connecting link between research and theory.

One link was how to use the results of the investigation to expand the creative use of content into existing resources. Another link was the knowledge that the theoretical framework should blend with the results to form a platform designed to sustain LBD activities and subsequent CoP modules. Accompanying the LBD compartment would be reflection practice. This phase could be a bonding component, which would also generate greater participation whose benefits would include visual representation in understanding technological growth. The findings also guided me in the idea of structuring a scaffolding component. Mouza and Karchmer-Klein (2013) noted that preservice teacher TPACK improved when they enrolled in an educational technology course with field experiences in which veteran teachers shared pedagogical knowledge. Additionally, hands-on teaching took place, and there was shared discussion among the students. Hence, perhaps teachers cannot acquire TPACK in isolation. They need internal and external support systems to bring the theoretical framework to fruition. The policy statement is illustrative of melding the results of these studies with my investigation. It is also a reliable example of interconnecting research with theory.

Summary

The review of the literature underlined a trend in changing from early criticisms of TPACK to acceptance and exploration of its constructs. When Mishra and Koehler (2006) introduced their theoretical framework, their intensions were to open dialogue on teacher- technology practices vis a vis integration of technology with content and pedagogical knowledges. Prior to their publication, emphasis was on teacher technology skills. Teacher content and pedagogical skills did not receive much attention (Buabendoh, 2012; Clarke-Midura & Dede, 2010; Nikolopoulou & Gialamas, 2013; Roschelle et al., 2010; Teo, Chai, Hung, & Lee, 2008). Since then, provocative, cogent discussions have embraced different variations on a theme by Mishra and Koehler (2006). The shift in position is showing an inclination towards an expansion of discussions amidst sincere inquiries. The impact of this trend on my study was that I now had wider range from which to compare results.

For example, the restructuring of TPACK, as in the study by Angeli and Valanides (2013), is a reaction to the problem of identifying the segments of TPACK. Other researchers, such as those of Meng and Sam (2011) and Shinas et al. (2013), purported that teaching colleges should emphasize PCK before introducing technology to preservice teachers. Hofer and Harris (2012) contended that empirical research on in-service teachers leans toward teacher TPK as opposed to TCK. Graham urged scholars to arrive at shared degrees of commonality in defining the constructs of TPACK and to understand the boundaries of TPACK. His position was that such an occurrence would improve understanding of the boundary issues. These varying philosophical platforms gave me balanced panorama in constructing the segments of the policy statement.

Research guides theorists and teachers to determine the borderlines among CPK, TPK, and PK. Additionally, they are not only dissimilar constructs, but their application depends upon the context, content, and experiences of the practitioners at the moment of usage. This is a point strongly supported by Harris, Grandgenett, and Hofer (2010) and Hofer, Harris, Hofer, and Harris, (2012). Furthermore, they held that scholars must voice the caveat that technology is not cognition. Thus, learners must obtain, assimilate, and creatively use information for present and future use as an enabling tool. Thus, it aids cognition. Tacitly supporting this argument, Stoilescu (2015) helds (in his study of three secondary, veteran math teachers and TPACK) that it is difficult to separate PCK because of the braiding of cognition and motor movement. Pamuk (2012) posited that teachers should concern themselves with developing PCK before delving into technology. Pamuk further argued that PCK is integral to integrating technology into the classroom. In-service teachers must be aware of the need to expand teaching experiences and continue to learn about content.

The reading of this study gave me the understanding that LBD activities would be a seamless segue for teachers to deconstruct TPACK while reconstructing it in terms of content, context, and new definitions (Ndongfack, 2015; Porras-Hernandez & Salinas-Amescua., 2013). This process would give the task an easier application for problem solving. From this, Pamuk (2012) added the new understanding that technology integration cannot occur without the support of strong PCK applications. Thus, it would also involve the design of an in-house educational technology course to encourage teachers to become lifelong TPACK learners.

Most compelling and thought provoking was the study of Angeli and Valanides (2013) with different observations on TPACK and its subconstructs. Using an approach called technology mapping, the authors' purpose was to find an alternative to facilitate teacher TPACK. Mishra and Koehler (2005) designed TPACK with the original intentions of applying it as a whole framework and not as individual parts. Thus, the model was to achieve technology integration in classrooms. From their prior studies of in service teachers and from their most recent study, Angeli and Valanides (2013) posited that empirical research has separated TPACK into its subconstructs. Thus, true assessment of teacher-TPACK is difficult to obtain. The issue is that teachers were and are unable to draw boundaries among CPK, TPK, and PK. The authors argued that consideration of TPACK, or rather TPCK, should be as a series of competencies that teachers need to teach with technology. Using this understanding, teacher assessment would be easier. Hence, the researchers restructured TPACK into a model that changed technology to information and communication technology. For further support, they added two new dimensions: student knowledge and contextual knowledge. Their argument was that teacher awareness of these knowledges facilitated student cognition and teacher instruction in a digital environment. This assessment supports my study's findings that teachers need LBD to moderate technology integration. However, there is a dearth of literature on LBD studies.

While scholars acknowledge LBD as an important structure in technology development (du Plessis. & Webb, P., 2011; Mishra & Koehler, 2006; Yelland, Cope, & Kalantzis, 2008), they have not forwarded the ways and means of its involvement. Noticeably lacking is its inclusion in teacher education and training curricula (Jaipal-Jamani et al., 2015; Lu, et al., 2011). Studies prior to 2012 showed that this theoretical framework is significantly supportive of and encourages an environment in which deep learning and collaboration are the norm (Han & Bhattacharya, 2007; Kolodner, 1993;

Kolodner et al., 1998; Schön, 1983). Current studies use LBD as a basis to emphasize that the properties of critical thinking, learning from errors, and research are pathways to technology-rich classrooms (Ertmer, Schlosser, Clase, & Adedokun, 2014; So, 2013; Walker, Recker, & Robertshaw, 2011; Ye et al., 2012). The lack of scholarly research on this important theoretical framework was my motivation to investigate the role of this important theoretical framework in teacher-technology training.

The writings of Mishra and Koehler (2006) influenced the development of my policy recommendation. Their reframing of TPACK provided deeper identification of the domain boundaries. Furthermore, the predictions of the data analysis (duality of TPACK) were easier to understand. Thus, they helped to advance of this study's policy recommendation. Their work incorporated significant teacher creative input into the learning environment through LBD activities. Furthermore, it took into consideration the schema of in-service teachers: what they know about technology and what they learned. Thus, it is supportive of student academic growth via teacher efficacy. There is also an increase in opportunity for tangible and meaningful teacher and student assessments. Most importantly, it is a robust conduit for technology-rich classrooms via TPACK or ICT-TPCK (Angeli & Valanides, 2013).

The readings afforded me critical review of my intentions for policy recommendations. I began to understand why teachers have difficulty in distinguishing the subconstructs of TPACK. Furthermore, this may be one of the reasons why technology has failed to improve student learning. Thus, the binding thread of the policy recommendation would be the implicit and explicit roles of pedagogy, content, and technology in TPACK. Pedagogy stimulates cognition and technology. While it is not cognition, it works as the catalytic agent helping students to acquire the knowledge. These studies also presented convincing evidence for the need to establish a common working application of PCK, TPK, PK, and their interplay with TPACK.

There is increasing focus on teaching colleges and new ideas about technological curricula. Changing TPACK from as-is acceptance to changing it for improvement appears to be the new trajectory in the literature. However, there is little evidence in the literature of using LBD as a possible gateway to teacher TPACK.

As a practitioner and a researcher, I drew inferences from the study. One important one was the connection between research and theory. I was able to observe this relationship by careful scrutiny of the theory put forth by Mishra and Koehler (2006) and how other studies used research to offer improvement. Two other important inferences I realized included that in-service teachers are more than willing to take chances with technology. Furthermore, they present an excellent source of mentoring for beginning teachers to continue their technological progress. However, unless schools use talent wisely in technology, fresher approaches to the field may be lost. From the studies took place in Indonesia, Malaya, and China, it is apparent that they share the same vision as I. Thus, the readings helped me to formulate ideas on establishing in-house PD units to work with problems and perpetuate technological growth, which was most appealing to my study.

The review has guided me in developing a viable platform for using LBD activities to enhance teacher-TPACK. I can use this information to assess the feasibility of using the project to withstand budget cuts. The policy recommendation advances the cost-effectiveness of the project. It is sustainable. It increases technology-rich environments. Most importantly, it builds teacher efficacy.

Project Description

Policy Statement Recommendation

The findings of this study combine with the review of current literature to drive the formulation of this policy statement. This policy statement is in keeping with the New Jersey Professional Development Statute 6A:9C (Trenton, 2014), which proposes to continue teacher advances in technology. The policy statement also supports the New Jersey District District Strategic Plan, 2014-2019: Priority I: Effective Academic Programs: Goal 5: Technology and 21st Century learning.

- The Policy recommends using teacher-conducted LBD to find solutions for TPACK-based problems.
- The Policy recommends that teachers function as trainers, facilitators, and project developers in finding solutions for building-specific technology issues.
- The Policy recommends that the district explore the permanent structuring of in-house, on-going Technology Professional Development sessions.

- The Policy recommends that the District encourage teachers to be Lifelong learners through research in and installation of TPACK practices.
- The Policy Recommends that teachers develop content and materials by using LBD activities, generated by TPACK-based problems.
- The Policy recommends that the school administrators support the teaching personnel to take responsibility for technology training.

Potential Resources and Existing Supports

The school district has multiple possibilities for site accommodations. I recommend that the administration work closely with the project coordinator for the use of existing resources and supports, which include:

- dedicated time allotments for sessions: As with all new programs, in particular in education, embracing the spirit of a new paradigm will take time. Faculty and related personnel will need periods that require discussion, question and answer sessions, adjustments to the idea of controlling one's destiny with in a system.
- dedicated classroom with whiteboards for facilitators, seminars, workshops and conferences. Establishment of such is vital to teachers' and related personnel's acceptance of the new paradigm.
- dedicated library with computer stations for personnel
- accessibility to copier with supplies whiteboard for conferences,

Project Evaluation Plan

Upon completing the study, I will present the district with the document and give a copy to the board. I will request a meeting with the superintendent and the director of staff development and program evaluation to discuss the findings and the acceptance of the project. I know that the district must have full approval of its board as well as approval from the State of New Jersey, Department of Education. This may take several months for a final decision. In the meantime, I will attempt to meet with teachers and department heads to review and explain the benefits of the project. As part of the evaluation process the findings of the study will accompany the project. The Office of Planning, Evaluation, and Assessment; teachers; department heads; and principals will receive a copy of the policy.

Project Implication

This project will require several meetings. After completing the project how would you follow up or determine the next steps? How will you implement the project? Unless the project itself was an implementation, include the following in the implementation plan.

Potential Resources and Existing Supports

The potential resources for this project are the teachers. They bring with them years of experience and a profound knowledge base that is diverse, creative, and flexible. The teachers are the individuals closest to the students. Hence, they are familiar with students' wants and understanding curves. Furthermore, they have mastered the delivery of instruction for their students' learning. As a creative force, this resource will empower itself and students to make use of 21st century knowledge. Furthermore, as a resource that is in charge of its own learning, it will know when to slow, accelerate, and shape its learning curve. The administrators at district and the building principals will be the existing support system. These entities bring with them experiences in fiscal and personnel management. They will be the references for the teachers.

Potential Barriers

In any building where bonding occurs among its personnel, affecting attitudinal change will be a barrier. The net result, if not approached with caution, will challenge the adoption of an innovative plan. The critical barriers that require early identification are ambivalence and fear of change and inadequate information concerning change. In buildings, there is also a hesitancy to recognize that change is necessary. The examination of one's work, cultural, and social habits and the ability to open them to outside observation is intimidating. Thus, careful consideration and sensitive approaches to staff are highly critical. A more significant barrier is getting the teaching staff to see themselves as facilitators, planners of adult education, and change agents (Edwards, 2015; Heijden, Geldens, Beijaard, & Popeijus, 2015; Priestley, Edwards, Priestley, & Miller, 2012; Senge, 2014).

Accepting the role of change agent means that one is accountable for and accepts change. This is a dynamic with many facets. There is the risk-taking section. This mode presupposes one to support a position, which may or may not be acceptable to the group.

The idea may be new. It may go against the “we have always done things this way” tradition. Another facet is the idea that one may fail. Another is having to negotiate with one’s peers for a winning position.

Potential Solutions to Barriers

To overcome the barriers presented by new programs, time and effort must go into preplanning. The most important aspect is understanding that the program affects attitudinal and behavioral change. Thus, there will be different belief systems of individuals with which to contend. The first phase toward program acceptance and enactment will be the development of a policy committee (PC). The committee will present the policy statement suggestions to the district administrators. Upon receiving a positive go ahead, the second phase will be to present the findings to staff, along with suggestions from the district administration.

The PC will then form teacher networks to prepare staff for presentation. This will work as a clearing-house for information. The committee will also give the building opportunities to “buy into” the project. It will also set an example for communities of participation. This process also gives a sense of shared community property. From this committee will come successive committees that include survey development, dissemination, and analysis of teacher attitude for the program. This phase is critical because the survey analysis results will drive the Program Mission Statement. For later development, and depending upon the survey analysis, the committees work will expand to allow new membership for taking on the following responsibilities: coaching methodologies, collaborative inquiry, and building inventory, content and scheduling of technology professional development sessions.

Proposal for Implementation with Timetable

This new program will require manpower and fiscal support from the sponsoring agency. To clarify all roles and to prevent future blurring of roles, there will be a meeting amongst the district administration and me. This meeting also establishes the path for open and honest articulation between the researcher, district administrators, and the school building.

Table 6

Project Implementation and Timetable

Activity	Target Date
Meeting with District Administration to present findings and Recommendations	June 2018
Obtain approval for the policy implementation and resource allocations	June 2018
Meeting with school administrators to explain project and solicit volunteers	July-August 2018
Present program to volunteer school. Canvass for committee volunteers	September 2019
Begin/complete analysis of teacher survey (team effort)	Through
Meet/discuss findings with teachers. Begin/complete Mission Statement	January 2019
Disseminate for discussion and finalization	
Prepare building for new program	January 2019
Begin canvassing for selection for TPD	January 2019
Preparation for Initial TPD session	February 2019
Implementation of Policy Statement	March 2019

Roles and Responsibilities of Others

Key personnel for involvement will be the principal and quasiadministrators (department heads, counselors). The project implementer would work closely in explaining, sharing ideas, attending department meetings, and getting the “buy-in” of the principal. These are the building leaders, and faculty tend to go to them with questions and comments. The term of approach would be the realization of the cost-effectiveness of the project and the empowerment of teachers. The next critical step would be forming a voluntary advisory committee, which would set a collaborative ambiance.

The primary function of the committee is to translate the policy statement for clarity. They will be the liaison between teacher acceptance and implementation. They must also establish a mission statement to drive the pilot. They would also spread information, answer questions, and listen. The committee would also set-up goals to achieve teacher involvement. The committee would also solicit among the faculty ideas for the development of a mission statement, which would unite faculty. In this project, there will be no student involvement. There will only be adults; therefore, they assume the role of the "others."

Project Implementation Coordinator

This person will initiate the workflow of the project. Some responsibilities include scheduling, staff meetings, conference planning, and dissemination of information to staff.

Project Sponsor

District and school building administrators, the director of training, and departmental heads will aid in strategic planning of the program and network with necessary personnel to ensure the success of the program.

Temporary Project Manager

The researcher will work closely with lead teacher to provide:

1. Definition of the project

2. Supervision of the implementation process

Project Team Members

Voluntary building members will help with the project and serve in any capacity to ensure success. A significant role for volunteers will be the mentoring of those teachers who have expressed caution about participation or did not want to participate.

The purpose of this study was to establish baseline of teacher knowledge of TPACK. The study confirmed the assumption that teachers had knowledge of TPACK concepts. Furthermore, they did use TPACK in the classroom. This includes content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), and technological content knowledge (TCK). The results also showed that the respondents did participate in LBD activities. Hence, the implementation of the project, with staff undertaking new roles, would not be an adjustment problem. With these skills and supported by the study findings, respondents can advance incorporation of TPACK through LBD. Interestingly, the analyses suggested that LBD and all components of TPACK (TK, TPK, and TCK) do predict technology integration. However, TPACK taken as a complete tool may result in over saturation. The caveat, then, would be that teachers would tire or lose interest from over exposure of TPACK. Therefore, a major premise of the policy statement would be moderation of TPACK sessions. Through professional development sessions centering on its constructs, participants would understand TPACK. Furthermore, the policy statement, in its flexibility, would allow positive teacher-understanding on the use of TPACK. The policy statement would guide the professional development unit to build a stable, moderate presentation of the pieces of the TPACK puzzle.

Project Evaluation Plan

Goal-Based with Justification

This project is unique in that it sets forth neither a curriculum nor an evaluation. The result of this study is an idea that presupposes that teachers control technological professional development. Furthermore, teachers are responsible and accountable for the content, facilitation, and follow-up. Its uniqueness arrives because its problems are building-specific, thereby filtering out any generic TPD or need for external contractors. The project is in the form of a policy statement driven by a quantitative analysis and review of current literature, which suggests the ways and means of reaching this goal. Because of its individual nature, the assessment for this program will be in two parts. They are goal-based formative and summative.

The newness of having teachers assume a TPD leadership role will require time and patience. Thus, a goal-based, formative assessment is necessary. This form of assessment allows the flexibility that a program of this nature needs. An example is the constant feedback that formative assessment provides. Thus, the project can identify what works or what will not work (Trumball & Lash, 2013). This process also strengthens group self-confidence and efficacy. Additionally, the teacher gravitation toward the "buy-in" aspects increases.

During the formative process, the observation of meeting goals and noting how they long they took and the reason for the length of time take place. Thus, modifications to the program become natural courses of action. For example, the number of surveys disseminated, the time it took for returns, and the application of the analysis results are important. These results become terms of measurement for the sessions. Another example is the number of requests for the types and kinds of content matter. The number of participants for the first sessions compared to the numbers generated for the next session will tell how the teachers respond. Above all, the formative assessment is complimentary to surveys taken after each training. It is important because it will identify problems before they become too large, and the results show teachers that they have a voice. Thus, formative assessment coupled with summative assessment are vital to the program.

Summative Assessment and Justification

Summative assessment will provide information and feedback from the implementation process once it is completed. The assessment instrument is very important because it becomes a yardstick of measurement for developing next year's programs. Among the assets are its identification of additional or superfluous staff members. It also focuses on critical or unmet content sessions. The summative assessment will also allow the project planners to follow up or determine the next year's workload and budget as it provides fiscal savings for the present year.

Overall Evaluation Goals

As mentioned previously, this project is unique in that it suggests changes to a system based upon teacher survey input, which also supports teacher efficacy (Fullan & Langworthy, 2013; Yoo, 2016). Thus, its individual role requires additional time, patience, with formative and summative assessments (Trumball, & Lash, 2013). In addition, informal discussion groups and observations will also be part of the evaluation, which will act as a cross-checker. This is a building-specific, teacher-manned venture. Therefore, there will be many stakeholders. They will add to a rich collection of formal and informal evaluations.

Key Stakeholders

All teachers will aid in the development of pre and post surveys. They will decide if the studies will be mixed-method, quantitative, or qualitative. They will make all presentations to staff and administrations. Other stakeholders include the students who will participate in informal discussion groups about any noticeable changes in teaching style. The technology team will receive invitations to participate in training as well maintain up to date technology software and programs. The training department for the school district will participate as trainers, participants, and evaluators. Their job will be to evaluate the ongoing work of the teacher-trainers as well as mentoring. Joining other stakeholders will be administrators and counselors who are not only participants, but also act in a capacity of observers. At the end of the year, they will give input in the summative report. Community residents will participate by forwarding suggestions for

TPD as well as partake in training sessions. They will give input in the summative reports.

Project Implications Including Social Change

Local Community

This district continues to search for ways to improve student learning and retention of information. The policy statement encourages teachers to collaborate for researching technological problems for professional development. Studies show that students learn better when in groups (Ku, Tseng, & Akarasriworn, 2013; Laal & Ghodsi, 2012; Popescu, 2014). Thus, students will model the behavior they see that is successful. For example, students will see how teachers use collaborative learning for finding solutions for problems. Hence, the program will be beneficial to the students. Through finding solutions for building-specific problems, teachers will become confident and build greater efficacy. These attitudes will also become part of the school ambiance. Hence, the policy statement fosters a student-centered ambiance, which serves the academic, social, and cultural needs of the student.

The importance of this project to the community as a whole (students, families, instructors, administrators, merchants) is that it creates a community of learners. Students teach parents the true meaning of TPACK, which their teachers have passed on to them. Thus, all community members empower themselves. Family members are able to speak in technological terms with teachers. Administrators and teachers bond under a canopy of technological understanding, and the loss of traditional professional development allows the use of capital for other needed items. Furthermore, members are able to grasp the magnitude of research combined with literature review to drive necessary changes in a curriculum. Subsequently, an people in an informed building talks to each other by sharing information and healthy discussion of ideas. These small steps are capable of becoming prototypical for other school districts.

Far-Reaching

Although it may be a costly venture in the beginning, its far-reaching effects are strong. As subsequent years go on, the program will improve itself, thereby decreasing dependency on outside sources for fiscal support. The program will be able to develop a self-sufficiency in content and personnel matters. It will also empower teachers, students, and staff members to take risks. Hence, the locus of influence changes from top-down to student-centered teachers supported by administrators (Kopcha, 2012).

The empowerment aspect is a significant outcome of the policy statement. As the program continues to improve its evaluation process, members will ask complex questions leading to new paradigms. A technologically proactive staff can identify problems before they arise. Thus, they can project course of actions. In such an environment, staff accommodates ad-hoc leadership for problems solving.

Accompanied by improved technology, a strengthened professional network among teachers and scholars will move onto a national and global scale. Hence, the sharing of ideas and solving of problems becomes the norm. Because the program opens many windows to online, on-site learning courses, others will want to participate. Thus, the building becomes a true center of participation. In the final analysis, the fiscal onus for running this program decreases as its knowledge base increases. The project shows how budgetary cost can be absorbed for the benefit of an entire school building. This an example of social change.

Conclusion

The goal in this study was to develop a project that would help the district absorb technology professional development budgetary cuts, while continuing teacher technology growth. Of particular interest was how mathematics teachers were using technology for student academic growth. The culmination of this study is a policy statement. Its development comes from the blending of a quantitative research approach driven by a robust literary review. Giving strong support for developing a policy statement were the data taken from the stakeholders. The results showed that teachers did have good experiences and backgrounds with technology. The data also showed that the teachers were somewhat versed in the constructs of TPACK, but they needed additional exposure to LBD activities. My conclusion was that the teachers were capable of operating their technology professional development (TPD). For better, meaningful results, the sessions must be building-specific with TPACK-based problems. Furthermore, LBD activities would be integral to the TPD.

The barriers to developing such a plan would be teachers’ lack of efficacy, administrative hesitancy, and central administration’s fear of losing power. To overcome the barriers, the project suggests that sharing of information, teacher surveys, and discussion sessions with teachers and administrators and soliciting volunteers to work on the planning committee are integral are parts of the startup. Implementation of the policy statement could be a prototype for use in urban school districts.

Section 4: Reflections and Conclusions

Introduction

I wanted to conduct an in-depth study on mathematics teachers and their use of technology. I wanted to know about mathematics teachers' dispositions toward technology integration. Additionally, with budgetary cutbacks, there was a concern, on my part, that teachers would lose gains they made in technology. From participating in experiences in group learning and design teams, I knew that teachers enjoyed learning better in groups. I also knew that teachers tended to share information and buttress one another in learning situations. Thus, my research began its formulations planted in teachers in charge of their own learning through research and design teams. Moreover, teacher mastery of TPACK would begin with learning by design (LBD) activities, which would be ongoing, in-house professional development units. My assumption was that such a program would increase teacher efficacy and improve student performance.

For the project, I needed a teacher baseline on attitudes and experiences with TPACK and learning by design. I selected a quantitative approach to give me a good surface trajectory. My reasoning was that a future study would involve a mixed method approach to probe deeper into the results and to answer new queries gleaned from the data. The study would also indicate teacher receptivity to advanced TPACK and LBD practices. Sufficient data indicated that teacher background and experiences in LBD would benefit from an embedded policy statement on technology integration. This information became the basis for a policy statement for the district. Furthermore, teacher willingness to be in charge of technology professional development would expand and improve existing nascent teacher efficacies. In this section, I critically examine the strengths and limitations of the project. I will direct attention to the application of the project. In particular, I will discuss other avenues of approach and present alternative discussions on the definitions and solutions to the problem.

Project Strengths and Limitations

Strengths

The strength of the project is that it offers teachers a variety of benefits. The first is they will be in charge of their own learning. They will develop topics for problem solving. The path to problem solving will include discussion, research, application of tentative solutions, and evaluation of the results. LBD is a reiterative process. Hence, teachers and administrators must work as a unit.

Another strength includes learning and relearning about TPACK. In this process, teachers will identify problems based on technology. As opposed to receiving mandates from an administrator or a central office, teachers will develop topics based upon in-house problems. Furthermore, they will see the problems through to the resolution of issues or give rise to new problems. This means that the project will offer developmental units of work. For example, there is the phase of problem identification and discussion of such. This phase is the research for problem resolution. As TPACK has seven constructs, teachers will be able to differentiate the constructs and make decisions about how to use each in a group or individually in teaching. This phase brings with it discussion, collaboration, and most importantly design. Thus, the theoretical framework is highly flexible and can examine complex, diverse issues relative to technology. Teacher assumption of TPACK is one of those intricate concerns for teacher-technology acquisition (Hofer & Grandgenett, 2012). Studies show that teacher-technology learning improves in design teams emanating from TPACK (Bos, 2011; Dawson et al., 2013; Wetzel & Marshall, 2012).

An additional strength is that the social nature of LBD (LBD) is a perfect fit to facilitate teacher-generated technology problem solving. Furthermore, LBD is an ideal conduit for building teacher efficacy (Thoonen, Sleegers, Oort, Peetsma, & Geijsel, 2011). It is an ad-hoc framework that is functional in formal, informal, and research settings. Its amoeba-like properties have no boundaries. Consequently, the degree of teacher anxiety becomes minimal. The other strength of the project is that it encourages and increases teacher efficacy. It combines TPACK and LBD to encourage teacher collaboration (Agyei & Keengwe, 2012; Agyei & Voogt, 2012). In the process, the combination challenges long-standing beliefs and pedagogical practices. As opposed to learning in a vacuum, teachers come together to discuss ideas relative to instruction. At the same time, they are learning and taking risks in technology. This practice increases teacher efficacy.

The overall strength of the project is that the results from the study confirms teacher readiness to use LBD activities to accomplish TPACK. The policy gives rise to on-going, need-based PD. The teachers become change agents (Watson, 2014) using technology. The policy statement lays the foundation for teachers to build enhanced, technology classrooms designed for student academic growth. Furthermore, with the study results driving the policy statement, the dynamics of the project become truly teacher driven and cost effective.

It is my goal to show that the policy is not only flexible in nature, but it takes into consideration that learning is a creative and exciting cognitive event. Above all, it is reflective of my beliefs that the policy is integral to the true intentions of technology in education.

Limitations

The approach of this study was quantitative. There was limited opportunity for deeper questioning or examination of answers. There were a few more than 100 respondents. Thus, the small number of participants does not support a call for generalization. There were a number of reasons.

Among them was the discipline restriction element, which did not permit participation from other teaching areas. Participants were middle school mathematics teachers. Thus, the exclusion did not permit the same characteristics of a larger, diverse sampling. The possibility of bias was present. Additionally, there was the chance of misleading information driving the conclusions.

To remove the limitation, future studies should consider a replication with a larger number of participants. There should also be more teaching disciplines with the inclusion of personnel ancillary to the teaching staff. The additional participants studied should be other staff members affiliated with teaching, such as counselors, special education teachers, and administrators. Future scholars should also consider making the study a mixed method longitudinal design. For studies rendering a pilot suggestion, this approach accommodates any time constraints, and it provides the flexibility of making changes, where necessary.

Another limitation is that the study covers one district instead using the entire state or region.

The sampling came from a district that was under state control. Additionally, the district had undergone several program changes. Therefore, the subjects faced more stress and authoritarian approaches to management. There were significant budgetary cuts and loss of personnel. The result was a teaching body that appeared to be low in spirit. Subsequently, it was very difficult to get respondents. However, the study is still of use by districts facing similar circumstances. It has strong implications for possible solutions.

The use of teachers as trainers is a significant, cost-effective recommendation. In one instance, it permits a culture of teacher empowerment through shared building responsibilities. Teachers will have a way to communicate ideas and work jointly on ideas and projects (Edwards, 2015; Kafyulilo, Fisser, & Voogt, 2016; MacPhail & Tannehill, 2012; Priestley et al., 2012). Most importantly, they will become the change they want to effect. Implementing LBD activities for problem solving also has sound considerations.

These advantages include problem solving on a building level. No longer will staff go to meetings that have generic content. They will have direct input into what is central to them. Another solid advantage is the identification of concerns before they become larger issues. The process is a direct off shoot from a flexible policy statement.

Recommendations for Alternative Approaches

My original intentions were to investigate the role of technology coordinators (TC) in the district. I wanted to complete a study that would give me a clearer understanding of technology in the district. There were two technology plans that lasted from 2006 to 2013, and the first included TC. However, the district dropped the positions from the second plan. I was curious to know how the schools were functioning without the TC.

The most feasible route for the investigation would be qualitative. The study would be exploratory, which would give me an understanding of overt and underlying problems. I could have elected to use a case study approach with five participants. Face to face contact is conducive for getting trust and additional information (Lodico, Spaulding, & Voegtle, 2010). Additionally, a group setting tends to bring a sense of comradeship, and thus I would have sincere answers. I would also have the flexibility of structuring instruments for data collection. However, I found that I would have difficulty recruiting the sampling. It seems teachers were under stress to perform and raise test scores, and they were reluctant to participate. Furthermore, timing became a factor. I had very little time and a limited budget to invest in a qualitative study.

A mixed method study would not have served the purpose of the study. My plans began to take shape, and I saw the mixed method approach answering questions arising from the qualitative study. Hence, the mixed method approach became part of my plan for subsequent studies. However, time again proved to be an influencing factor, and I chose a simple quantitative research approach.

Scholarship, Project Development, and Leadership and Change

Throughout the course of this study, I began to question myself concerning what scholarship is and what research is. Furthermore, the big question arose: Was there a difference between the two? As I continued upon my literature quest, I realized that scholarship referred to my growth in knowledge, advancement of skills I already possessed, and above all the ability to think out of the box without losing perspective of the task. I was particularly goaded in my quest as I read and reread the writings of Kolodner (2009) and Mishra and Koehler (2005); I deeply appreciated the manner in which they though out of the box. Their expertise and commitment to an idea became a standard-bearer for me from which I could identify biases and narrowness of thinking.

From this process and self-questioning, I learned that while one has cognitive abilities, they are meaningless unless one takes risks. This was a trait found in all of the writings. Additionally, my scholarship increased with the continuation of the search and cross-examination of knowledge presented. A useful vehicle for me was matching the literary papers with the theoretical concepts used to guide the study. The project began to take shape as I shifted presurvey assumptions to concrete assumptions based upon the data. There were moments when I questioned the information I read; I was able to confront my own biases concerning technology and teacher acceptance. The most significant thing I learned about project development is that patience and understanding time takes precedence.

I became aware of the facets of the process that can act as barrier to success. TPACK was first introduced in 2006. Yet, 11 years later, educators and scholars are still searching for a common understanding of its constructs. Furthermore, they are still trying to find a way that makes teachers understand and identify the differences between TPK and TCK. Thus, the success of this project depends upon a gradual approach to systemic change.

Having been a school administrator, I was familiar with human behavior and change. However, with this project, I witnessed the demoralization of a district losing self-control. I saw how teachers who had to implement curricula that were not of their choosing just gave up. The students also noticed this attitude. Moreover, I understood how leadership could choose to lay the ground for motivation or just follow the course. Thus, I realized that change was inevitable. However, leadership's perception of power was fleeting. I solidified my supposition that one has a choice in commanding one's destiny. That is, leadership can choose to be creative and grow against insurmountable odds, or leadership can stagnate. I understood from seeing the examples before me that leadership can be a creative factor in accepting change. It is merely leadership's understanding that the power is in leadership's hand.

Analysis of Self as Scholar

As a scholar, I learned that if I did not capture the intellectual moment, I would have regrets, later. That is, I must constantly ask myself why and continue to pursue the question, which would lead into intellectually comparing and contrasting. This process became a cerebral game with me, and it was an exciting venue. However, I also learned that time was of the essence. Thus, management of time and the acquisition of knowledge can be successful. I was able to discuss with my peers problems and points of stagnation, which was of immense support. This was a new step for me, for I had always worked alone.

Now, as I am finishing, I have a new respect for those teachers who attempt to instruct and practice research at the same time. I realize that if their potential for scholarship is tapped and they are given correct time, they will blossom.

Analysis of Self as Practitioner

As a former teacher practitioner, I am now concerned with the assault upon American education, in particular teachers. The attempts at dismantling a free public education system by taking away the creditability of teachers is a frightening reality. Unfortunately, Americans tend to be alliterates, which means that they can code words on paper. However, they do not read for comprehension nor for informative purposes. One can see this in their responses at political rallies, supporting and viewing political leaders whose double talk is more akin to a dog chasing his tail.

The movement for charter schools is a classic example where teachers do not have to be certified, and there is no oversight. Not all charter schools are bad, but too many have poor academic records of accomplishment. In the future, religious institutions will and are applying to run charters. Hence, the onslaught against science, social studies, literature, and art will be full scale. I marvel at parents who would send their most precious treasures to a school that is profit motivated. Instead, they are not thinking about ways of improving their public schools.

My experiences in research through Walden University have made me understand that my talent for writing and a nose for curiosity would better serve the public by writing to question and inform. My Walden experiences have taught me how to be a better practitioner.

Analysis of Self as Project Developer

With the new skills Walden has taught me, I see myself as a project developer of thinking minds. My work will be with adults, not children. My belief is that working with the parents lets me understand their children. My project would be to establish small circles of information in neighborhoods for discussion. The basis of the circles would be reading comprehension using newspapers and brochures. As a project developer, I would have to relearn and learn the major concepts of human behavior and of course history. I would also have to be a keen judgement of personality traits. My intentions are to lay the groundwork for individuals to think deeply about what they are reading.

Reflections on the Importance of the Work

As a retired teacher and administrator, I used the results of this study to advance the idea of a teacher-run professional development plan. This study underscores putting and supporting teachers as change agents. It advances the idea that teachers, who are closest to academic and social problems in schools, should collaborate in finding solutions. They know part of the answers. They have never had an audible voice. Technological professional development is an exciting vehicle for introducing teachers in a shared administrative capacity. Navigating problems of which they know, teacher-efficacy becomes stronger through collaborative learning. Furthermore, the role of teacher as researcher pivots to expanded acceptance. From facilitating LBD activities to follow-up for PD sessions is a social change that goes beyond schools walls. That is the importance of this work.

Implications, Applications, and Directions for Future Research

This quantitative study did not require interaction with the sampling. However, there

are three observations I learned that are critical to me as a professional educator. The first is that teachers in districts are state-mandates. Therefore, the district has no input in curricular matters, selection of curricular material, and the content or scheduling of professional development segments. Most of the professional development is by contract with outside agencies.

The second is that for the past 26 years, the state has run the district. However, students are not progressing. A major cause for this is that every year the state raises the passing bar. They publish the achievement levels but not the developmental levels. Thus, students in underserving districts do not appear to have made any progress. The information goes public, and this is demoralizing to staff.

The community and the school give no input into the selection of its superintendent. The state does the selection. This often leads to mistrust, poor communication, and accusations between the top echelon and the remainder of the personnel branch. This was the case in this particular district. The implication for me was that one should not attempt a research project in a school under state review or control. There is a preponderance of test preparation, and teacher-motivation is not positive. Furthermore, time limitations are crippling factors in that teachers and administrators constantly have to meet real and unrealistic deadlines.

Applications and Directions for Future Research

The application of the goal this study is to continue technology growth. An analysis of mathematics teaching staff supported the idea that teachers had experience in TPACK,

The results also showed that LBD did support TPACK experience. Therefore, teachers are capable of operating an in-house, professional development program. Initially, manpower hours and fiscal costs may appear to be intense. However, future fiscal outlays will decrease as the program improves. Instituting this policy would give the district an extraordinary amount of expertise in self-management and teacher continuing education.

Future research should reach into areas the study did not approach. For instance, what are teacher attitudes on becoming change agents? Often this role is thrust upon individuals without planning or preparations (DeChenne, Enochs, & Needham, 2012; Edwards, 2015; Heijden et al., 2015; MacPhail & Tannehill, 2012). Teacher belief systems in working in the capacity of shared administrative duties was another area. Would teachers be willing to conduct research on school problems (Krainer, 2014)? This role takes teachers away from classroom duties and requires time for exploration. Most importantly, school districts may be reluctant to develop this activity. How do teachers think and feel about becoming a community of participation (Tam, 2015; Thang, Hall, Murugaiah, & Azman, 2011; Watson, 2014)? With an expansion to include entire buildings, the district is positioning to itself to save meaningful fiscal outlay.

Conclusion

In this section, the goal of the policy statement provides a framework for instituting in-house TPD. The objectives are to:

- Increase teacher mastery of TPACK
- Use LBD activities (based upon building-specific problems) as steps leading to teacher mastery of TPACK
- Use teachers to administer, facilitate, and maintain TPD sessions

Inherent in the plan is teachers' full integration of technology in the classroom (Koehler & Mishra, 2005a; Mishra & Koehler, 2006). Based upon an extensive literature review supporting data findings, the plan is a flexible overture for teacher mastery of technology. The data findings show that LBD activities do promote TPACK (Koehler & Mishra, 2005b). Despite results showing that teachers need additional experience in LBD activities, they are capable of implementing and maintaining an in-house technology professional development unit. The recommendations suggest that a team acts as liaison between the conceptual and implementation stages. Additionally, recommendations suggest key personnel for transition purposes.

Significantly, the policy statement instigates positive social change. Its suggestions advance teacher empowerment through participation in-group problem solving. This creates a bond among the teaching staff, and teacher self-efficacy becomes contagious (Al-Shareef & Al-Qarni, 2016; Zundans-Fraser & Bain, 2016). The bonding also supports teacher risk-taking from which student benefit. The creative incidences of process are an indirect change to greater student-centered technology instruction, teacher efficacy, and collaborative problem solving. They also become an agent instigating teachers as researchers.

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Appendix A: Policy Statement

Teachers for Teachers: A Permanent, Teacher-Driven Technological Professional Development Site

I. Introduction and background of the issue

The teachers in the district have made good progress in technology, through professional development. According to data taken from two consecutive technology plans, teacher and student progress in technology, within a six-year period. In particular, the research showed that teachers were attending professional development sessions and using the information. Furthermore, students were benefitting from their teachers' technological growth. Furthermore, teachers in the district were sharing information and helping each other. They were change agents. Hence, teachers were capable of teaching teachers. The precursory readings became the motivation for selecting an appropriate theoretical foundation for advancing the idea of a teacher- directed professional development facility. Confronting the challenge of a fund scarcity, another motivating factor was the cost-effectiveness of the project.

Accordingly, teacher awareness and technological acceptance are now common throughout the district. However, with impending fiscal decreases resulting in the advent of generic professional development, it has become obvious that long-range projections are necessary. Such forecasting would ensure continued technological development of teachers. It would also foster creative ways of engaging reductions in fiscal support. Hence, a flexible platform such as a policy statement would serve these purposes.

The Problem

The Northern New Jersey District (NJD) takes education seriously and works arduously with local and national government agencies to attract funding for its schools. Sources for outside local, funding are limited: a low tax base caused by business relocation coupled with a high unemployment rate. Additionally, its system has a growing student population, which requires additional support; however, its students are making academic progress. To ensure its commitment to the community, the district encouraged teachers to begin crafting technology-rich classrooms. In addition to purchasing equipment, professional development training sessions were plentiful, and external classes were contracted. The outcome was that teachers made gains in acquisition of technological knowledge. Students improved developmentally in learning, test performance, and technology skills.

The district understands that technology and other STEM skills are prerequisites for future employment. This philosophy translates into teachers skilled in technological, pedagogical and content knowledge, which would bridge the digital divide. However, sources of fiscal support are not as available as before, and the need for advance technological skills grows. The problem is that without the continuation of teacher-technology training, students will not be able to make progress academically and technologically. Compounding this issue is decreased fiscal support.

Importance of This Policy Statement

American educational reform emphasizes vast changes in the quality of instruction and teacher accountability propelling technology to the forefront. School districts attempted to meet the nationwide goals by involving technology driven curricula. Support for professional development for teachers became an important third goal. Professional Development budgets received strong fiscal funding. The chief objective was to establish technology-rich environments in American classrooms to bring them up to 21st century standards. Hence technology integration and teacher professional development, in particular, technology competency, were at the forefront of American educational reform. However, while technology was making significant advances, school budgets were facing unlimited decreases. Unless districts become creative in attracting external funding sources, technological growth will limit itself to a selected few. Most importantly, the quantity of sessions and caliber of teacher-technology training will concern itself with maintaining marginal existence. Thus, the issue of good technology training for teachers, nationwide, continues to be a need.

Another important acknowledgement is that it is incumbent upon school districts to be proactive in projecting expenditures vis a vis current costs. Special attention focuses on changes in algorithmic programming and advances in hardware requiring different software. The impact of technology travels through local and larger school populations. Thus, districts are aware of technology's place with pedagogy and con It is a sign of progress; however. However, the degree of its success depends upon schools capable of meeting its fiscal demands.

This policy statement will serve as a management tool for the inception, implementation, and maintenance of a teacher-driven technological professional development. That is, teachers would be responsible and accountable for their own learning through participation in Learning by Design activities, which lead to teacher and student acquisition of Technological, Pedagogical, and Content Knowledges (TPACK). It is based on a survey completed by teachers in the district. The analysis of the survey resulted in suggestions for establishing a framework for an-site program, which is cost-effective and permanent. Its supervision, with limited, external administration, and ultimate conduction is by teachers for teachers.

This policy is in alignment with the New Jersey Professional Development Statute 6A:9C, (Trenton, 2014), that proposes to continue teacher advances in technology. The policy statement also supported the Paterson District Strategic Plan, 2014-2019**:** Priority I: Effective Academic Programs: Goal 5: Technology and 21st Century learning.

Statement of the Problem

Continuing teacher progress in technology integration without adequate funding is the problem. Severe budget cuts were becoming the norm for American education. At this school district with its burgeoning, the diverse student population was not an exception. Thus, it was incumbent upon administrators to explore alternatives for affecting technology integration. The implication was that the study could present a low-cost model for technology integration. The anticipated results offered an opportunity to explore other avenues for technology development. Should the District adapt these possibilities and produce technology-rich classrooms, it would establish a blueprint for success. Teachers will become accepting and less wary of technology integration. Student achievement and improved test scores were part of the blueprint. Accordingly, the District would establish a Technology professional development Plan for inner cities through sharing findings, ideas, and concepts. Hence, the construction of carefully designed and articulated guiding questions were important. They formed the skeletal framework for this study. Subsequently, exploration of the research questions could solve the problem of continued teacher progress in technology integration. Most studies concerned teachers and technological operations. Another branch of information was the impact of technology on student learning. The literature review highlighted the gap in the informational studies. Through a conduction of quantitative, descriptive investigation, this study sought to add to that body of knowledge.

Policy Recommendations

This policy statement is in tandem with the New Jersey Professional Development Statute 6A:9C (Trenton, 2014). Hence, its recommendations are in keeping with the spirit of state law. Of importance, the recommendation developed from an analysis of the data that grounded its concepts in teacher responses. The goal of the project is to combine the quantitative results of the study to support sound strategies that ensure on-going, teacher professional development in technology. Its data-driven tenets provided a robust foundation for structuring and sustaining teacher-generated professional development workshops.

Policy Recommendations

- The Policy recommends using teacher-conducted LBD to find solutions for TPACK-based problems.
- The Policy recommends that teachers function as trainers, facilitators, and project developers in finding solutions for building-specific technology issues.
- The Policy recommends that the district explore the permanent structuring of in-house, on-going Technology professional development sessions.
- The Policy recommends that the District encourage teachers to be Lifelong learners through research in and installation of TPACK practices.
- The Policy Recommends that teachers develop content and materials by using LBD activities, generated by TPACK-based problems.
- The Policy recommends that the school administrators support the teaching personnel to take responsibility for technology training.

Potential Resources and Existing Supports

The school district has multiple possibilities for site accommodations. I recommend that the administration work closely with the project coordinator for the use of existing resources and supports, which include:

- Dedicated time allotments for sessions: As with all new programs, in particular in education, embracing the spirit of a new paradigm will take time. Faculty and related personnel will need periods that require discussion, question and answer sessions, adjustments to the idea of controlling one's destiny with in a system.
- Approval from the District Office and School Board to proceed
- Dedicated classroom with whiteboards for facilitators, seminars, workshops and conferences. Establishment of such is vital to teachers' and related personnel's acceptance of the new paradigm.
- Dedicated library with computer stations for personnel
- Accessibility to reproduction and supplies whiteboard for conferences

Appendix B: Permission to Use Instrument

Joan BrunerTimmons <curtisbruner@gmail.com> Wed, Oct 15, 2014 at 3:27 PM

To: jzelkowski@bamaed.ua.edu

Dear Dr. Zelkowski:

It was with great interest that I read your article, "Developing and Validating a Reliable TPACK Instrument for Secondary Mathematics Preservice Teachers," as published in the *Journal of Research in Technology Education,* 46(2). Your article was rather provocative in that it made me review the variables, which I was considering.

Presently, I am pursuing a doctorate degree focusing on TPACK development in an inner cityschool. I am preparing my instrument search and subsequent construction. Your measurement tool is a good match for my study. Hence, I am requesting permission to use the instrument. Please know that should you consent, you and your colleagues will receive full recognition, wherever possible. Should you have questions or points of interest, I would gladly welcome your response. Please feel free to contact me at the following address:

joan.bruner-timmons@waldenu.edu

Sincerely,

Joan Bruner-Timmons

Zelkowski, Jeremy <jzelkowski@bamaed.ua.edu> Wed, Oct 15, 2014 at 3:38 PM

To: Joan BrunerTimmons <curtisbruner@gmail.com>

Absolutely. When we published it, we essentially released it for research use. Hopefully it will go well. I've just finished three years on two cohorts' data collection longitudinally. Very good findings so far. Seems like it is working well for why we created it for our purposes.

Jeremy Zelkowski, PhD
Associate Professor
Secondary Math Education
University of Alabama

Joan BrunerTimmons <curtisbruner@gmail.com> Wed, Oct 15, 2014 at 10:51 PM

To: "Zelkowski, Jeremy" <jzelkowski@bamaed.ua.edu>

Dear Dr. Zelkowski:

Thank you so much for your permission. I know that it will go well with my study. I will have to add modifications as my investigation involves integrating technology into the curricula without the expertise of school-based technology coordinators.

If you don't mind, I would be interested, from time to time, in learning more of your longitudinal investigation. I would imagine that the results will be very promising for teaching colleges.

Sincerely,

Joan Bruner-Timmons

Appendix C: Participant Letter of Agreement

Research Participant Name: ____________________________________

Phone:_______________

Address:

____

<u>Discloser of Information</u>: ______Joan Bruner-Timmons________________

Recipient of Information: Joan Bruner-Timmons

Means of disclosing information written

Information to be disclosed: School district/educational data

1. Mental Health/psychological data
2. Legal data
3. Chemical dependency/abuse data
4. Medical data
5. Other (specify) Teacher use of technological, pedagogical, and content knowledge and Learning by Design activities in classroom instruction

<u>Reason for the Release:</u> This information is being released/obtained for the purpose of research study of technology integration in mathematics classrooms, grades 6-8.

Authorization Provided by Research Participant:

I understand that this authorization permits the release of information between the two parties named above.

I understand that I have the right to refuse to sign this release form.

I understand that upon release, this information will be kept confidential; my identity will be concealed and data will not be re-disclosed outside of the specified individuals or agencies.

I understand a photocopy of this release will be as effective as the original.

I understand this authorization will be in effect for 12 months from the date signed unless cancelled by me in writing. Upon receipt of the written cancellation, this release will be void.

____

Signature Date

(Signature of a Parent/Guardian if the person is under 18 or incompetent)

____

Witness Date

Appendix D: Request for Volunteer Instrument Review

Request for Instrument Review

Joan BrunerTimmons <curtisbruner@gmail.com> Wed, October 15, 2014 at 3:27 PM

To: ISTE: Technology Coordinators Network

https://mail.google.com/mail/u/0/?tab=wm#label/Technology+Coordinators'+Network/14a4213f7eb69620

Dear Colleagues:

I am conducting research on the importance of school-based technology coordinators vs centrally based technology coordinators. The instrument needs reviewing. Among the criteria would be ease of use, accuracy, length, and anything that you feel I need to consider. It would help me to pinpoint any inconsistencies. You can send your comments to the address below:

Thank you,

Joan Bruner-Timmons

joan.bruner-timmons@waldenu.edu

Appendix E: Confidentiality Agreement

Name of Signer: **<u>Joan Bruner-Timmons</u>**

During the course of my activity in collecting data for this research: Technology Integration in Schools: The Effects of Centrally Based vs. School Based Technology Coordination. I will have access to information, which is confidential and should not be disclosed. I acknowledge that the information must remain confidential, and that improper disclosure of confidential information can be damaging to the participant.

By signing this Confidentiality Agreement I acknowledge and agree that:

1. I will not disclose or discuss any confidential information with others, including friends or family.
2. I will not in any way divulge, copy, release, sell, loan, alter or destroy any confidential information except as properly authorized.
3. I will not discuss confidential information where others can overhear the conversation. I understand that it is not acceptable to discuss confidential information even if the participant's name is not used.
4. I will not make any unauthorized transmissions, inquiries, modification or purging of confidential information.
5. I agree that my obligations under this agreement will continue after termination of the job that I will perform.
6. I understand that violation of this agreement will have legal implications.
7. I will only access or use systems or devices I'm officially authorized to access and I will not demonstrate the operation or function of systems or devices to unauthorized individuals.

Signing this document, I acknowledge that I have read the agreement and I agree to comply with all the terms and conditions stated above.

Signature: **Date**

Appendix F: Letter of Cooperation from a Research Partner

Community Research Partner Name: NJD

Contact Information: Office of the Superintendent

Date:

Dear Mrs. Joan Bruner-Timmons,

Based on my review of your research proposal, I give permission for you to conduct the study entitled Technology Integration in Schools: The Effects of Centrally Based vs. School Based Technology Coordination within the Paterson School District. As part of this study, I authorize you to recruit personnel, disburse, and collect data questionnaires online, and results dissemination activities. Individuals' participation will be voluntary and at their own discretion.

We understand that our organization's responsibilities include: Insert a description of all personnel, rooms, resources, and supervision that the partner will provide. We reserve the right to withdraw from the study at any time if our circumstances change.

I confirm that I am authorized to approve research in this setting and that this plan complies with the organization's policies. I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Walden University IRB.

Sincerely,

Authorization Official

Appendix G: Teacher Technology Survey

Joan Bruner-Timmons
joan.bruner-timmons@waldenu.edu

Letter of Invitation

Dear Colleagues;

My name is Mrs. Joan Bruner-Timmons. I am conducting research on teachers and technology. I am a graduate student at Walden University pursuing a post-graduate degree. The purpose of the study is to use the results to give insight in planning future technology professional development sessions, which will be teacher-developed and implemented for and by teachers. This study is not an evaluation of your teaching use of technology. As Walden University doctoral student, I am inviting you to participate in this study.

As a mathematics teacher, you are in an ideal position to give valuable, first-hand information from your own perspective. You are asked to complete a 56-point questionnaire. This should take about 20 minutes. There is no compensation for participation in this study. Your participation is voluntary, and your answers will be analyzed as a group, not individually. Please know that your answers will be kept confidential. As a participant, your name will be used only for tracking purposes, if you decide to withdraw from the study before posting. At the end of five years (5) all data are destroyed. Until that time all data will be kept on a dedicated hard drive. Only Mrs. Bruner-Timmons will have access to the raw and analyzed data. At the end of the study, I will notify the District of the results including findings and suggestions. If you wish to participate, please access the survey by clicking on the following link:

https://www.surveymonkey.com/r/w3vxr9m

Thank you for your consideration.

Joan

CONSENT FORM

You are invited to take part in a research study about Teachers and Technology integration using Learning by Design Activities and TPACK. This study investigates teacher combining of technological, pedagogical and content knowledge to make technology-rich classrooms. The researcher is inviting teachers of mathematics, grades 5-9 to participate in this study. The criteria of selection are: 1) Teachers employed by the Paterson Board of Public Instruction in mathematics; 2) Teachers with at least one-year teaching experience, or who have begun teaching; 3) Teachers who have some experience using technology and software for instruction; 4) Teachers who have accessibility to technology; 5) Teachers have had some experience in technology professional development. I obtained your name/contact info via The Office of Planning, Evaluation, and Assessment. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part. You may print or save a copy of the consent form.

This study is being conducted by a researcher named Joan Bruner-Timmons who is a doctoral student, at Walden University. This Consent form is sent to you from the researcher's Walden University address (joan.bruner-timmons@waldenu.edu).

Background Information:

The purpose of this study is to find an alternative to technology professional development, which is teacher-based. The anticipated benefits accruing from the completion of the study will be a policy statement to facilitate the development of a site-based technology professional development site. Contents of the sessions concern using Learning by Design activities to acquire Technological, Pedagogical, and Content Knowledge (TPACK) for teachers. An important benefit is that teachers will be able to develop, explore, and technology professional development, which they have tailored to their wants and needs.

Procedures:

If you agree to be in this study, you will be asked to:

· Complete a survey of 56 questions

· Know that the completion time is 20 minutes

· Know that the data will be collected one time

· Know and understand that your

participation is voluntary and

not required ·

Know that only fully completed

surveys will be used.

· Know that should you encounter questions you do not want to answer, you may discontinue the survey by closing the

browser.

· Know that if you have any questions, you may contact me: joan.bruner-timmons@waldenu.edu.

Here is a sample question:

A) I know how to solve my own technical problems.

Strongly Disagree vDisagree Somewhat Disagree Neutral Strongly Agree Agree Somewhat Agree

Voluntary Nature of the Study:

This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at the Paterson Board of Public Instruction or Walden University will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:

Being in this type of study involves some risk of the minor discomforts that can be encountered in daily life, such as slight fatigue. Being in this study would not pose risk to your safety or wellbeing. Upon your completion of the surveys, you will return them to me, face-toface, at the site. I will place them in a sealed envelope for return to my home for analysis. You will be informed of the results, at the same time as the district, by email.

The anticipated benefits accruing from the completion of the study will be a curriculum plan and accompanying manual on using Learning by Design Activities to acquire Technological, Pedagogical, and Content Knowledge (TPACK) for teachers. Furthermore, teachers will be able to explore, and develop technological professional development tailored to their needs and wants.

The identifiers for names, dates, and signatures have been removed to ensure your privacy and confidentiality. Thus, your consent is implied because you have completed the survey.

Payment:

There will be no payment for your participation

Privacy:

Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Participants' names will be retained separately from data. Codes will be used in place of names only to identify those participants wishing to withdraw from the study. After applying data to spreadsheet, all participants' names will be erased from the data. Data will be secured in a dedicated hard drive accessible only by password. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:

You may ask any questions you have now. Or if you have questions later, you may contact the researcher via email (joan.brunertimmons@waldenu.edu).

IRB will enter approval number here 07-25-16-0263198 and it expires on July 24, 2017

PATERSON PUBLIC SCHOOLS
Division of Assessment, Planning and Evaluation
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Jazmin Rotger de Parra
Director of Assessment
Email: jparra@paterson.k12.nj.us

Donnie W. Evans, Ed. D.
State District Superintendent

TO: Laurie Newell, Ph.D., Chief Reform and Innovations Officer
FROM: Jazmin Rotger de Parra, Director of Assessment, Planning and Evaluation
DATE: June 1, 2015
RE: Research Request

In accordance with district policy 9550, I have reviewed the research request application for the applicant/project referenced below and have determined that the request meets the criteria to conduct research within the Paterson Public School District.

The attached document is being provided for your signature and if you would like to view the request in more depth a copy of the application is being provided as well.

Researcher/Applicant Name:	Mrs. Joan Bruner-Timmons
Project Title:	Technology Integration: The Effects of Centrally Based vs. School-Based Technology Coordination
Institutional Affiliation:	Walden University- Graduate Student

☑ I hereby authorize Mrs. Joan Bruner-Timmons, to use the Paterson Public School premises to conduct a study entitled Technology Integration: The Effects of Centrally Based vs. School-Based Technology Coordination

☑ I hereby authorize Mrs. Joan Bruner-Timmons, to recruit subjects for participation in a study entitled Technology Integration: The Effects of Centrally Based vs. School-Based Technology Coordination.

☐ I hereby deny Mrs. Joan Bruner-Timmons, to use the Paterson Public School premises to conduct a study entitled Technology Integration: The Effects of Centrally Based vs. School-Based Technology Coordination.

☐ I hereby deny Mrs. Joan Bruner-Timmons, to recruit subjects for participation in a study entitled Technology Integration: The Effects of Centrally Based vs. School-Based Technology Coordination.

Laurie W. Newell

Laurie Newell, Ph.D.
Chief Reform and Innovations Officer

Appendix H: Teacher Technology Survey

* 1. What is your gender?

- Female
- Male
- I prefer not to say.

* 2. What is your age?

- 19-25
- 26-39
- 40-45
- 46-49
- 50-56
- 55+

* 3. How many years have you been a teacher?

- 1-5
- 6-10
- 11-14
- 15-19

20+

* 4. What grades do you presently teacher?

5th

6th

7th

8th

7th and 8th

9th

5. What are the terms of your teaching position?

Full-Time, Part-Time, Itinerant

6. What degree(s) do you presently have? (Please circle only one): B.S. Math, B.S. Science, B.A., Master's Math or Science, M. Ed. Math or Science, Doctoral

7. Ethnicity

African-American or black, Asian, Hispanic or Latino, Native – American, Pacific Islander, White or Caucasian, Other

Appendix I: Questionnaire Survey

Section 2- Teacher Technology Survey

Questionnaire used in the survey

Section 2

Technology is a broad concept that can have different meanings to teachers. For the purpose of this study, technology refers to computers, computer software, and printers. Please answer all of the questions, and if you are uncertain of or neither agree or disagree, you my always select neutral.

Item code	Item
TI1	I can work with my peers to solve technology in the classrooms.
TI2	I implement ideas and concepts learned in professional development technology mathematics.
LBDPLC1	I use technology to collaborate with peers outside of the school building to solve problems relative to mathematics.
LBDPLC2	I am a member of one or more professional technology organization.
LBDPLC3	I subscribe to one or more professional journals in mathematics.
LBDPLC4	I subscribe to one or more professional journals in technology.
LBDPLC5	I am a member of one or more professional organization in mathematics.
LBDI1	I voluntarily attend after school meetings with my peers to discuss technology in the classroom.

LBDI2	I voluntarily head group studies concerning secondary school mathematics and technology.
LBDI3	I attend at least one professional technology workshop.
LBDI4	I attend at least one professional development workshop in mathematics.
TPACK51	I can use strategies that combine mathematics, technology, and teaching approaches in my classroom.
TPACK53	I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students will learn
TPACK55	I can teach lessons that appropriately combine collaborative website development, technologies, and teaching approaches for students.
TPACK59	I can teach lessons that appropriately combine algebra, technology, and teaching approaches.
TPACK60	I can teach lessons that appropriately combine geometry, technologies, and teaching approaches.
TPACKn1	I can teach lessons that appropriately combine division, technology and teaching approaches.
TPACKn2	I can teach lessons that appropriately combine multiplication, technology, and teaching approaches
TPACKn3	I can teach lessons that appropriately combine student collaboration in global problem solving, technologies, and teaching approaches for the classroom.
TPACKn4	I can teach lessons that appropriately combine student ability to communicate ideas and concepts through technology.
TPACKn5	I can teach lessons that appropriately combine website development, technologies, and teaching approaches for students
TK1	I know how to solve my own technical problems.
TK2	I can learn technology easily.
TK3	I keep up with important, new technologies.
TK4	I frequently play around with technology.
TK5	I know about many different technologies.
TK6	I have the technology skills I need to use technology.
TK7	I have sufficient opportunities to work with different technologies.

TK8	When I encounter a problem using technology, I seek outside help.
TCK32	I know about technologies that I can use for understanding and doing ratio and proportions
TCK34	I know about technologies that I can use for understanding and doing algebra.
TCK35	I know about technologies that I can use for understanding and doing geometry.
TCK38	I know that using appropriate technology can improve one's understanding of mathematical concepts.
TCKn1	I know about technologies that I can use for understanding and doing math problems.
TPK39	I can choose technologies that enhance the teaching of a lesson.
TPK40	I can choose technologies that enhance students' learning of a lesson.
TPK42	I think critically about how to use technology in my classroom.
TPK43	I can adapt the use of technologies to teaching activities.
TPK44	Different teaching approaches require different technologies.
TPK45	I have the technical skills I need to use technology appropriately in teaching.
TPK47	I know how to use technology in different instructional approaches.