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The Instructional Technology Resource Teacher: A Descriptive Case Study of Deployment, Use, and Perceptions

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The Instructional Technology Resource Teacher: A Descriptive Case Study of Deployment, Use, and Perceptions

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

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Abstract

THE INSTRUCTIONAL TECHNOLOGY RESOURCE TEACHER: A DESCRIPTIVE CASE STUDY OF DEPLOYMENT, USE, AND PERCEPTIONS

By Mary Sepelyak, PhD

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

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Dr. Jonathan D. Becker,
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This case study describes one professional development approach to support technology integration at all public schools in one large county in central Virginia. Using data obtained from daily time logs, the frequency of Instructional Technology Resource Teacher (ITRT) use by classroom teachers was analyzed. Descriptive statistics were used to describe overall percentage of ITRT use, the various types of professional development requested by teachers, the consistency of those activities over time, and if the frequencies of activities varied as a function of school level, Title I status at the elementary level, or subject area taught by teachers at the secondary level. Qualitative data was collected via focus group interviews of the involved ITRTs, and an exploratory attempt to understand the reasons behind their use was made. Data indicated that ITRTs were used 52% of the time offered with 5% variation over 3 years. Across school levels, ITRT time was used more at the secondary level and use varied no more than 9% over time. Google Apps for Education and web-based programs represented 73% of the training requests. Over time, fluctuations in the number of requests for assistance with different applications were explained by contextual factors. Elementary schools classified as Title I accounted for 23% of the total time elementary ITRTs were used. At the secondary level, teachers of science and language arts requested ITRT assistance more often. ITRTs made sense of these results by identifying first order barriers as more influential than second order barriers. Of these, access barriers were the most frequently cited barrier by the ITRTs followed by subject culture, institution, assessment, attitude and beliefs, and knowledge and skills. Elementary ITRTs cited more instances of barriers than secondary. Recommendations for practice and future research were made.

I. Overview of the Study

If the purpose of schooling is to prepare students to become successful members of society and that society is becoming increasingly techno-centric, then we need to modernize schools, both in the way we teach and in its content. However, this has not always been the case. While teachers have embraced technology to increase productivity, they have successfully integrated it into their curriculum to a lesser extent. And, when it is used to support curriculum it is most often used to support traditional pedagogies.

One way in which an attempt has been made to affect technology integration is through professional development. Numerous models and approaches to this professional development have been developed and studied. County X has created a fairly unique approach to its technology professional development via its Instructional Technology Resource Teachers (ITRTs) which has heretofore, remained unstudied. County X's model was investigated in order to evaluate the ways in which its ITRTs are used and to begin to understand the reasons behind those outcomes as interpreted by the involved ITRTs.

Background of the Study

"Throughout human history, education has been shaped by the societal needs of the societies in which it is set. Education, after all, is the attempt to convey from one generation to the next the skills, values, and knowledge that are needed for successful life" (Partnership for 21st Century Skills, 2007, p.1). This requires that education remain flexible and, as a result, its purpose has changed as a function of society's progression through the Agrarian and Industrial Ages, and into the current Digital Information Age (Gilbert, 2007; Karolyn & Pains, 2004;

Luterbach & Brown, 2011). While its purpose may have changed, its methodology has not always kept pace.

"A Nation at Risk" (1983), a report on our nation's schools, called for global competitiveness, higher standards of excellence and accountability, and an emphasis on math and science. This 33-year-old document still defines the dominant trend of the American educational agenda, as we continue to teach a prescribed curriculum in a prescribed time with little effect on student achievement (neaToday, 2013; Reigeluth and Avers, 1997, p. 134; Sancho, 2010).

In 1991, the U.S. Secretary of Labor called forth a panel of experts, the Commission on Achieving Necessary Skills[1], to determine twenty-first century workplace skills and how to evaluate American schools' preparation of students with these skills. The Commission found that schools continued with the organization and methodologies inherited from a 100-year-old system based upon an industrial model of schooling and despite cries for reform had not substantially changed (Duncan, 2010; Partnership for 21st Century Skills, 2007).

In 2002, the No Child Left Behind Act was signed into law with a goal of increasing American competiveness globally and closing achievement gaps for economically disadvantaged and minority students. It emphasized increased accountability, school choice, research-based teaching methods, and highly qualified educators. It provided for technology funding through its Enhancing Education through Technology provision, and at least 25 percent of any funds allocated were required to be spent on technology professional development to empower teachers to use technology effectively. Vockley (2008), in conjunction with a task force spearhead by the International Society for Education in Technology, the Partnership for 21st Century Skills, and the State Educational Technology Directors Association, stated that our continued efforts to

[1] The Secretary's Commission on Achieving Necessary Skills, U.S. Department of Labor (June 1991). *What Work Requires of Schools: A SCANS Report for America 2000.*

improve student achievement have been largely unsuccessful, and that we need to incorporate technology into educational practice on a regular basis to maximize its impact.

In 2009, the U.S. Department of education introduced its Race to the Top competitive grant program for states aimed at improving teaching and learning by raising standards and creating systemic change in order to achieve needed college and career readiness. Applicants were awarded points based upon predefined criteria and alignment with its four initiatives which included the adoption of rigorous common standards and assessments to prepare students for college, the workplace, and to be globally competitive; building data systems to measure student growth and inform instruction; the recruiting, professional development, and retention of effective staff; and assisting the lowest performing schools.

At the same time, the Common Core Standards initiative was launched. Led by government officials from 48 states, two territories, and the District of Columbia, its purpose was to ensure that ALL graduates were prepared for success in college, career and life. Common standards were written for mathematics and language arts and aligned to expectations set forth by employers, training programs, and colleges. The use of technology, problem solving, creativity, communication, and critical thinking are interwoven throughout its constructs. As of 2015, 42 states, the District of Columbia, 2 territories and 1 commonwealth have adopted or were in the process of adopting the standards (Common Core Standards Initiative, 2016).

We are continuing to teach a prescribed curriculum in a prescribed time with little effect on student achievement (neaToday, 2013; Reigeluth and Avers, 1997, p. 134; Sancho, 2010). What is needed, in the twenty-first century, is a school that can provide individualized as well as large-scale assessment, rigorous content with real world relevance, attention to the individual as well as to society and the world, the individualized ways in which each student learns, the fostering of higher-order thinking skills and creativity, and opportunities for group work (Hayden, Ouyang, Scinski, Olszewski, & Bielefeldt, 2011; ISTE, 2014; Partnership for 21st Century Skills, 2007). According to the U.S. Department of Education's 2016 National Education Technology Plan, technology can help achieve this by transforming learning, eliminating equity and accessibility divides, helping build relationships between teachers and students, and transforming approaches to learning and collaboration while meeting the needs of all learners. To do so, "Educators should be collaborators in learning, seeking new knowledge and constantly acquiring new skills alongside their students. Education leaders should set a vision for creating learning experiences that provide the right tools and supports for all learners to thrive" (p. 1). It is necessary for all educational stakeholders to integrate technology effectively to provide authentic learning experiences in order to improve education. Karen Cator, former Director of the Office of Education Technology, US Department of Education, states:

> Tomorrow's graduates are growing up in a world where technology dominates various aspects of daily life, from social interaction to data analysis to professional advancement. Their education should reflect this reality, by better equipping them to interact with a digital world, and by using technology to drive student achievement, measure student progress, and create an individualized approach to learning that instills students with invaluable critical thinking skills (Cator, 2010).

After all, "The prevailing technologies of a particular place and time have always been linked with education, because a society's tools are both the subject and the means of its learning" (Partnership for 21st Century Skills, 2007, p. 5).

The need for the integration of technology is also expounded by educational and legislative bodies at the federal, state, and local levels as evidenced by their technology plans, technology funding, and mission and vision statements (Trotter, 2007). Most recently, the Every Student Succeeds Act (ESSA) was signed into law and provides, under its Title IV block, the possibility of one billion dollars in flex grant funds that are eligible to be used for educational technology.

By 2009, the national ratio of students to instructional computer was 5.3:1, while the percentage of Internet-connected computers was 93 percent (Education Week[2], 2011). In a 2013 survey of 503 teachers, Ninety percent had at least one computer in their classroom and fifty-nine percent have an interactive whiteboard. Thirty-five percent have a tablet or e-reader in their classroom (PBS, 2013). In addition, Fifty-five percent of public school districts reported students enrolled in online classes (Queen & Lewis, 2011). Thirty-one percent of public schools reported full-time staff whose sole responsibility was to technology support or integration (Grey & Lewis, 2010). Of these staff members, twenty-nine percent assisted with the integration of technology into instruction to a major extent and thirty-four percent to a moderate extent.

The 2016 Federal Education Technology Plan stresses the need for a 21st century model of learning that practices engaging, relevant, personalized learning experiences that include collaboration, complex problem solving, critical thinking, and multimedia communication that are incorporated across all content areas. It proposes that educators make a move to online, connected classrooms that encourage collaboration among educators and the use of data to drive instruction. It recognizes that many teachers are not technologically proficient enough to achieve this end when it addresses the continued digital divide that exists between, "learners who are using technology in active, creative ways to support their learning and those who predominantly use technology for passive content consumption" (p. 5). It trumpets the need for technology use that is carefully designed and thoughtfully applied in order to utilize best-practice

[2] Most recent data available

in teaching. To carry out this vision, teachers need to have acquired the necessary skill set. However, research on how these skills should be acquired is still limited and needs to be conducted on the individual, program, and community levels as teacher professional development programs fail to prepare teachers to use technology in effective ways. (U. S. Department of Education, 2016, p.3-5)

The Virginia 2010-15 Educational Technology Plan was updated with its 2015-2017 Addendum. Five years later, it continued the focus reflected in its first iteration calling for the incorporation of technology to prepare students for a changing world, so they acquire the aptitude to be successful in a global community and to act as a skilled workforce to attract business and investors to the commonwealth. "The commonwealth's ability to capitalize on this advantage is the extent to which Virginia's schools prepare the next-generation workforce for knowledge-based jobs that utilize cutting-edge information technology." (Virginia Department of Education, 2010, p. 3).

To support its focus on technology, in 2005, Virginia required and funded, through its standards of quality, the Instructional Technology Resource Teacher (ITRT) with staffing set at 1:1000 students. This position was established to provide staff-development for teachers, in order to empower them to integrate technology into their curricula. According to Nash (2013), ITRTs were created to be agents of change. In its 2010-2015 Technology Plan, ITRT professional development is interwoven into each of the plans five overall objectives:

Objective 1.2: Provide the technical and human infrastructure necessary to support real, blended, and virtual learning environments.

Objective 1.3: Provide high-quality professional development to help educators create, maintain, and work in a variety of learner-centered environments.

Objective 2.1: Support innovative professional development practices that promote strategic growth for all educators and collaboration with other educators, content experts, and students.

Objective 3.1: Provide and support professional development that increases the capacity of teachers to design and facilitate meaningful learning experiences, thereby encouraging students to create, problem-solve, communicate, collaborate, and use real-world skills by applying technology purposefully.

Objective 4.2: Provide technical and pedagogical support to ensure that students, teachers, and administrators can effectively access and use technology tools.

Objective 5.2: Provide support to help teachers disaggregate, interpret, and use data to plan, improve, and differentiate instruction[3] (p. 13-15).

The ITRT position, as defined by Virginia's technology plan, has gradually become more comprehensive. Virginia's first technology plan in 1989 recommended that schools designate a staff member to coordinate technology training and its application. This could be any staff member working either full or part-time. By the publication of its second plan, the state recommended specialized training for this staff member and the development of technology competencies. In 2003, Virginia's plan called for the establishment of instructional technologists, licensed teachers, who work directly with teachers to assist with the integration of technology into classrooms.

In 2008, expectations for ITRTs were operationalized because their roles were not clearly defined or understood. The following responsibilities of the ITRT were defined:

[3] This is a partial listing that only reflects those that directly address professional development.

- Working collaboratively with individual teachers or groups of teachers to integrate technology into instruction
- Assisting with curriculum and content development
- Disseminating information regarding technology resources, emerging technologies, best practices using technology, and professional development opportunities
- Facilitating or conducting technology-related professional development for school staff
- Assessing levels of teacher and student technology use and skills
- Modeling effective instructional strategies using technology
- Serving as a member of the school technology committee
- Supporting implementation of the division and state technology plan
- Researching use of newer technologies in instruction
- Using data to design technology-based instructional strategies
- Recommending hardware, software, and related resources
- Identifying trends in software, curriculum, teaching strategies, and other educational areas
- Creating learning resources for teachers, staff, and students
- Serving as a strong advocate for technology integration
- Participating in software selection and use (Virginia Department of Education Division of Technology and Career Education Office of Educational Technology, 2008, p. 10-11).

The following time allocations were also recommended:

Percent of Time	Task
>=68% Initial estimate: >=70%	Assist teachers with the integration of technology in the classroom, train teachers to use technology, assist with curriculum development as it relates to educational technology, model instructional strategies with students, provide training and professional development, collaborate with teachers, research technology-based instructional strategies, review/evaluate technology software, offer direct assistance to teachers by way of classroom visitations, or fulfill similar kinds of duties and responsibilities as the school division may deem appropriate. Provide professional development activities for administrators.
<=14% Initial estimate: <=15%	Meet with administrators and content supervisors at the building and/or central office level to coordinate services and resources. Serve on building and/or division leadership teams relating to technology and instruction, professional organizations related to technology, and other responsibilities. Assist administrators and content supervisors with data-driven decision making relating to all areas of curriculum and instruction.
<=9% Initial estimate: <=10%	Create and implement a plan to communicate progress and activities to school, faculty, and administration (e.g., newsletter, technology Web site, e-mail notifications).
<=3% Initial estimate: <=4%	Conduct minor troubleshooting of computer lab equipment, hardware, or software problems.
<=1% Initial estimate: <=1%	Maintain records necessary to document progress and activities, such as a journal, blog, or database of activities (see Spotsylvania database example: http://www.spotsylvania.k12.va.us/itrt/ITRTevaluation.htm).
<=5% Initial estimate: N/A	Conduct personal professional development, including research relating to professional growth goals, related conference attendance, workshops, and coursework.

Illustration 1. VDOE recommended ITRT time allocation. From "Instructional Technology Resource Teacher Guidelines for Teachers and Administrators," by The Virginia Department of Education Division of Technology and Career Education Office of Educational Technology, 200.

Virginia supports its vision with its Educational Technology State Grants Program designed to improve student achievement through the use of technology, to ensure that students are technologically literate by the end of eighth grade, and to encourage the effective integration of technology through professional development. To this end, it requires that twenty-five percent of its funds be targeted for technology professional development.

The mission statement of County X[4] states, "County X, in partnership with students, families and communities, emphasizes and supports high levels of achievement through a global education for all, with options and opportunities to meet the diverse needs and interests of individual students" (County X, 2015a). Its current six-year strategic plan embeds technology and twenty-first century skills in all three of its goals, and its Capital Improvement Plan provides funding for the implementation and maintenance of the division's 2015-2017 Technology Master Plan.

County X's emphasis on technology is explicitly expressed in one of the three goals of its 2020 Design for Excellence Plan (2015a) which states, "All learners will demonstrate the 21st-century learning and technology skills and knowledge that will prepare them for success in school, postsecondary education, work and life in a global society", and is further illuminated in its Department of Technology's mission which is, "to empower teachers to integrate technology, into all aspects of teaching and learning, through the delivery of quality instructional resources, exemplary training, and friendly customer service" (County X, 2015c, p. 5).

The division's Technology Master Plan's goals include (1) providing a safe, flexible and effective learning environment; (2) using technology to engage students in meaningful content; (3) creating opportunities for students to gain, develop, and apply knowledge and skills through the effective use of technology; (4) providing each student with access to a personal device, and (5) using technology to facilitate data-driven decision making in order to improve teaching and learning (County X, 2016c).

County X supports its mission and goals with Capital Improvement Funds and with grants from outside agencies. The Capital Improvement Plan identifies $3,100,000 annually for the

[4] The site studied will be referred to as County X.

continued implementation of this Technology Master Plan (p. 22). It also employs ITRTs to aid in carrying out divisional goals. At this time, there are thirty ITRTs. In the 2015-16 school, 3 full days were devoted to technology training for secondary teachers. In addition, the county is currently rolling out its Anytime, Anywhere learning initiative providing 1:1 devices for all secondary students, with a continued rollout of additional devices to elementary schools.

Statement of the Problem

Over time, little progress has been made in the utilization of technology. In 2000, The National Center for Education Statistics reported that only 44% of all teachers used technology for instruction. Eight years later, less than thirty-five percent of teachers acquiring funding through the United States' Department of Education's Enhancing Education through Technology integrated technology at least once a week. And, a decade or more later, Grey, Thomas, and Lewis (2010), in a survey of 3000 teachers conducted under the auspices of the National Center for Education Statistics, noted that fewer than half used computers frequently for instruction. Govender and Govender (2014) found that, even when teachers possessed the necessary technology skills, 84% failed to integrate technology, and Pittman and Gaines (2015), in a study of 75 teachers, found that only 18.7 % integrated technology at a high level of usage.

Additionally, little progress has been made in the way in which technology is used. In 2002, Hart, Allensworth, Lauren, and Gladden surveyed over 11,000 teachers and found that 6% highly integrated, 11% integrated, 24% modestly integrated, 31% limited integration, and 49% had no integration of technology into their classrooms. Eight years later, Eteokleous (2008), in an evaluation of one elementary school, found that computer use was sporadic and not integrated into the curriculum. Technology was used, "more as supporting tools or fancy chalkboards than as educational tools" (p. 669). A decade later, in a 2012 study of 2,462 advanced placement and National Writing Project secondary teachers, teachers most commonly used digital tools to have students conduct research online (95%), have students access (79%) and submit (76%) assignments online, create or post work on the internet for classmates or teachers only (40%), participate in online discussions (39%), edit or revise their own work (36%) or others' collaboratively (29%), and post work to the internet for others to view (22%) (Purcell, Heaps, Buchanan, & Friedrick, 2013). Technology is used less in student-centered practices and is instead used in more traditional ways (Ertmer and Ottenbreit-Leftwich, 2013).

Rationale for the Study

The research presented here argues that teachers still have a way to go before they are effectively and comprehensively integrating technology into teaching and learning. In order to integrate technology effectively, teachers need instructional support and ongoing staff development (Giordano, 2008; Greaves, Hayes, Wilson, Gielniak, & Peterson, 2012; Harris & Hoffer, 2011). Teachers' use of technology evolves with increased technological proficiency. Researchers have identified several stages through which teachers progress as they become masters of utilizing technology in the educational setting. While they have been labeled differently, they share common identifying characteristics in that teachers move from the acquisition of basic skills to simple use for delivery of instruction to implementation with best practice using customized resources (Hixon & Buckenmeyer, 2009; Mills & Tincher, 2003; Sheingold & Hadley, 1990). The rate at which teachers move through these stages is dependent upon the type of professional development they receive. Technology professional development that is sustained, engaging, individualized, and embedded in curriculum that matches stated objectives is more likely to be effective (Thomas, Hassaram, Rieth, Raghavan, Kinzer, & Mulloy, 2012). Gerard, Varma, & Linn (2011) conducted a meta-analysis encompassing 360 studies and found that for technology tools to be used effectively in instruction, technology professional development needs to last longer than one year, be constructivist in nature, and allow for teacher reflection on pedagogical approaches.

The ITRT model of professional development was established by Virginia lawmakers in 2003 in response to teacher needs for professional development in the integration of technology. County X's ITRT program was developed as a direct result of that legislation. If ITRTs are available upon demand to act as facilitators by training, modeling, and coaching teachers in the integration of technology into their content areas, why have they not been used to capacity?

This study adds to the body of research by turning the technology in education spotlight away from the acquisition of devices and onto the importance of integrating technology into the classroom, and, as a result, it is hoped that it will lead to an increase in technology integration due to the paucity that currently exists. Further, this study investigated one system's model of professional development to more fully understand the effectiveness of the ITRT model. "The challenge is not getting appropriate technology into classrooms, but getting those in classrooms prepared to use those technologies, and facilitating greater willingness to incorporate changing technologies as they emerge" (Buckenmeyer, 2010, p. 27).

Research Questions

The following questions guided this study:

1. How were ITRTs utilized for professional development by teachers?
    a. What were the frequencies of the types of professional development requested by teachers in County X?
    b. Did the frequency of these professional development activities remain constant over time?
    c. Did the frequencies of professional development activities in County X vary as

a function of:

i. School level?

ii. School Title I status at the elementary level?

iii. School subject at the secondary level?

2. How did the involved ITRTs make sense of how teachers used their professional development services?

II. Literature Review

A review of the literature was conducted using the following databases: Academic Search Complete, Education Research Complete, ERIC, and Dissertation Abstracts International. Searches were limited to peer-reviewed journals and dissertations, and the search dates were confined to those occurring after 2005, due to the rapidly changing nature of technology. If results were not forthcoming, date limits were broadened. Search terms included technology integration in combination with classroom or K-12. Once general research had been conducted, technology integration in conjunction with specific search terms (classroom management, teacher beliefs, etc.) was conducted. Finally, articles were found by perusing the reference lists of key studies.

Technology Integration in Education

Traditionally, school districts have been more focused upon acquiring and allocating funds to purchase technological tools, than they have been on providing adequate professional development to prepare teachers to use these, and, as a result, teachers use said tools in traditional ways to support traditional pedagogy, if at all (Ertmer and Ottenbreit-Leftwich, 2013; McLeod and Richardson, 2013; Purcell, Heaps, Buchanan, & Friedrick, 2013; Shiang-Kwei, Hui-Yin, Campbell, Coster, & Longhurst, 2014; U. S. Department of Education, 2016). Further, many teacher preparatory programs do not adequately prepare teachers to integrate technology into their classrooms (Al-Ruiz & Khasawnet, 2011; McLeod and Richardson, 2013; U. S. Department of Education, 2016).

While a lack of ready resources or professional development may act as a barrier to the integration of technology, once removed, it still requires that teachers change their practice. There is no consistent model or pathway to success (Greaves et al., 2012, Harris & Hoffer, 2011; U. S. Department of Education, 2016). "Technology integration is a complex phenomenon that involves understanding teachers' motivations, perceptions, and beliefs about learning and technology." (Keengwa, Ochwari, & Wachira, 2008, p. 560).

Barriers

Barriers to technology integration have been identified and characterized in a number of different ways. Early research focused upon external factors that dealt with funding, equipment, professional development, and technical support. Later research began to focus more upon internal factors such as teachers' beliefs and perceptions about technology and pedagogy, as well as organizational culture or administrator attitudes and beliefs. These factors have been categorized in a number of different ways as well, from internal or external, first or second order, to those that are resource, personal, or organizationally related and more.

Based upon an analysis of forty-eight empirical studies, Hew and Brush (2007) identified 123 barriers to technology integration and assigned these to the following six categories using a constant comparative method: (a) Resources, (b) Knowledge and Skills, (c) Institution, (d) Attitudes and Beliefs, (e) Assessment, and (f) Subject Culture. The numbers of barriers falling into each category were as follows:

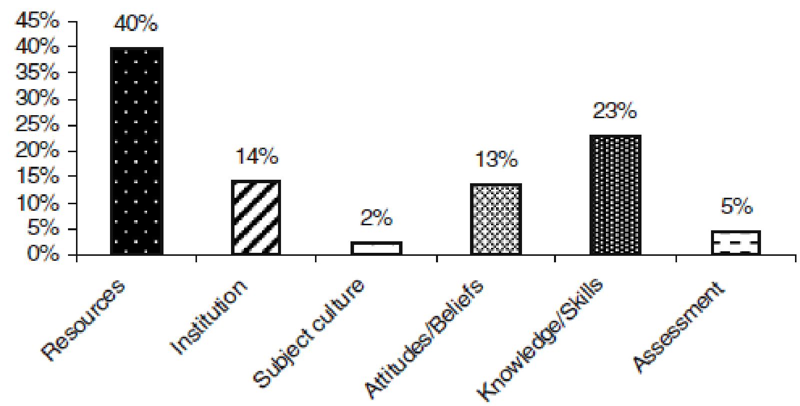

Illustration 2. Percentage of barrier types mentioned across studies. From "Integrating Technology into K-12 Teaching and Learning: Current Knowledge Gaps and Recommendations for Future Research," by K. F. Hew and E. T. Brush, 2005, Education Technology Research and Development, 55, p. 226. Copyright 2005 by Springer.

Resources. Resources were described as those things concerning funding, equipment purchase or availability, time to locate or develop lessons and electronic resources, and technical support. These factors were identified as barriers in forty percent of the studies Hew and Brush (2007) investigated. Inoperable or a lack of equipment was found to be a barrier, in subsequent studies as well (Kopcha, 2012; Kress, 2011; Miranda and Russell, 2012; Pi-Sui, 2016; Shiang-Kwei, et al., 2014; Spector, Johnson & Young, 2014).

Initiatives supplying billions of dollars annually have been enacted, in order to place technology within public schools, and have resulted in lower student-to-computer ratios (McLeod and Richardson, 2013; Miranda and Russell, 2012). By 2009, the average ratio of students-to-instructional-computer was 5.3:1, with 93 percent of those being Internet connected (Education Week, 2011). In a 2013 survey of 503 teachers, Ninety percent had at least one computer in their classroom and fifty-nine percent have an interactive whiteboard. Thirty-five percent have a tablet or e-reader in their classroom (PBS, 2013). Utilizing data from a nationwide survey of teachers, Becker (2000) found that a 4:1 or less computer-to-student ratio led to increased student use of technology.

With the availability of free Web 2.0 software tools, “No longer are we limited to the software someone else has designed, the limited uses of computers that others have pre-determined, or the resources someone else has put on the Web” (Schrum & Levin, 2009, p. 47). No longer are teachers impeded by a lack of funding to purchase software (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012). Yet, despite the provided funding, less than thirty-five percent of teachers, who received monies through the USDOE’s Enhancing Education Through Technology program, integrated technology on a weekly basis (USDOE, 2008). And, only forty percent of K-12 teachers surveyed across the country reported using technology often (Gray et al. 2010). Govender and Govender (2014) found that, even when teachers possessed the necessary technology skills, 84% failed to integrate technology.

There is a distinction to be made between access and availability. Access refers to the possession of equipment, and availability refers to the opportunity to use purchased equipment, as it is often inoperable, placed in communal labs, and reserved for technology content classes or for testing (Kress, 2011). Based upon the National Center for Education Statistics Report, *Teachers’ Tools for the 21st Century: A Report on Teachers’ Use of Technology*, teachers who have access to an adequate number of computers, in the classroom, were more likely (sixty-eight percent) to use them, as opposed to those who had to use computer labs (thirty-eight percent) (Lanahan & Shieh, 2002). This was attributed to the need to schedule labs ahead of time and to competition for limited resources (Chamber & Bax, 2006; Shiang-Kwei, et al., 2014; Starkey, 2010).

Closely aligned is a teacher expressed lack of time to focus upon locating or creating technology rich resources (Hechter and Vermette, 2013; Pi-Sui, 2016; Shiang-Kwei, et al., 2014). In a survey of 256 randomly selected high school teachers from across Ohio, Latio

(2009), found lack of time to be the second most often cited barrier to technology integration. According to Latio, “Lack of time, as teachers see it, is compounded by the fact that teachers are busy during the day teaching, and understanding non-teaching functions such as grading papers, preparing lesson plans, communicating with parents, or even counseling students” (p. 170).

Technical Support or poor infrastructure are also differentiated from professional development and are frequently found to be of issue (Dell, 2006; Hinson, LaPrairie, & Heroman, 2006; McLeod and Richardson, 2013; Shiang-Kwei, et al., 2014). Based upon the National Center for Education Statistics Report, *Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology*, fifty-six percent of teachers who were provided with technical support used computers with their students, as opposed to forty-two percent who were not provided technical support (Lanahan & Shieh, 2002).

Ancillary studies found that strategies to overcome scarcity of resources could include placing technology in all classrooms, using mobile labs, rotating students through labs or in collaborative groups, teacher collaboration on lessons, introducing technology gradually across subject areas, increasing teacher planning time or class time, and using students as technology helpers (Grant, Ross, Wang, & Potter, 2005; Heider, 2005; Lim & Khine, 2006).

Knowledge and Skills. Knowledge and Skills refer to a dearth in teachers' technological skills, the inability to integrate pedagogy and technology, or weak classroom management skills when enacting technology integration and were found to be of issue in twenty-three percent of the studies Hew and Brush (2007) evaluated. Teachers' self-perceived, inadequate technology skills were of issue in subsequent studies as well (Blackwell, Lauricella, and Wartella, 2014; Ertmer, et al., 2012; Inan & Lowther, 2010; Karaca, Can, & Yildirim, 2013; McLeod and Richardson, 2013; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Pi-Sui, 2016;

Shiang-Kwei, et al., 2014).

Cuban (2001) found that computers were most often used to, "supplement traditional classroom pedagogy" and were not effectively integrated with the curriculum (p. 121). Six years later, Eteokleous (2008), in an evaluation of one elementary school, also found that computer use was sporadic and not integrated into the curriculum. Technology was used, "more as supporting tools or fancy chalkboards than as educational tools (p. 669). This was still an issue in 2013 and 2014, when Ertmer & Ottenbreit-Leftwich and Shiang-Kwei, found that technology continued to be used in ways that were not meaningful or student-centered but in ways that supported traditional practices.

Mishra and Koehler (2006) defined the intersection of technological skills and pedagogical knowledge that teachers possess as technological pedagogical content knowledge (TPACK). TPACK is described as, the connections between curricular content knowledge, knowledge of technology, and pedagogical knowledge, and the powerful interactions that occur when these domains are combined (Archambault & Barnett, 2010).

Hughes (2005) postulated a continuum, upon which teachers may be placed, with regard to their ability to integrate pedagogy and technology ranging from Replacement to Amplification to Transformation. Replacement is defined as using technology to support traditional pedagogy. Amplification is defined as using technology to improve productivity, and Transformation is defined as using technology to transform teaching and learning.

Classroom management, in a technology rich environment, requires additional rules and procedures to manage resources, collaboration, and digital citizenship (Fenton, 2016; Lim, Teo, Wong, Khine, Chai, & Divaharan, 2003; Newhouse, 2001). Chambers and Bax (2006) found that the way in which the classroom was arranged affected the way in which computers were used, but not the frequency. When rooms were designed to allow easy transitions from computer to non-computer activities, teachers were more likely to use computers in higher-level thinking activities. Zandvliet and Fraser (2004) found that both students and teachers preferred to have computer stations arranged peripherally. Students preferred the ease of movement and collaboration opportunities that it afforded, and teachers enjoyed the ability to monitor student work.

Institutional Barriers. Institutional barriers are characterized as those involving leadership, school planning, and school time-tabling. These were identified as barriers in fourteen percent of the Hew and Brush (2007) studies. Planning refers to the deficiency of a comprehensive plan to enact technology integration or the incorporation of new technological tools. School time-tabling refers to the lack of time provided during the instructional day for students to participate in technological projects (Latio, 2009; Pi-Sui, 2016; Starkey, 2010).

Later studies defined the roll that leadership might play. Leadership may act as a barrier when administration is not perceived as placing value upon or being supportive of technology, or when failing to have a concrete vision for technology's role in the school (Anthony, 2012; Ertmer, et al., 2012; Lui, 2012; McLeod and Richardson, 2013; Sarapani & Calahan, 2015). A distributed leadership style resulted in increased use of technology (Levin & Schrum, 2012; McLeod and Richardson, 2013). Other leadership factors found to positively affect technology use were policies that encouraged teacher experimentation and collaboration and the availability of incentives for teacher use. Anderson & Dexter (2005) examined a survey of over 800 schools and found that strong technology leadership had the largest positive, significant correlation with technology use.

Research has also addressed the needed skill sets for technology leaders recommending that administrators know how to operate technology, and use it frequently (McLeod and Richardson; 2013). It is also the responsibility of the technology leader to provide time and professional development for staff members to become proficient in the use of technology (Anthony, 2012; Sarapani & Calahan, 2015). An additional competence, often suggested, is the need for leaders to have a vision for the role of educational technology in schools and the importance of involving stakeholders during its development, in order to create a shared vision and employee buy-in (Anthony, 2012; Ertmer et al., 2012; McLeod and Richardson, 2013). To create this vision, administrators must understand the way in which technology should be integrated into the classroom and work to see that is (Anthony, 2012). Leaders must also be prepared to use data when planning and assessing the effectiveness of this integration and their technology plan (Anthony, 2012).

Attitudes and Beliefs. Teachers' attitudes and beliefs toward technology were identified as barriers in thirteen percent of the Hew and Brush (2007) studies. Attitudes and beliefs reflect the value teachers place upon technology and their pedagogical philosophy concerning teaching and learning. Subsequent studies showed that even when barriers of access and support are removed, teacher beliefs and attitudes remain a factor-- specifically; attitudes about the relevance of technology to students' learning were most influential in teacher technology use (Blackwell, Lauricella, and Wartella, 2014; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Karaca, Can, & Yildirim, 2013; Ottenbreit-Leftwich, Glazewski, Newby & Ertmer, 2010).

Negative attitudes toward technology have been found to impede successful technology integration. Two that were set apart from pedagogical considerations were resistance to change and feelings of inadequacy. Chamber & Bax (2006), in an ethnographic study of two sites, reported that teachers felt, "that students might know more about technology than they did, causing them to 'lose face'" (p. 472). This finding was supported in additional studies (Bennett & Maton, 2010; Teo, 2011).

The degree to which teachers embrace a student-centered philosophy is also a factor in technology use. Teachers who are student centered use technology more frequently than teachers who are not student centered despite the existence of other barriers. When their pedagogical beliefs are compatible with the use of technology and they believe that its use positively affects student outcomes, then teachers are more likely to use it with students (Ertmer, et al., 2012; Kim, Kim, Lee, Spector & Meester, 2013; Miranda and Russell, 2012; Lim & Khine, 2006; Pi-Sui, 2016). Specifically, teachers, who embrace a more Constructivist philosophy, are more likely to incorporate technology into their classrooms and in meaningful, student-centered ways, as to opposed to those who use technology to support their traditional pedagogy or for teacher-centered activities (Hermans, Tondeur, van Braak, & Valcke, 2008; Kim, Kim, Lee, Spector & Meester, 2013; Mama and Hennessy 2013; Pi-Sui, 2016).

Assessment. Assessment barriers refer to those associated with high stakes testing and were found to be barriers in five percent of the Hew and Brush (2007) studies. According to subsequent studies, the emphasis placed upon student test scores leads teachers to feel that they don't have "time" to use technology or to develop and explore technological tools and lessons (Shiang-Kwei, et al., 2014). In addition, when used, technology is often utilized as a means for assessment as opposed to learning (Bichelmeyer, 2005; Schneiderman, 2004). This does not refer to the inability to use computers due to their being used for testing. That is considered to be an Access Barrier.

Subject Culture. Subject Culture barriers are those that are related to deep-seated school or organizational culture. These were found to barriers in two percent of the Hew and Brush (2007) studies. Subsequent studies found that teachers are reticent to use technology that is incompatible with their school culture (Hennessy, Ruthven, & Brindley, 2005; Kress, 2011; Shiang-Kwei, et al., 2014). They are reluctant to be perceived as different from their peers. Unless the school's culture is one embracing innovation and change, it is inherently resistant to change, because it is constructed over time with teachers being conditioned to teach specific content using certain methodologies, and by design, it preserves existing practice (Zhao & Frank, 2003). Tondeur, Valcke and van Braak (2008) investigated the degree to which a school's culture could predict technology integration. The authors found that those cultures characterized as innovative and goal oriented positively affected the way in which technology was used by students for acquiring basic computer skills and using computers as a learning tool, but not for using computers as an informational tool, which requires higher level thinking and a more innovative approach to teaching and learning.

Professional Development

General Professional Development. To understand professional development, one must first turn to adult learning theory. Merriam's (2004) statement still holds true today, "After some 80 years of study, we have no single answer, no one theory or model of adult learning. What we have instead is a colorful mosaic of theories, models, sets of principles, and explanations that combined create the knowledge base of adult learning. At the center of these theories and models is the adult engaging in formal and informal learning activities that address some perceived need or interest" (p. 199).

In 1926, Lindeman introduced many of the modern concepts associated with adult learning theory, which he called Andragogy. He stated that adult learning is, "a co-operative venture in non-authoritarian, informal learning-- the chief purpose of which is to discover the meaning of experience" (Brookfield, 1987, p. 122). He postulated a distinction, not between adult and children's education, but between adult and conventional education. He believed that adults were motived to learn by needs and interests satisfied by knowledge acquisition. Adult learning is life-centered, should be self-directed, and is based upon experience. Finally, people become increasingly different as they age. So, adult learning situations should not be pedagogically rigid, designed to avoid original thinking, and preclude the importance of experience, but should be collaborative, informal, and based upon small-group discussion (Brookfield, 1984).

Cyril Houle defined adult learning as, "the process by which men and women (alone, in groups, or in institutional settings) seek to improve themselves or their society by increasing their skill, knowledge, or sensitiveness; or it is any process by which individuals, groups, or institutions try to help men and women improve in these ways" (Houle, 1972 p. 32). He further divided adult learners into three categories based upon their motivation to learn—those that are goal-oriented (participating to achieve a goal), activity oriented (participating for social reasons), and learning-oriented. He was particularly interested in those who were learning-oriented, or learned to just acquire knowledge (Houle, 1961). It was for this group that he felt self-directed learning was of import. Andragogy and self-directed learning was further expounded upon by one of his students, Malcolm Knowles.

Knowles' theory of Andragogy, and it is he who popularized the term, is based upon five assumptions about adult learners and four principals to be applied in adult learning situations (Knowles, 1984). The five assumptions are:

1. Self-concept—as one matures, one moves toward being less dependent and more self-directed.
2. Experience—as one matures, one accumulates experience that acts as a

resource for learning.

3. Readiness to learn—as one matures, one becomes more oriented to the developmental tasks of one's social roles.
4. Orientation to learning—as one matures, one becomes increasingly more likely to apply knowledge immediately and shifts away from subject-centeredness toward problem-centeredness.
5. Motivation to learn—as one matures, one's motivation to learn is more internally based.

The four principals are:

1. Adults should participate in the planning and evaluation of instruction.
2. Experience provides the basis for the learning.
3. Adults are most motived by subjects that demonstrate immediate relevance and impact.
4. Learning should be problem-centered.

Bandura's Social Cognitive Theory holds that behavior is learned through the process of environmental observation and that the consequences of enacting a behavior are taken into account when a decision is made to model said behaviors—motivational factors and self-regulatory mechanisms come into play (Bandura, 1986). Reinforcements can be both internally and externally generated and usually lead to a change in behavior, although, external reinforcements have little impact when they are at odds with the individual's needs. Identification and modeling occur when a model possesses a quality, which one would like to possess, and requires that one adopts their observed behaviors, values, beliefs and attitudes. In order for a behavior to be modeled, one must attend to a behavior, retain the steps to recreate the behavior, be able to reproduce the behavior, and be motived to do so. The decision to model the behavior occurs as a function of self-regulation and requires that one participate in self-observation (reflecting on one's behavior), judgment (is the behavior desirable or acceptable), and self-response (the self-given reward or punishment for performing the behavior well). Self-efficacy, "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995, p. 2), affects the likelihood of success that one will experience when trying or learning new things. Those with a stronger sense of self-efficacy are more likely to be challenged to master problems, to express a stronger interest in tasks, experience a stronger commitment to these tasks, and to recover quickly from failures.

Kolb's Experiential Learning Theory also addresses active and life-long learners. He defines adult learning as, "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (Kolb 1984, p. 41). His model stresses the experiential, cyclical nature of learning and includes four stages: concrete experience, observation and reflection, the formation of abstract concepts, and testing these in new situations (Smith, 2010). It is important to note that this is a spiral process, and the learner can begin at any one of the four pillars. "Two aspects can be seen as especially noteworthy: the use of concrete, 'here-and-now' experience to test ideas; and use of feedback to change practices and theories" (Kolb, 1984, p 21-22). In his work with Fry (1975), four learning styles, associated with these stages, were identified which range from more concrete to more abstract (Illustration 3). In order to enact meaningful professional development, these tenets and the way in which adults learn need to be considered.

Learning style	Learning characteristic	Description
Converger	Abstract conceptualization + active experimentation	strong in practical application of ideas-- can focus on hypo-deductive reasoning on specific problems— unemotional-- has narrow interests
Diverger	Concrete experience + reflective observation	strong in imaginative ability-- good at generating ideas and seeing things from different perspectives-- interested in people-- broad cultural interests
Assimilator	Abstract conceptualization + reflective observation	strong ability to create theoretical models excels in inductive reasoning-- concerned with abstract concepts rather than people
Accommodator	Concrete experience + active experimentation	greatest strength is doing things-- more of a risk taker-- performs well when required to react to immediate circumstance-- solves problems intuitively

Illustration 3. Kolb and Frye on learning styles. From "David A. Kolb on Experiential Learning," by Infed.org at http://infed.org/mobi/david-a-kolb-on-experiential-learning/. Reprinted with permission from the encyclopedia of informal education [www.infed.org].

Ensuring that all teachers are highly qualified and that their methodologies enhance student achievement were cornerstones of the No Child Left Behind Act and continue to be of focus in its reauthorization as the Every Student Succeeds Act. The primary vehicle, by which this is expected to occur, is professional development. According to Lawless and Pellegrino (2007), after a review of the research on professional development, professional development serves a critical role in helping educators learn new pedagogical methods, make the most effective instructional use of new technologies, and adapt to their student's needs. To be effective, professional development must be longer in duration and include follow-up, provide access to new technologies, be differentiated, actively engage teachers in meaningful and relevant activities in context, promote peer collaboration and community building, and have a clearly articulated and common vision for student achievement (Learning Forward, 2011; McLeod and Richardson, 2013).

Most professional development programs ignore the realities of the classroom and do not afford the opportunity for the trainee to be involved in directing the scope of the training (Richardson, 2003). Carryover of training is best achieved by providing sustained professional development in the actual classroom and should include experimentation, discussion, collaboration, and a nonthreatening environment (Muir-Herzig, 2004; Peeraer & Van Petegem, 2012; Wei, Darling-Hammond, Andree, & Orphanos, 2009).

Professional development must also be perceived as relating to a teacher's needs (Keller, Bonk, & Hew, 2005). As such, its goals must be related to the school or district's mission and be perceived as having an impact on student achievement (Lawless & Pellegrino, 2007). Hence, just-in-time professional development is more effective than pre-scheduled training (Granger, Morbey, Lotherington, Owston, & Wideman, 2002; Schrum, 1999). This is particularly true when teachers perceive ownership created by self-selecting content and activities (Davis, Preston, & Sahln, 2008).

To affect change, it is vital that the suggested innovation is compatible with existing values, beliefs, pedagogical orientations, and attitude towards teaching and learning (Roblyer, 2004). If the content of that which is being trained requires the changing of teaching practices, teachers' existing beliefs and practices must be examined in order to develop a "buy-in" (Latio, 2009). It is not that teacher's resent change based solely on a desire to remain constant—research shows that teachers continually change– all on a voluntary basis (Richardson, 2003).

Technology Professional Development. While having access to technology does increase the likelihood of its use, just having equipment is not enough. Successful integration of technology into the curriculum requires continuous and ongoing professional development (Greaves et al., 2012; Hew & Brush, 2007; Lawless & Pellegrino, 2007; Wei, et al, 2009). When provided with up-to-date technological tools that are accompanied by professional development, teachers are more likely to use technology and use it in different ways than those who receive tools alone (Greaves et al., 2012). This may occur, in part, because providing professional development also addresses barriers involving teachers' attitudes and beliefs and lack of skills. As stated in Walker, Recker, Ye, Robertshaw, Sellers, and Yeary (2012), professional development should address teacher's knowledge, beliefs, attitudes, and behaviors, because these change practice and influence student achievement.

A number of different models have been postulated to describe the stages through which teachers' progress as they integrate technology into their curriculum. The rate at which advancement across stages is made is directly dependent upon the quality of the professional development received (Mills & Tincher, 2003).

Sandholtz, Ringstaff, and Dwyer (1997) identified five stages through which teachers progress as they become more successful integrators of technology. These are entry, adoption, adaptation, appropriation, and invention. At the entry level, teachers use technology in support of teacher-directed activities. At the adoption level, teachers have students use technology for word processing or drill-and-practice activities, and at the adaptation level, teachers have students use additional programs such as database or graphic organizer programs. Finally, at the appropriation level, teachers have students use technology to participate in project based learning, and at the invention level, they use multi-curricular project based learning or individually paced instruction with students (Muir-Herzig, 2004).

Lin, Wang, & Lin (2012) developed a model whereby advancement occurs through eight levels. At level zero technology in not used for instruction. At level one technology is used for clerical tasks, and at level two, CD-ROMS or canned programs are used to enhance instruction. At level three, the Internet is used, and at level four, simple multi-media products are created and used in instructional delivery. At level five, multi-media products are customized to better meet instructional needs, and at level six, instructional applications are created and used. At level seven, one is adept at creating and interweaving multiple technological platforms to provide sophisticated learning environments.

Davies (2011) concentrated on skill acquisition alone and postulated three levels of technological literacy, through which one moves. The first is the Awareness level. At this level, one becomes aware of the types, purposes, and functions of available technologies, but is not able to use them. Level two, the Praxis level, involves actually learning to use the technology, and at level three, the Phronesis level, users are adept at learning new technologies.

TPACK would describe the intersection, but not necessarily the sum, of where a teacher's three knowledge bases overlap-- the intersection of their technological knowledge/skills, their academic content knowledge, and their pedagogical knowledge/skills/philosophies (Ertmer, et al., 2012; Morsink, Hagerman, Heintz, Boyer, Harris, Kereluik, & Hartman 2011). One must address all three areas, when conducting technology professional development, in order to bring them into alignment, so as to affect change.

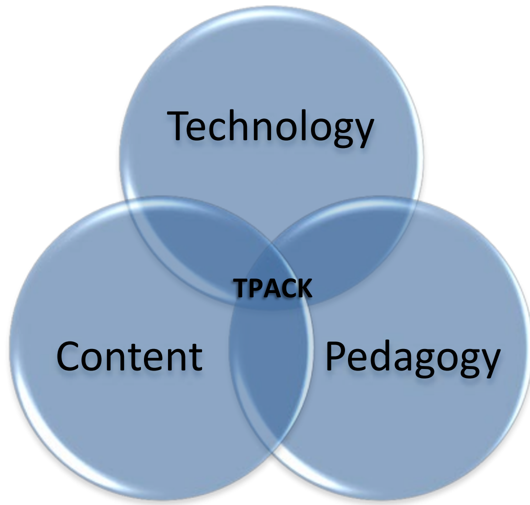

Figure 1. TPACK knowledge framework.

Lawless and Pellegrino's (2007) review of the research found that high quality professional development must be longer in duration (preferably greater than one year), include follow-up, provide access to new technology, actively engage teachers in relevant activities in context, include peer collaboration and team building, have a clear, common vision related to student achievement, and situated within these three domains for successful technology staff development to occur. As such, this would address many of the perceived barriers to the integration of technology: teacher knowledge and skills, subject culture, teacher attitudes and beliefs, and resources. Institution and assessment barriers generally fall outside the scope of individual professional development for teachers and may not be addressed by this model.

Long in Duration. According to Lawless and Pellegrino's (2007) analysis of the body of professional development research, opportunities that are longer and consist of training time plus follow-up are more successful than other approaches. This holds true for technology professional development as well. Those who receive no ongoing support are less likely to be as successful as those who receive ongoing support and opportunities for collaboration or discussion of difficulties (Thomas, Hassaram, Rieth, Raghavan, Kinzer, & Mulloy, 2012;

Vavasseur & MacGregor, 2008). Gerard, Varma, Corliss and Lin (2011) conducted a meta-analysis of forty-three empirical studies analyzing the effect of professional development on the integration of technology-enhanced science lessons for 2,350 K-12 teachers. Professional development programs that lasted longer than one year were more likely to result in sustained technology use.

Those professional development opportunities that are longer in duration may also address several of the previously identified barriers to technology integration. They may assist with teachers' lack of knowledge and skills in classroom management or integration and address specific weaknesses in technology skills. In addition, they may also address resource barriers via technical support, and subject culture barriers via time to implement change.

Meaningful, Relevant Activities in Context. According to Lawless and Pellegrino (2007), it is important to differentiate between professional development focused upon skill acquisition and professional development focused upon integrating technology into the curriculum, and to deliver both simultaneously. Technology skills are best taught actively, while situated within the curriculum, and attached to instructional design in order to address and align trainees' TPACK knowledge base and address existing knowledge and beliefs about teaching and learning (Buckenmeyer, 2012; Hew & Brush, 2007; Koehler, Mishra, & Yahya, 2007; McVee, Bailey, & Shanahan, 2008; Thomas et al., 2012). Direct instruction on how to integrate technology into the curriculum must be provided (Peeraer & Van Petegem, 2012; Stobaugh & Tassell, 2011; Zandvliet & Fraser; 2004). In a study of four English teachers, Hughes (2005) found that the teachers' perceptions of technology as being valuable in providing instruction and learning in the classroom were crucial to developing technology-supported pedagogy. When technology is perceived as valuable, teachers take more ownership over the resources, feel more confident in their ability to integrate the technology, and believe that it will influence student achievement (Kubitskey, Fishman, & Marx, 2003).

While this is often the goal, it is sometimes not the reality. Anthony (2012), in a three year longitudinal study of a 1:1 laptop initiative, found that, while teachers valued professional development, it often resulted in limited integration success, because the connection between how to use technology and how to integrate technology was not well developed. The connection was alluded to, but it was not explicitly taught and the training did not emphasize ways in which technology infused instruction was different from existing practice.

Direct instruction on classroom management skills in a technology rich environment must also be addressed. This would include explicit instruction on how to design tasks that incorporate technology, classroom layout to facilitate technology use, and classroom management skills in a technology rich environment (Lim, et al., 2003; Rogers & Finlayson, 2004).

This type of professional development opportunity would address barriers in teachers' knowledge and skills with regard to classroom management and how to integrate technology into the curriculum. It would also address teachers' attitudes and beliefs about teaching, learning, and technology. Finally, it may address subject culture barriers as the bonds between change and traditional practices become weakened.

Peer Collaboration and Community Building. Peer collaboration and community building have only recently begun to be addressed in technology professional development research and their value as tools to transmit TPACK knowledge addressed. Much of what teachers learn about integrating technology is learned from peer networks, which allow for scalability of support as they remove the need for "experts" (Glazer, Hannafin, Polly, & Rich, 2009; Peeraer &

Van Petegem, 2012). They also allow TPACK construction to continue over time as teachers collaborate, share ideas and resources, set goals, seek answers, and troubleshoot problems (Brill & Walker, 2006; Glazer, Hannafin, & Song, 2005). On one front, there is mentoring and, on the other, peer collaboration and professional learning communities (PLCs).

Teachers, who are mentored, integrate technology more frequently than those who are not (Lowther, Inan, Strahl, & Ross, 2008; U.S. Department of Education, 2016; Zhao & Bryant, 2006). In a study conducted across twenty-six schools, Lowther found that those who were mentored were more confident in their ability to use technology, more likely to use it, and more likely to use it in student-centered practices.

Teachers who take advantage of PLCs have been found to experience positive changes in their attitudes toward and an increase in use of technology (Cifuentes, Maxwell, & Bulu, 2011; Hew & Brush, 2007). Glazer and Hannafin (2008), in a study of nine teachers participating in technology PLCs, found that most increased in their ability to integrate technology as a result of their once-a-month participation in a PLC. Similarly, Hughes and Ooms (2004), in a study of five teachers participating in technology PLCs for one year, found that participants also increased the frequency with which they used technology.

Established five years ago, the unconference or Edcamp is similar to the PLC. These are relatively new styles of professional development conferences where attendees decide the topics, on the fly, and attend discussion sessions, in person or virtually, based upon their interests. Knowledge is built collaboratively by attendees and created resources are shared and built upon as a community of learners is established. Carpenter (2015) surveyed 95 participants in one Edcamp and found that 85% rated the experience highly, 91% planned to attend to again, and participant autonomy and the integration of technology were valued. One negative experience of note was that not all attendees felt their voices were heard due to the number of attendees in each session. Carpenter and Linton (2016) in a survey of 769 attendees found 94% rated their experience highly and planned to attend additional Edcamps. Twenty percent wanted to learn something new with regard to technology and collaboration, positivity, energy level, and self-directed learning were considered to be positive aspects. Not having all voices heard and not everyone being satisfied with topic choices were negatives associated with the experience. There have been no studies as to the effectiveness of this type of professional development in creating lasting change in practice or carryover to the classroom.

Peer collaboration opportunities address resource barriers related to a lack of technical support, time to create lessons, technological skills, classroom management, and the need for help with integrating technology into the curriculum. Troubleshooting issues were not found to be alleviated by their use (Hew & Brush, 2007). Finally, collaborative opportunities might address subject culture barriers and teachers' negative attitudes and beliefs about technology.

Common Vision for Student Achievement. "A significant challenge to schools is selecting the staff development approach that aligns most clearly with the assumptions and beliefs of staff members and produces the results desired for students" (Hirsh, 1999, p. 39). When student achievement is perceived to be positively influenced by the proffered technology professional development, it is more likely to be implemented (Blackwell, Lauricella, and Wartella, 2014; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Karaca, Can, & Yildirim, 2013; Kim, Kim, Lee, Spector & Meester, 2013; Miranda and Russell, 2012; Pi-Sui, 2016). Likewise, Ottenbreit-Leftwich, et al. (2010) found that teachers may not be persuaded to attempt new student-centered practices unless these have been linked to student learning outcomes. This is particularly true when new methodologies are associated with increased student achievement scores on standardized tests (Geier, Blumenfeld, Marx, Krajcik, et al., 2008). Hughes (2005) found that the power to develop technology supported pedagogy lies in the teacher's interpretation of the technology's value for instruction and learning in the classroom.

As stated in Ottenbrite, et al. (2010), teachers' beliefs regarding technology are based upon whether or not they perceive it as supporting relevant instructional goals. When presented, they make value judgments based upon its ability to aid them in reaching goals based upon their import. Indeed, Snoeyink and Ertmer (2002) found that, when teachers perceived the value of a proffered technology professional development to be of use in specific educational purposes, they were more likely to implement it despite other barriers. According to Coppola (2004), technology use is perceived as requiring a great deal of work, so value must be associated with it in order for it to be carried out.

Technology professional development that addresses a common vision for student achievement might also address barriers that affect teachers' attitudes and beliefs. It may also affect subject culture barriers by making sure that the vision and mission for all is unified and aligned with technology integration.

Conclusion.

> There is much work to be done in the field of technology professional development. The literature base on technology professional development for teachers reveals that there is a long way to go in understanding methods of effective practice with respect to the various impacts of these activities on teaching and learning…we need to move to a more systematic study of how technology integration occurs within our schools, what increases its adoption by teachers, and the long-term impacts that these investments have on both teachers and students" (Lawless &

Pellegrino, 2007, p. 575).

Indeed, this is reflected in the United States' Department of Education's Technology 2016 Plan where, "Across the board, teacher preparation and professional development programs fail to prepare teachers to use technology in effective ways" (p. 5). And, recommends that, "Professional learning and development programs should transition to support and develop educators' identities as fluent users of technology; creative and collaborative problem solvers; and adaptive, socially aware experts throughout their careers. Programs also should address challenges when it comes to using technology learning: ongoing professional development should be job embedded and available just in time" (p. 34).

III. Methodology

Research Questions

The following were the guiding questions for this study:

3. How were ITRTs utilized for professional development by teachers?
    a. What were the frequencies of the types of professional development requested by teachers in County X?
    b. Did the frequency of these professional development activities remain constant over time?
    c. Did the frequencies of professional development activities in County X vary as a function of:
        i. School level?
        ii. School Title I status at the elementary level?
        iii. School subject at the secondary level?
4. How did the involved ITRTs make sense of how teachers used their professional development services?

Methodological Framework

This case study describes one school system's approach to supporting technology integration. Using archival data, the ITRT program is described longitudinally across various features in an attempt to provide some insight into a largely undescribed professional development practice. Stake (1995) defines a case as a specific, complex, and functioning integrated system and, as such, identifies people and systems as appropriate subjects for case studies. In addition, he defines an intrinsic case study as one in which the studied phenomenon is a given-- in situ. The purpose of this design is not to generalize but to understand this one specific case (as when one evaluates a program). According to McMillan (2004), "A case study is an in-depth analysis of one or more events, settings, programs, social groups, communities, individuals, or other 'bounded systems." (p. 271). Yin (2009) further amplifies its importance as a method to increase knowledge of organizational phenomenon when there is little control over events, when real-life phenomenon is investigated in context, and when "how" or why" questions are investigated.

The current study was designed to investigate one entity, situated in one real, well-described time and place, in order to obtain a detailed description of and gain understanding about a phenomena over which I had little control. This aligns with Yin's definition of appropriate case study methodology used to, "describe a real life intervention and the context in which it occurred" (p. 20). To this end, the current study employed a case study design as I sought to describe the process of County X's ITRT model to support technology integration and to begin to understand the reasons behind these outcomes as interpreted by the involved ITRTs in focus group interviews.

Setting

Description of Site. Data was obtained for all schools in one large suburban county public school district in central Virginia, which I will refer to as County X. In 2016, the county included 63 schools, with 38 of those at the elementary, 12 at the middle, 11 at the high school level, and two technical centers. Elementary grade levels include pre-kindergarten four-year-olds and grades kindergarten through five. Middle schools include grades six through eight, and high schools and technical centers include grades nine through twelve.

According to County X's planning department, student enrollment for the county is approximately 59,000, with a variation of fewer than 500 students, over the four years investigated. County X is among the seventy largest school districts in the U. S. The county is a little more than 3% whiter than Virginia and close to 4% whiter than the U.S. as a whole (sees Table 1).

Table 1

Percentage of Public School Students by Race or Ethnicity

	County X[b]				Virginia[b]				United States[c]			
	2012	2013	2014	2015	2012	2013	2014	2015	2012	2013	2014	2015
American Indian/ Alaska Native	.2	.2	.2	.2	.3	.3	.3	.3	1.1	1.0	n/a[a]	n/a
2 or more races	4.3	4.4	4.6	4.8	5.0	5.2	5.5	5.7	3.2	3.5	n/a	n/a
Asian	3.5	3.5	3.5	3.4	6.2	6.4	6.6	6.8	4.8	4.8	n/a	n/a
Pacific Islander/Native Hawaiian	.2	.1	.2	.2	.2	.2	.2	.2	.4	.4	n/a	n/a
Black	23.7	23.6	23.9	23.9	22.6	22.5	22.4	22.3	25.6	26.2	n/a	n/a
Hispanic	12.5	13.2	13.9	15.1	13.8	14.4	15.1	15.6	15.3	15.3	n/a	n/a
White	55.6	54.9	53.8	52.5	51.6	50.9	50.0	49.2	49.6	48.9	n/a	n/a

[a] Data not available.
[b] Data acquired from Virginia Department of Education (2016) Data for Researchers and Developers.
[c] Data acquired from National Center for Education Statistics (2016) ELSi Table Generator.

With regard to socio-economic status, as measured by free and reduced lunch eligibility, the county was more prosperous than the rest of Virginia and the United States (Table 2). Thus, the county is not completely representative of Virginia or the U.S. as a whole.

Table 2

Percentage of Students Eligible for Free and Reduced Price Lunch

Year	County X[b]	Virginia[b]	United States[c]
2012-13	31.2	40.1	49
2013-14	32.9	41.2	49
2014-15	33.8	42	n/a[a]
2015-16	30.2	41.9	n/a

[a] Data not available.
[b] Data acquired from Virginia Department of Education (2016) Data for Researchers and Developers.
[c] Data acquired from National Center for Education Statistics (2016) ELSi Table Generator.

County X is nationally known as a forerunner in the educational technology community as signaled by their invitations to present at numerous national conferences, national press received, their designation as an ambassador district for the #GoOpen campaign of the U.S. Department of Education which recognizes school districts that replace traditional textbooks with openly licensed educational materials, and numerous awards received by their director. In the 2011-12 school year, County X welcomed a new director of technology and launched their "digital ecosystem," a single sign-on repository of digital resources, which signaled their shift to online content and an early commitment to GAfE. At the same time, each teacher was trained on the use of Edmodo, a blended learning platform, for use with students. At that time, they were the largest school district using Edmodo in the U.S. In the 2013-14 school year, preparation began for the 1:1 Chromebook roll-out at the secondary level. At the time, it was the largest Chromebook rollout in history. Each school's annual operating plan included a requirement for teachers to meet with their ITRTs four times each year. Currently, grades four and five are being prepared for their 1:1 Chromebook rollout.

Description of Site ITRT Model. ITRTs in County X are assigned to a level (elementary or secondary) and two to three support schools for which they supply assistance in specific software or hardware training, troubleshooting, and are available to coach teachers in the integration of technology into the content. Elementary ITRTs spend one 8 hour day in each of their support schools each week. Elementary ITRTs go to each support school on the same day of the week (i.e. one specified school every Monday and a different specified school every Tuesday, etc.). Specific days are attended to because ITRTs are only available one day each week, so they try to avoid PLC or other meeting days at their support schools, so teachers are unencumbered. Secondary ITRTs spend three 8 hour days days every 2 weeks in each of their support schools such that schools get one day one week and two days the following week. Secondary schools are allotted more time as they currently subsist in a 1:1 environment. Secondary ITRTs have more flexibility in scheduling their support, since there are fewer schools at that level, and no ITRTs have more than two schools. ITRTs send out a weekly sign-up sheet via email that teachers use to reserve time with their ITRT on their school's specified support day. ITRTs are available via email and Google Hangout for anytime, anywhere support. No school is given more than the specified one or two day time allotment. Wednesdays are held as team meeting and professional development days, so no support is provided on Wednesdays. The remainder of the ITRTs' time is spent in work that supports the technology department and district. Table 3 displays the number of ITRTs at each level over a four year period.

Table 3
Number of ITRTs by Level[a]

	2012	2013	2014	2015
High	6	6	6	6
Middle	6	6	6	6
HS/MS	0	1	1	2
Elementary	18	16	16	16
Total	30	29	29	30

[a]Data provided by County X

According to County X's ITRT Data Guidelines (2015b), the scope of activities for which ITRTs were responsible includes:

- Classroom integration coaching, defined as:
  - A planning session with a teacher on a lesson that the ITRT and the teacher, or the teacher, will implement. This consists of time showing, demonstrating, and giving advice on the lesson.
- Trainings, defined as:
  - Specialized content training using technology resources to support classroom

instruction or productivity. These resources can include the software or digital equipment.

- Troubleshooting Activities, defined as:
    - Training and support for teachers and students for network logins, passwords, printer, or server management.
    - Troubleshooting and problem-solving with employees.

Sample. In the four years I am studying, 29 to 30 ITRTs were deployed to schools. Of those, 25 ITRTs had been in the position for all years from 2012-13 to 2015-16 in County X. Therefore, my sample is 25.

Data Collection and Analysis

Two types of data were collected and analyzed in an effort to understand how the ITRTs functioned in the selected site as well as how they explained their utilization by teachers. First, I analyzed four years of time and task logs for the ITRTs in the county. Then, I presented these data to the ITRTs and asked them to make sense of the data and teacher technology immersion and involvement.

Time and Task Logs. Data was obtained via ITRT databases for four consecutive years for all public schools in County X. ITRTs are invited, by the teacher, to provide specific troubleshooting or professional development on hardware, software, or curriculum development. Each of these activities is documented for record keeping purposes. Data was collected from end-of-year ITRT databases which were compiled as part of ITRT work duties. ITRTs are required to chart their activities daily, to the 15 minutes, on their electronic sign-up sheets. Data was collected for activities occurring in the 2012-13, 2013-14, 2014-15, and 2015-16 school years and included the following: application, date, school, subject, teacher's name, and a brief description. In the 2012-13 databases, time used was coded differently, so that year was excluded in calculations of overall time used.

I obtained ITRT databases in Google format, downloaded to Excel, from the Manager of Instructional Technology for County X, with the approval of their research director.

Quantitative data was imported into an Excel spreadsheet and consisted of data that indicated how each ITRT has spent his or her time on the job over the past four years. Descriptive statistics were used to develop the patterns and practices of ITRT work with teachers.

ITRT Focus Group Interviews. Qualitative data was obtained from group ITRT semi-structured interviews. Focus groups promote interactions among participants which lead to richer understandings of phenomena and are valuable when used with knowledgeable participants in order to solicit insights or opinions (McMillan, 2004). Because ITRTs were focused solely upon technology integration, were located in the schools, and worked closely with teachers, ITRTs were uniquely situated and, as such, were privy to the minutiae of the attitudes toward, abilities possessed, and use of technology by teachers across all classrooms. By employing ITRTs as focus groups, I gained a deeper understanding of the barriers and facilitators of technology integration in order to establish better professional development practices.

ITRT focus groups were stratified such that each school level was equally represented in each group. ITRTs were stratified because the research questions specifically addressed levels of school. This was done in an attempt to provide rich responses and interaction across different levels and subjects. All 25 eligible ITRTs agreed to participate.

Focus groups lasted until no new information was forth coming. Interviews were recorded for accuracy and to provide the ability to code data at a later date. I read a scripted statement at the beginning of the interview. See Appendix A.

Participants were shown, via an LCD projector and screen, graphs for each research question, one-by-one, and asked to respond to the following prompt, “I would like for you to comment on the findings. Can you share anything that you believe influenced the data to look as it does? For example, are there any factors that you believe caused it to look the way it does?” Responses were recorded for accuracy in the focus group language and response. Due to the fact that I am an ITRT in County X, I remained neutral and made no further response other than, “Did anyone else have something to add, or could you explain in more detail your meaning?” At the conclusion, I again read a scripted response. See Appendix B.

Focus group data was transcribed by me. Finally, the data was coded for level, subject area, application, and theme and checked for accuracy independently by a second researcher (see Table 4). When one category of coding discrepancy occurred, the two researchers mutually agreed upon a coding by referring back to the Hew and Brush’s category descriptions.

Table 4
Coding Key

Level		Subject Area		Application		Theme	
1	High	A	Computer Tech Ed	K	Google Apps	4	Time
2	Middle	B	Lang. Arts	L	Web-based tools	5	Assessment
3	Elementary	C	Heath/PE	M	Computer-based tools	6	Access
		D	History	N	Gradebook	7	Attitude/Beliefs
		E	Math	O	Edmodo	8	Subject Culture
		F	Science	P	Mobile Devices	9	Knowledge/Skill
		G	Visual/Performing	Q	Chromebooks	10	Institution
		H	Arts	R	Promethean Boards	11	Initiatives
		I	Exceptional Ed				
		J	Library				
			World Language				

I coded the focus group protocols using an Excel spreadsheet. All data was analyzed descriptively and the percentages and frequency distribution were provided for each emerging theme. Focus groups were made up of ITRTs who worked all four of the years studied and were made up of an equal mix of school levels. Focus groups consisted of 13 elementary and 12 secondary ITRTs. Because one elementary ITRT remained silent, the numbers of integrators actively participating at the various levels were equal.

Limitations

This case study of one school district limits generalizability to other populations or programs. As an involved ITRT within County X, I could potentially influence focus group respondents. As a result, I only used scripted responses in focus group interviews in order to refrain from leading respondents. Finally, I would like to state my preconceived beliefs, so that any potential bias is exposed.

I believe ITRTs are severely hampered by two factors over which they have few potential avenues of influence—teachers' lack of time and access to devices. Due to budgetary constraints, possible antidotes might be to provide more online training resources, to better promote virtual meetings, be more flexible in scheduling support days at each school, and to facilitate the building of PLCs to provide support, encouragement, and ideas for integration to teachers by teachers.

I believe ITRTs are also hampered by a lack of administrative buy-in and a school culture in which technology is not valued. In order to combat this, ITRTs could help to create a climate of need by educating school administrators on the importance of a school culture based upon change and innovation. There is also a need for professional development for administrators on creating, communicating, and sustaining a cohesive vision for technology. When delivering professional development to teachers, ITRTs must customize their trainings so they are situated with curricular content, address pedagogy, integrate classroom management skills, and link technology to student outcomes in order to address teacher attitudes, beliefs, knowledge, and skills.

I believe the majority of the problem lies in a disconnect between the expectations for technology that are laid out in County X's vision statement and their Design for Excellence roadmap to success and their individual curriculum and instruction departments' vision and pedagogical focus, as well as teachers' perceived importance placed upon test scores.

The county espouses the importance of technology use. The departments within curriculum and instruction present structured, proven pedagogical models that are promoted at all schools and are required to be followed in language arts and math in low performing schools at the elementary level. As they stand today, these leave little room for technology use. At the secondary level, instructional technology is not a focus in several of the Curriculum and Instruction departments.

In addition, when language arts and math coaches are sent to assist teachers, they are sent to those schools that are not performing well on standardized tests to "teach them how to teach." Teachers' evaluations are tied to student standardized test data, and frequent standardized tests are mandated by the county. This reinforces the teachers' perceptions that test scores are important. They see technology as an add on and instead teach to the test (Shiang-Kwei, et al., 2014). In order to countermand this, ITRTs need to approach the departments of curriculum and instruction to demonstrate the disconnect, provide them with any technology skills needed, and demonstrate how technology can work within their existing frameworks, while making connections between technology use and student success. The department of instructional technology has begun to make inroads in this area by establishing quarterly joint meetings and by assigning an ITRT to each content area to promote technology integration into their instructional model.

IV. Results

Results are presented as the percentage of ITRT time used for professional development during their allotted weekly support days in schools. Frequency data represents each 15 minute slot for which professional development was provided. County X has microcomputer analysts who are responsible for the installation, set-up, and repair of computers and software. ITRTs are solely charged with professional development. This professional development takes many forms and includes classroom integration coaching, training, and troubleshooting. Troubleshooting involves training and instructional support for teachers and students for network logins, passwords, printer, or server management, and problem-solving.

Question 1: In What Ways Did Teachers Use the Professional Development Services of ITRTs in County X?

Question 1a: What Professional Development Was Requested by Teachers? Over the three years included,[5] teachers utilized 52% of the weekly professional development support time offered by ITRTs. Over the four years included, teachers requested professional development with 8 categories of applications. Google Apps for Education (GAfE) and other web based applications accounted for 73% of all requests made to ITRTs (Figure 2). Web based applications are those stored "in the cloud" and include applications like Kahoot, Socrative, Flubaroo, WeVideo, or Discovery Education. The remainder of the applications (e.g., gradebook, Promethean board software, Edmodo, Microsoft products) for which help was

[5] 2012-13 data was excluded due to the nature of the collection logs.

requested were fewer than 10% with most being requested 5% or less. See Table 5 for actual frequency counts.

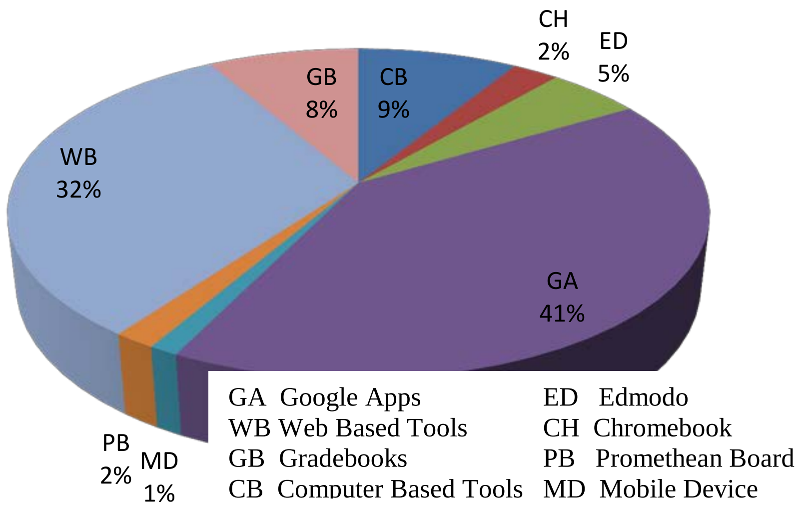

Figure 2. Percentage for which assistance with each application type was requested

Table 5
Number of Requests for ITRT Support by Application 2012 – 2016

Application	Frequency
Google Apps	38,353
Web Based Tools	29,785
Computer Based Tools	8,282
Gradebooks	7,868
Edmodo	4,856
Chromebook	2,390
Promethean Boards	1,566
Mobile Devices	1,072

Question 1b: Did Requests for Professional Development Support Vary by Year? For 2013-14, 52% of ITRT available time for professional development was utilized while in 2015-16, 47% was utilized. Over the course of the three years included,[6] usage declined 5% (Figure 3).

[6] 2012-13 data was excluded due to the nature of the collection logs.

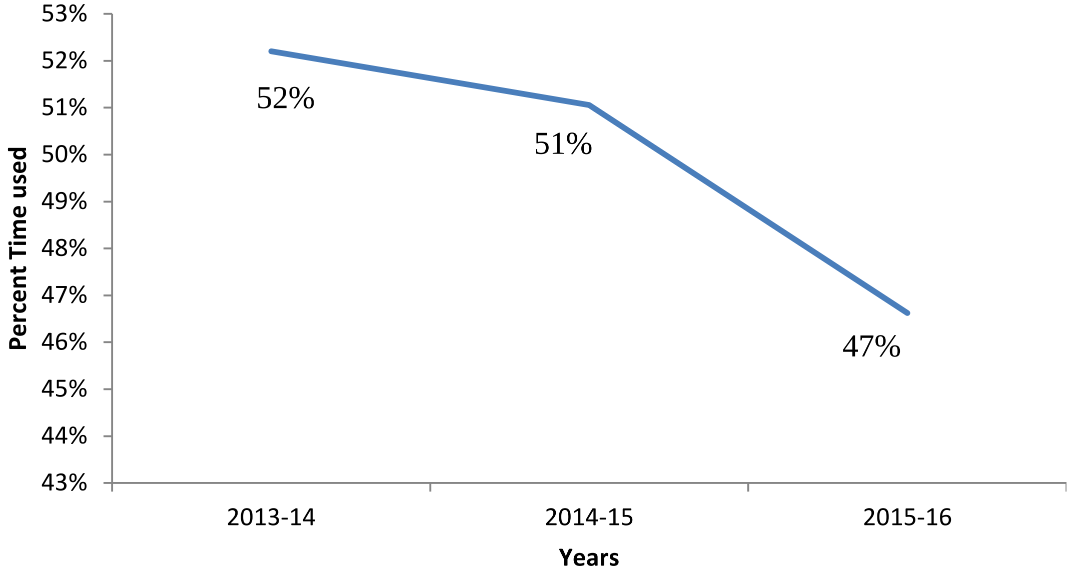

Figure 3. Percentage of ITRT utilization, 2013-2016

With regard to professional development assistance for specific applications requested over the four years studied, there was more fluctuation (Figure 4).

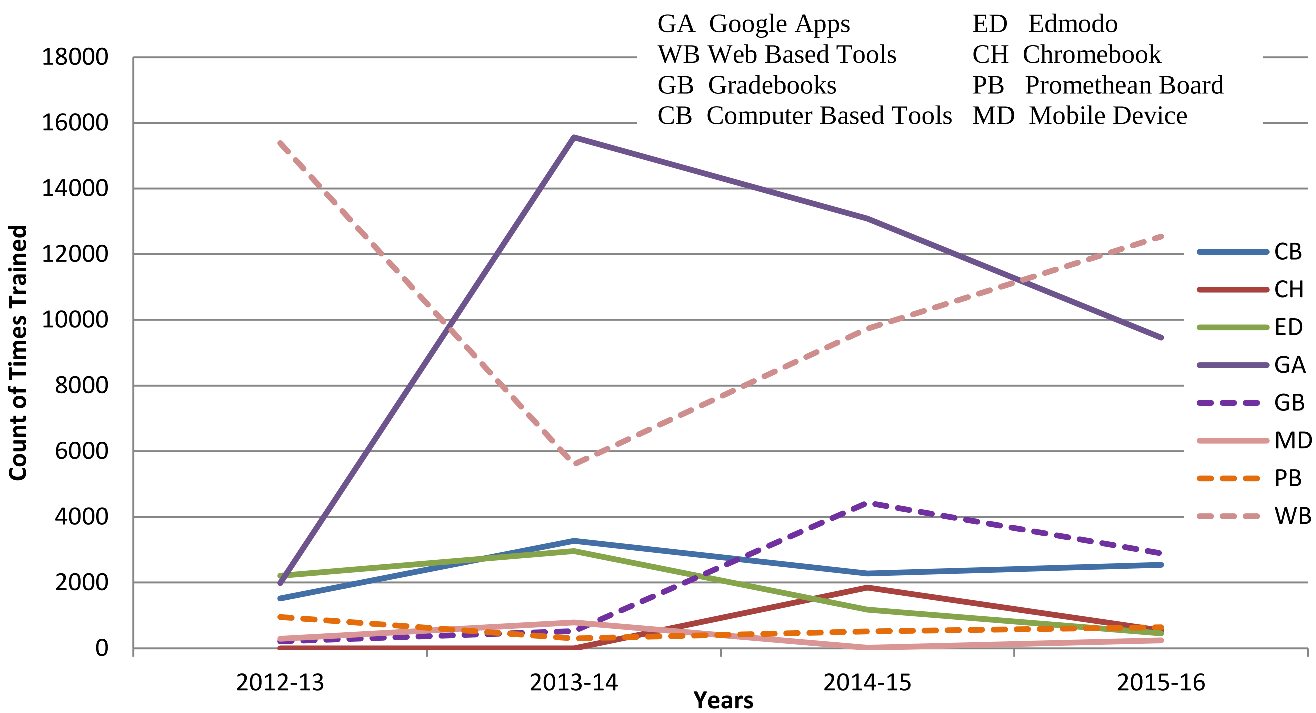

Figure 4. Count of applications for which training was requested over time

GAfE training requests increased dramatically in the 2013-14 school year and then declined slightly over the next 2 years. With the highest requested professional development in the 2012-13 school year, web based tools decreased significantly in the 2013-14 school year and then increased over the next 2 years. Gradebook software was low for the first two years and increased dramatically in the 2014-15 school year. Edmodo saw a gradual decline over the last two years studied. See Table 6 for frequencies.

Table 6
Frequency of Applications Requested by Year

Application	2012-13	2013-14	2014-15	2015-16
Web Based Tools	15,384	5,598	9,727	12,537
Edmodo	2,208	2,955	1,176	449
Google Apps	1,984	15,563	13,081	9,461
Computer Based Tools	1,512	3,272	2,280	2,541
Promethean Boards	952	298	510	639
Mobile Devices	288	785	13	238
Gradebooks	208	517	4,433	2,892
Chromebook	0	0	1,850	540

Question 1c: What Were the Frequencies of Professional Development Activities by School Level, Elementary School Title I Status, and Secondary Subject Level

School Level. Over the three years included[7], elementary teachers utilized 44% of the professional development time ITRTs offered, middle school teachers used 56%, and high school teachers used 55%. Over time, middle school use decreased 9% and high school decreased 8% after the first year. Over the three years studied, elementary use decreased 3%. Elementary use increased 4% after the first year and then fell 7% (Figure 5).

[7] 2012-13 data was excluded due to the nature of the collection logs.

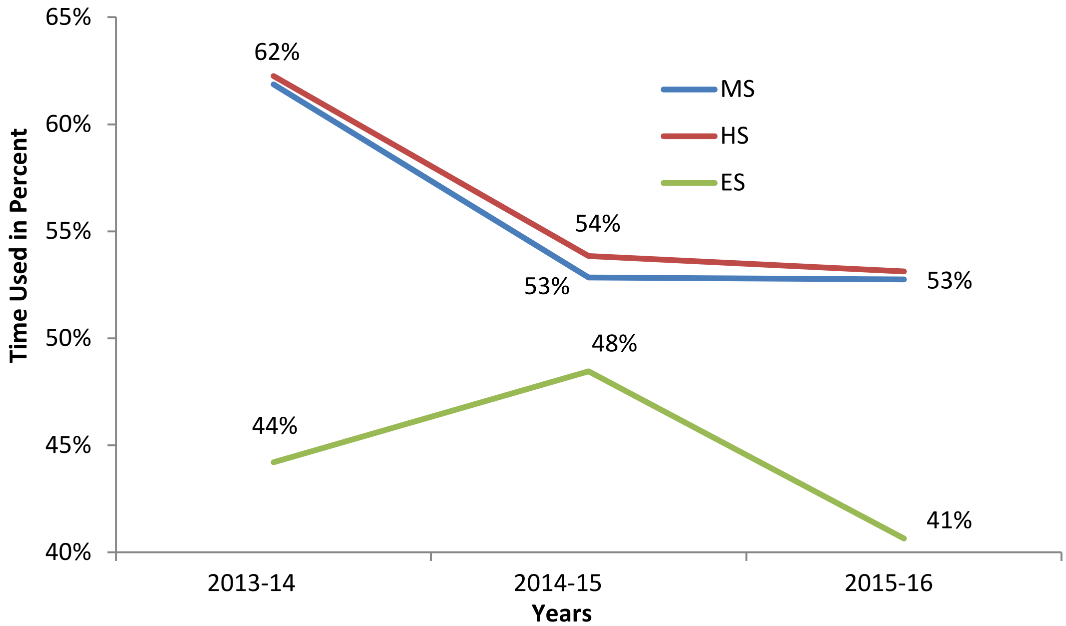

Figure 5. Percentage of ITRT time used by level and year

With regard to applications for which professional development assistance was requested over time, teachers at the elementary level requested more assistance with Promethean boards, computer based tools, gradebooks, mobile devices, and gradebooks (Figure 6). Middle and high school teachers requested more professional development assistance with Chromebooks, GAfE, and web based applications than elementary teachers (Table 7).

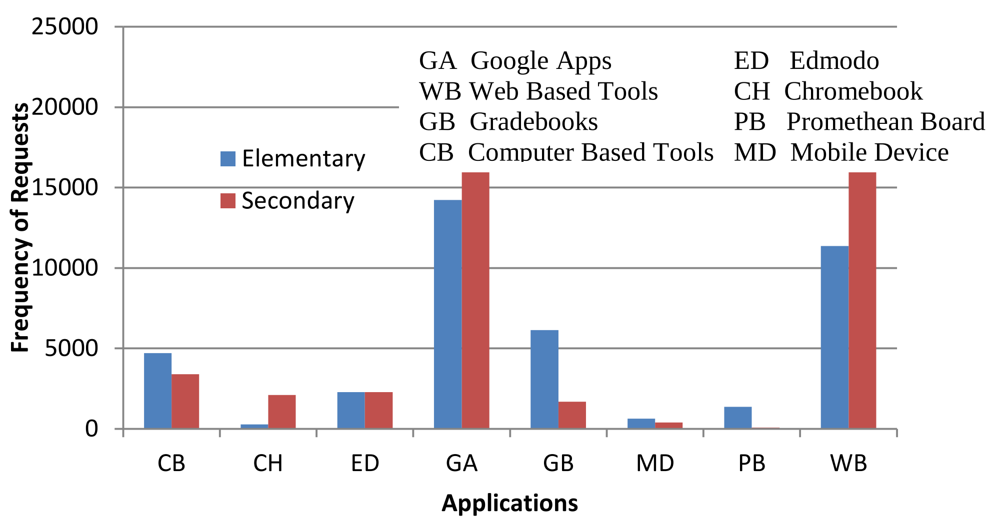

Figure 6. Application help requested by school levels.

Table 7
Frequency of Applications Requested by School Levels

Application	Elementary	Secondary
Google Apps	14,224	23,873
Web Based Tools	11,359	16,502
Gradebooks	6,146	1,696
Computer Based Tools	4,703	3,389
Edmodo	2,290	2,289
Promethean Boards	1,374	73
Mobile Devices	633	401
Chromebook	282	2,108

Elementary Title I Status. Of the ITRT professional development time utilized, elementary schools not classified as Title I used 77% of those hours as opposed to the 23% utilized by Title I schools. There are 17 Title I elementary schools and 21 elementary schools that are not. With regard to applications for which professional development help was requested, schools remained proportionately the same, with the exception of GAfE and web based tools (Figure 7). Title I schools requested less assistance with these applications. Software requests for mobile devices and Promethean board requests were roughly the same (Table 8).

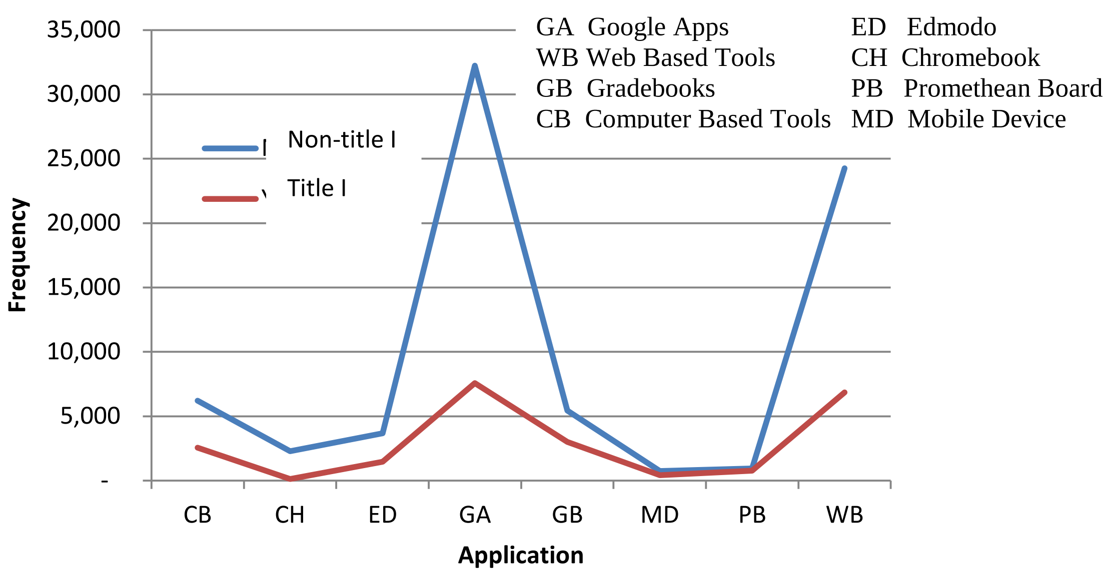

Figure 7. Applications for which assistance was requested by Title I status

Table 8

Frequency of Applications Requested by Title I Status

Application	Title I	Non-Title I
Google Apps	7,571	32,239
Web Based Tools	6,849	24,261
Gradebooks	3,016	5,436
Computer Based Tools	2,567	6,211
Edmodo	1,467	3,672
Promethean Boards	776	940
Mobile Devices	413	737
Chromebook	134	2,282

Secondary Subject Area. Secondary science (36%) and language arts (30%) teachers requested more of the proffered ITRTs' professional development time than did teachers of other subjects (Figure 8). Secondary math teachers used the ITRTs' time fractionally more than secondary history teachers (Table 9).

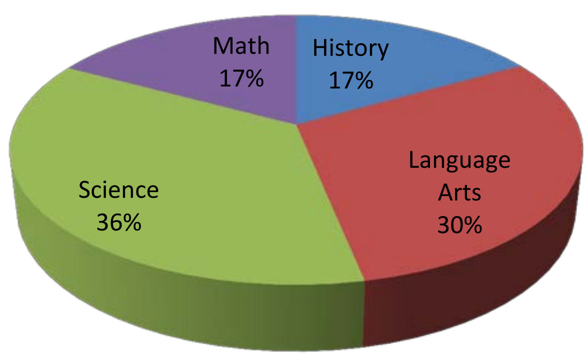

Figure 8. Percentage of ITRT time requested by secondary teacher subject taught

Table 9

ITRT Requests by Subject

Application	Frequency
History	3,291
Math	3,362
Language Arts	5,896
Science	7,081

Question 2: How do ITRTs Describe Their Utilization by Teachers?

In order to make sense of the data depicting the patterns of their professional development use, 25 ITRTs met in heterogeneous focus groups. ITRT focus groups were presented with graphs detailing their use and were asked to describe the reasons behind or the perceived barriers to the use of their professional development services.

Participants in focus groups provided a number of reasons and challenges in working with teachers. Overall, elementary ITRTs cited more barriers to their professional development use than secondary. I coded ITRT responses using Hew and Brush's theory of barriers. According to Hew and Brush, barriers to technology can be categorized as either first order or second order.

First Order Barriers to Professional Development Use. First order barriers refer to those that are external. These consist of barriers related to resources, institutions, subject culture, and assessment. In explaining the level of professional development use of ITRTs in County X, ITRTs identified first order barriers to their use 192 times.

Resource Barriers. Resources are first order barriers that relate to funding, equipment purchase or availability, time to locate or develop lessons and electronic resources, and technical support. ITRTs mentioned resources as barriers to their use 119 times, with 23 times related to equipment access or availability and 96 related to time to locate or develop lessons. Elementary ITRTs indicated the presence of resource barriers more often than secondary ITRTs (Table 10).

Table 10

Frequency of First Order Barriers Mentioned by ITRTs

	Elementary		Secondary		Total	
Barrier	n	%	n	%	n	%
Time (Resource)	81	57	15	30	96	50
Access (Resource)	23	16	0	0	23	12
Subject Culture	17	12	0	0	17	9
Institution	12	9	7	14	19	10
Assessment	9	6	28	56	37	19
Total	142	100	50	100	192	100

When referring to time constraints, elementary ITRTs stated:

- "Teachers constantly complain about time and what is on their plate. I hesitate to use complain because it is a legitimate argument. They are very busy and are asked [to do] a tremendous amount."
- "We are not used more because of time. Teachers are so time constrained that they feel they cannot add anything else...even though we want them to replace something."
- "It is more difficult at the elementary level for them to meet with us, because their resource block is only 45 minutes, so they can only potentially meet with us for a half of an hour at a time."
- "Elementary numbers are lower in part due to the fact that teacher planning times are much less than in secondary."

When addressing Title I schools and time, elementary ITRTs said:

- "Title I schools demand more of teacher time during their 45 minutes of planning. They have so many programs that they need to do. Technology must compete with all of them."
- "I think that teachers have a lot of required meetings and limited time. I wouldn't expect them to spend all of their time with me when there are other coaches and support people in the building that are equally important."

When addressing time, secondary ITRTs said:

- "I think we're not used more because teachers already have a lot on their plate and find it difficult to carve out time to meet with us."
- "Teachers are busy. There's a lot going on outside the world of technology. Elementary teacher planning time is taken up in meetings 90% of the time."

With regard to the lack of devices, elementary ITRTs said,

- "We have not had the same opportunity with how devices trickle into elementary schools."
- "There is little to no access to technology."

Institutional Barriers. Institutional barriers to technology use are characterized as those involving leadership, school planning, and school time scheduling. Institutional barriers were described as barriers to their professional development use 19 times by ITRTs. Elementary ITRTs listed these slightly more often than secondary ITRTs. Leadership was the only subcomponent mentioned as a barrier.

When making sense of their use, elementary ITRTs responded:

- "I think teachers are not encouraged to learn and use technology in the classroom."
- "At some elementary schools, principals do not make technology important."
- "We do not have a cohesive K-12 vision delivered by administrators."

Secondary ITRTs mentioned:

- "Whether or not the principal is on board makes all the difference."
- "There is a big variation in usage because of the admin."

District initiatives were also listed as interfering with ITRT usage:

- "Too many initiatives."
- "County initiatives were at play."
- "They had so much on their plates with all of the different initiatives that they were dealing with, and it depended on how administrators decided which were important."

Assessment Barriers. Assessment barriers refer to those associated with high stakes testing and were specified by elementary ITRTs 17 times with secondary ITRTs not mentioning assessment barriers at all.

When making sense of their professional development use in focus groups, Elementary ITRTs shared:

- "Testing was an issue."
- "When we added more mandated testing, teachers focused less on the classroom and using us."
- "The problem isn't the want. They want to use it, and they want to learn how, but the devices are used for testing."
- "The emphasis is always on the SoLs and making the score."

Subject Culture Barriers. Subject Culture barriers are those that are related to deep-seated school or organizational culture. These were cited as barriers 37 times, with secondary ITRTs listing them more often.

When making sense of their professional development use, elementary ITRTs stated:

- "The school climate is a huge factor in the onboarding of edtech."
- "School culture and perception of technology integration is a factor."

Secondary ITRTs stated:

- "The climate of the building and the perception of the viability of integration in instruction play an important role."
- "School climate is important with regard to the overall perception of how vital technology is to instructional practices and how the staff buys into that. If it is perceived as vital, then they will use the integrator more steadily than a school that sees technology as a sidebar."

One additional type of subject culture mentioned by the ITRTs was that of the relationships between teachers and ITRTs. In the 2015-16 school year, many ITRTs were moved to different schools for the first time in the 4 years studied. They referred to this as a barrier, saying:

- "The Integrator shake-up."
- "In my schools, relationships are growing and that translates to more usage."
- "We need more time in schools, so that we can build better relationships, so that they are more likely to use us."
- "Some trainings were required. Then, that changed because people weren't happy, and my numbers dropped off, so I had to rebuild relationships because people were not happy about the required trainings."

Second Order Barriers to Professional Development Use. Second order barriers refer to those that are internal and are related to teachers' attitudes and beliefs and their knowledge and skills. ITRTs identified second order barriers to their professional development use 27 times. Secondary ITRTs cited more instances of second order barriers affecting their use than elementary ITRTs.

Attitude and Belief Barriers. Teachers' attitudes and beliefs toward technology were voiced as barriers 15 times. Secondary ITRTs listed attitudes and beliefs as barriers to their professional development use substantially more often than elementary ITRTs (Table 11).

Table 11
Frequency of Second Order Barriers Mentioned by ITRTs

	Elementary		Secondary		Total	
Barrier	n	%	N	%	n	%
Knowledge/Skills	5	83	7	33	12	44
Attitude/Belief	1	17	14	67	15	56
Total	6	100	21	100	27	100

Elementary ITRTs addressed barriers to their use by explaining:

- "People are always reluctant to shout for help."

- “Some see their name on the sign-up sheet as being incapable. Some see their name on the sign-up sheet as being an over-user.”
- “Many of them are happy and or complacent with the worksheets they've uploaded and sites they're currently using.”

Secondary ITRTs addressed these by explaining:

- “We are one service of many that are offered to the teachers.”
- “This is really a measure of the teachers that don't think technology is extra.”
- “If the teachers’ felt as though their specific needs would be met, I believe that we would be used more.”
- “Teachers gauge what is important to them and only focus on developing themselves according to their needs. Once a teacher feels comfortable with what they are doing and the level of integration that they are using, they don't ask for more support.”

Knowledge and Skill Barriers. Knowledge and skills refer to a dearth in teachers’ technological skills, the inability to integrate pedagogy and technology, or weak classroom management skills. Teachers’ technological skills were cited as barriers to their professional development use 12 times. Elementary and secondary ITRTs indicated that these were barriers fairly equally.

Elementary ITRTs declared:

- “They don’t even know what they don’t know.”
- “We have teachers who don’t know how to use them and they are trying to train the kids.”

Secondary ITRTs declared:

- “Teachers don't know what to ask or where to start.”

- “Teachers are getting more comfortable with the technology, but need that push to learn how to go further with the application and the cool things the can be done.”

Interestingly, three ITRTs believed that the high level of skills possessed by teachers acted as barriers to their use saying:

- “I do have some high flyers, so they don’t need me, and that doesn’t mean high quality technology is going on.”
- “Teachers have become more comfortable and knowledgeable on the use of technology.”
- “Teachers aren't using us as much, because we've done a good job of training them to use essential technologies.”

Summary

The role of ITRTs in County X is to support teachers as they integrate technology into their teaching. Overall, ITRTs are underutilized with only 52% of their allotted time used to support teachers through professional development. Secondary teachers (particularly those teaching science and language arts) have taken greater advantage of the ITRTs’ time, and elementary teachers at Title I schools have been particularly reticent to do so. Over time, total ITRT professional development time usage has decreased 5 percent.

Google Apps for Education and web-based programs were the applications for which professional development was most frequently requested, representing 73% of the requests. These were also requested most often across all school levels. Over time, there was some fluctuation in the requests for assistance with different applications that is explained by contextual factors addressed in Chapter 5.

The ITRTs provided a number of reasons as to why they believe they weren’t called upon for professional development as often as they could have been. The reasons given were placed within the context of Hew and Brush's classification model of first and second order barriers. ITRTs identified more first order barriers as influencing their use, with secondary ITRTs identifying more second order barriers than elementary ITRTs. Chapter 5 discusses these findings, places them in context within the body of research, and makes recommendation for future practice.

V. Discussion

This case study describes one professional development approach to support technology integration at all public schools in one large county in central Virginia. Using data obtained from daily time logs, the frequency of ITRT use for professional development by classroom teachers was analyzed. Focus group interviews of ITRTs were conducted to explore how they made sense of the data on the use of ITRTs for professional development.

The findings echo much of the current research and address recommendations made for future research. Findings of interest documented longitudinal data of ITRT use, less ITRT use by elementary Title I teachers, and higher use by science and language arts teachers at the secondary level for professional development. This study addressed calls for needed research that utilized a large sample size, longitudinal data, and results that were based upon data other than that provided by teachers themselves (Hechter and Vermette 2013; Hew & Brush, 2007; Lawless & Pellegrino; 2007; Roschelle, Shechtman, Tatar, Hegedus, Hopkins, Empson, Knudsen, & Gallagher, 2010; Wachira and Keengwe 2011; Walker, Recker, Ye, Robertshaw, Sellers, & Leary, 2012).

Patterns of ITRT Use

Overall Use for Professional Development. Over time, ITRT use for professional development declined slightly, increased when new devices or software were introduced, and was slightly higher at the secondary level.

Decreased usage over time was explained by ITRTs as teachers becoming more facile in their use of technology and the accompanying applications which resulted in less need for professional development. If so, this study might predict continued decrease use of ITRTs, unless new skills, software, or hardware are introduced. Future research is needed to determine if this pattern continues, and if it is occurring because teachers are feeling more technologically skilled and comfortable with using technology, or it is attributable to some other factor.

Time as a barrier to Professional Development Use. When asked, ITRTs largely attributed the difference between elementary and secondary teachers use of their services for professional development to a lack of devices and less teacher planning time at the elementary level. Secondary teachers have twice the planning time as elementary teachers. In addition, secondary teachers frequently repeat lessons across class periods whereas elementary teachers, generally, do not and are usually required to plan for 4 core subject areas each day. This leaves elementary teachers at a disadvantage when trying to find time to plan, train, and find or create computer-based lessons. For secondary teachers, time invested in learning about and using technology in teaching is more efficient since the effort put into the development/learning can be used with more students and in more classes than is true for elementary teachers, who would need to spend perhaps 4 times the effort to integrate technology.

When elementary teachers attempt to integrate technology in teaching, they are not always guaranteed that there will be devices available for students to use. To date, the county has provided elementary schools with approximately 90 Chromebooks to share across each school by approximately 40 teachers and 700 students. Once devices are readily available at all levels to all students, elementary ITRT use might increase as access barriers are reduced and more value may be placed upon learning about and using technology. When devices are made more accessible in elementary schools, ITRTs should be shifted to provide more support, for at least the first two years of preparation and implementation as usage trends suggest a two year peak. Given the ability level of the younger child, teachers may need additional in-class support with students, which will demand additional onsite presence, as both teachers and students become acclimated.

Shifts in Applications for Professional Development. Overwhelmingly, teachers requested more training from ITRTs with GAfE and web based applications. This is not surprising as the county self-identifies as a "Google Apps for Education County." All secondary students are provided with Chromebooks that only support GAfE and web based tools, and a significant amount of mandatory training time has been focused upon the adoption and use of the GAfE suite with students. In addition, many teachers have embraced the collaborative nature of the product and the easy access of files from any location.

Over time, the number of professional development requests per application fluctuated. Much of the ebb and flow could be explained by contextual factors. GAfE training requests increased dramatically in the 2013-14 school year, which coincided with the implementation of training for the 1:1 rollout in middle schools and a move to Gmail from Microsoft Outlook. They remained high in the 2014-15 school year when the high school 1:1 rollout preparation began.

Web based programs were the second largest category of applications for which teachers requested training. These also reflect the nature of the Chromebook as no applications live on the device but instead reside "in the cloud." Requests for professional development with web based applications declined at the height of the 1:1 rollout and then increased again. There seems to exist an inverse relationship with regard to the number of training requests for GAfE and web-based applications. The pattern demonstrated that, as GAfE requests peaked, the requests for web based applications decreased. This could be attributed to a finite amount of teacher training time, the increasing familiarity of teachers with the GAfE suite, and the infinite number of applications available via the web.

Of additional note, there was a peak in professional development requests for the gradebook application in the 2014-15 school year. This represents the first year with a new digital gradebook. Requests for Edmodo, a blended learning platform, decreased overtime, which may reflect increased competence of teachers who had been using Edmodo since the 2011-12 school year. Finally, requests for training with Chromebooks peaked with the first year of roll-out and then gradually decreased. This may reflect an increase in a teacher's ability to troubleshoot Chromebook applications and comfort with the device itself.

Across the different school levels, there were more requests for professional development with gradebook software, computer based software, and Promethean board software at the elementary level. Elementary schools have a significantly larger number of Promethean boards and desktop computers in their classrooms than do secondary schools, so increased training requests of these types could be attributed to additional access to these devices. In addition, due to the way in which their gradebooks are managed and, in the case of kindergarten and first grade, the implementation of a standards based report card, the elementary gradebook program is more difficult to use. As a result, these teachers require more training and help by ITRTs.

There were fewer requests for training with using Chromebooks, GAfE, and web based programs at the elementary level than at the secondary level. As elementary schools have only been provided with approximately 90 Chromebooks to share across each school, the paucity of devices should have resulted in fewer instances of requests for professional development with Chromebooks. Based upon the increased use of ITRT time for GAfE and web based programs in secondary, when the 1:1 rollout occurred, it is expected that requests for training with these two application types might not be as high at the elementary level due to a lack of readily available devices.

As teachers become more familiar with the gradebook software and the 1:1 rollout continues into the elementary schools, I anticipate that ITRT professional development requests would become more closely aligned with those currently at the secondary level.

Subject Area Taught and Professional Development Use. Secondary ITRTs received more requests for professional development from science and language arts teachers, a finding similar to that from Hsu's (2016) study of kindergarten through grade six teachers that found language arts as the subject in which teachers integrated technology most often (90%) with social studies second (50%) followed by science (30%) and math (20%).

Language Arts use is not surprising as teachers use technology tools to support traditional pedagogies, and language arts lends itself to that with the writing and editing of papers (Ertmer and Ottenbreit-Leftwich, 2013). When technology tools are used by teachers, they are most commonly used to have students conduct research online (95%), and have students access (79%) and submit (76%) assignments online (Purcell, Heaps, Buchanan, & Friedrick, 2013). When solely based upon secondary teacher responses, Purcell et al. (2013) found science teachers more likely to use technology. This is not surprising as constructivist pedagogies have been linked to the increased integration of technology (Hermans, Tondeur, van Braak, & Valcke, 2008; Kim, Kim, Lee, Spector & Meester, 2013; Mama and Hennessy 2013; Pi-Sui, 2016). Due to its investigative nature, science learning lends itself to constructivist pedagogies as students experiment and construct meaning while the teacher acts as facilitator (Seimears, Graves, Schroyer, & Staver, 2012). In addition, the integration of technology into the science curriculum has been associated with enhanced understanding of scientific concepts, and a positive effect on student achievement has been associated with increased technology use in the classroom (Chang, Quintana, & Krajcik, 2010; Nicolaidou, Nicolaidou, Zacharia, & Constantinou, 2007; Zucker, Tinker, Staudt, Mansfield, & Metcalf, 2008). It is not surprising that those subjects that utilize and embrace technology require more training.

Future research should be aimed at investigating differences in subject area use across all school levels and the exact reasons behind why different subject area teachers use ITRTs for professional development to different degrees. Is it because they don't feel it's pedagogically sound, there aren't good resources available, they fail to see the connection between technology use and student outcomes, or perhaps something else?

Until such time as the reasons behind their lack of use are determined, future professional development opportunities should be aimed at teachers in subject areas who use ITRT time less frequently by purposefully integrating specific subject area curriculum and skill training. Technology skills are best taught actively, while situated within the curriculum, and attached to instructional design in order to address existing knowledge and beliefs about teaching and learning (Buckenmeyer, 2012; Hew & Brush, 2007; Koehler, Mishra, & Yahya, 2007; McVee, Bailey, & Shanahan, 2008; Thomas et al., 2012). Instruction on how to integrate technology into the curriculum must be provided (Peeraer & Van Petegem, 2012; Stobaugh & Tassell, 2011; Zandvliet & Fraser; 2004).

Title 1 Status and Professional Development Use. Of particular note at the elementary level is the difference in the percentage of ITRT time used for professional development between those schools classified as Title I and those that are not. ITRT use was much lower at elementary schools that were classified as Title I. These findings contraindicate several studies that found that lower socioeconomic status may positively influence teacher attitudes toward technology. Because teachers believe that these students may have less access to technology outside of the classroom, teachers are more likely to use it to help close the divide (Blackwell, 2013; Purcell et al., 2013). Title I elementary schools in County X have more devices than those in non-Title I schools due to having additional Title I funds available to purchase devices. In many cases, they have at least twice the devices as non-Title I schools. This may serve as a mitigating factor as the access barrier has been reduced. It has also been well publicized that surveys of students and parents revealed that 92 percent or more of our students have access to devices and the Internet at home (County X, 2015c).

In County X, ITRTs attributed low use for training to a lack of teacher planning time and an increased focus upon test results. Title I schools have more demands placed upon their planning and instructional time through the use of instructional coaches, PLC meetings, data and testing administration and analysis, and additional instructional programs and requirements (Peeraer and Van Petegem 2012; Starkey, 2010). As a function of their proscribed instructional support due to the threat of low test scores, pedagogical models which do not encourage the use of technology are mandated at many Title I schools.

ITRTs did not report that these outcomes were attributable to Title I teachers possessing poor technological skills which contraindicates Chapman, Masters, & Purdulla's (2015) finding that teachers in lower socioeconomic schools rated their technology skills lower. However, if ITRT support has been found to increase teacher skill, then a lack of ITRT use might indicate less skilled teachers (Beglau et al., 2011, Glazer et al, 2009; Juuti, Lavonen, Aksela, & Meisalo, 2009; Kopcha, 2012; Yemothy, 2015).

Title I teachers' requests for assistance with application types mirrored those of other elementary teachers with the exception of requests for GAfE and web based tools. They asked for significantly less training on these types of tools. The applications for which they asked assistance were primarily those that were associated with job functions or those that had been in use for many years. Purcell et al. (2013) noted that teachers in lower socio-economic schools used digital tools less effectively than their higher socio-economic counterparts. In addition, Blanchard, LePrevost, Dell Tolin, & Gutierrez (2016) found that middle school teachers in low socio-economic areas were particularly resistant to changing their teaching practices even after having been engaged in intense technology professional development.

In the past, the digital divide in instructional technology has referred to the access to technology of the haves versus the have nots. Of late, this lens has refocused from actual possession of technology to the way in which it is used—for higher order thinking processes or not. Perhaps this should be the focus in County X. Because administrators believed that lower socioeconomic students needed access to technology, they purchased more devices, but they don't have teachers who either want or know how to use this additional technology. There seems to be a gap between what Title I money can buy and what Title I teachers are willing or are allowed to do. Future research should be aimed at helping to identify the exact barriers which led to less ITRT use. Professional development should be made a priority at these schools. There should be a focus on training in technological skills, using technology to complete higher order tasks, and in attaching student outcomes to technology use as this has previously been demonstrated to affect use. In addition, there needs to be an emphasis on building a cohesive vision for technology with buy-in from the curriculum and instruction departments. As technology and 21st century skills are a district priority according to the Design for Excellence master plan, it should be embraced by all and interwoven within the proscribed pedagogical models.

Sense Making by the ITRTs

ITRTs made sense of these findings by attributing the patterns of their use for professional development to first and second order barriers. Overall, ITRTs mentioned more first order barriers than second. Elementary ITRTs cited barriers as affecting their use for professional development more frequently than secondary ITRTs. It is not surprising that elementary ITRTs cited more instances of barriers, because they lack devices. Secondary ITRTs cited more second order barriers, because more of the first order barriers have been eliminated at the secondary level with the 1:1 rollout and the increased availability of teachers for training due to increased planning time.

Second order barriers may have more impact on teachers' acceptance and use of technology than first-order barriers and remain influential when first order barriers are eliminated (Ertmer et al., 2012; Polly, Mims, Shepherd, & Inan, 2010) I postulate that second order barriers may have been mentioned by ITRTs less because they are internal to teachers and less easily visualized. Because second order barriers can be so influential, I recommend that additional research into these barriers be conducted by surveying the involved teachers. This would allow a comparison to be made between those voiced by the involved ITRTs and those influential second order barriers can be adequately explored and addressed when planning for future professional development.

First Order Barriers to Professional Development Use. At the elementary level, 44% of the ITRTs' time offered was utilized for professional development. Since 56% of their time is unused, online training exists, and ITRTs are available anytime via email or Google Hangout, the first order barriers of training, support, and professional development should have been reduced, while access, assessment, institution, and subject culture have not. This was directly supported by the ITRTs' perceptions. At the secondary level, 56% of the ITRTs time offered was utilized. Since 44% of their time for training is unused and they serve in an environment that is 1:1, the first order barriers of training, support, professional development, and access should have been greatly reduced, while institution and subject culture have not. Again, this was directly supported by the ITRTs' perceptions.

As the Chromebook rollout continues to occur in the elementary schools, it would be of interest to see if elementary ITRT use for professional development increases as the access barrier is reduced. Future professional development, planning, and ITRT resource deployment should address the first order barriers of access, assessment, institution, subject culture.

Resources. ITRTs cited a lack of time for teachers to plan, create resources, and be trained as the most significant barrier to their use. This was particularly prevalent at the elementary level where teachers are provided with only 45 minutes of planning time each day, and many of their planning times are consumed with scheduled meetings. At many Title I schools, literacy and math coach, data analysis, and PLC meetings often take 4 out of 5 weekly planning times. The demands on Title I teacher planning time has been noted in previous research (Peeraer and Van Petegem 2012; Starkey, 2010).

Elementary ITRTs also mentioned a lack of devices as a significant barrier. As secondary schools in County X exist in a 1:1 environment, this was not mentioned as a barrier by secondary ITRTs. Elementary schools currently subsist in a 1:5 environment and usually share one Chromebook cart, consisting of 25 to 30 devices for each grade level or share 1 between 2 grade levels. In addition, each classroom has 1 to 3 stationary computers, and each school possesses two shared labs of 25 to 28 computers (County X, 2015c). Kindergarten and first grades are slated to go 1:4, second and third grades are slated to go 1:2, and fourth and fifth grades are slated to go 1:1 in an eventual rollout (County X, 2015c). While it is desired that all students have a device, this was the lowest ratio that could be achieved within budgetary constraints, while still acknowledging the 1:4 ratio Becker (2000) found as the threshold to increased computer use.

The time and access or availability barriers reported echo the findings by Hew and Brush (2007) in which 40% of the studies listed these as barriers, and they were the most frequently mentioned barrier to technology integration. Access refers to the possession of equipment, and availability refers to the opportunity to use purchased equipment, as it is often placed in communal labs and reserved for testing (Kress, 2011). Teachers, who have access to an adequate number of computers in the classroom, are more likely to use them (Lanahan & Shieh, 2002; Latio, 2009). This is attributed to the need to schedule labs ahead of time and to competition for limited resources (Chamber & Bax, 2006; Shiang-Kwei, et al., 2014; Starkey, 2010). Closely aligned is a teacher expressed lack of time to focus upon creating technology rich resources (Hechter and Vermette, 2013; Pi-Sui, 2016; Shiang-Kwei, et al., 2014).

Virginia Standards of Quality recommend 1 ITRT to each 1000 students. Currently, there is approximately 1 ITRT to every 2000 students (County X, 2015c). Standards of Quality are mandated by law. However, they were revised in 2008 to allow the positions to be filled as either an ITRT or data coordinator. So, instead of having approximately one for each school, there is one for every 2 to 3 schools. Currently, ITRTs have a fixed schedule and are in each support school on the same day each week. Increased availability of ITRTs and flexible scheduling of ITRT support days may be of benefit, so they are able to meet with teachers more often and on non-scheduled meeting days. In addition, online on demand professional development opportunities should be expanded.

Assessment. Testing was mentioned 17 times by elementary integrators as a barrier to the use of their professional development services. The county requires online benchmark testing every 9 weeks in all 4 core subject areas. In addition to these, the county uses an online testing system to create and deliver tests. At several of the Title I elementary schools that are at risk of losing accreditation, additional online testing is required. Testing was mentioned by the ITRTs as an issue with regard to time taken away from instruction that prohibits additional online activities as well as not having access to devices because they were reserved for testing and not available for other use.

Assessment barriers were cited as the least influential first order barrier in the current study and were found to be barriers in five percent of the Hew and Brush (2007) studies which ranked them as the least mentioned barrier to technology integration. According to subsequent studies, the emphasis placed upon student test scores leads teachers to feel that they don't have "time" to use technology or to develop and explore technological tools and lessons (Biancarosa & Griffiths, 2012; Hsu, 2010; Shiang-Kwei, et al., 2014). In addition, when used, technology is often utilized as a means for assessment as opposed to learning (Bichelmeyer, 2005; Schneiderman, 2004). The inability to use computers due to their being used for testing is considered to be an access barrier and was included in those totals when mentioned by the ITRTs.

Institution. A lack of administrator buy-in was mentioned as a barrier to professional development use by ITRTs 19 times. Closely aligned is school culture. School cultures that do not place value upon technology use were mentioned as factor 37 times by ITRTs.

Administrators may act as barriers when they are not perceived as placing value on and being supportive of technology or when failing to have a concrete, shared vision for technology's role in the school (Anthony, 2012; Ertmer, et al., 2012; Lui, 2012; McLeod and Richardson, 2013; Sarapani & Calahan, 2015). Strong technology leadership has been found to have the largest positive, significant correlation with technology use (Anderson & Dexter, 2005; Sarapani & Calahan, 2015). To create a concrete vision, administrators must understand the way in which technology should be integrated into the classroom and work to see that it is (Anthony, 2012; Sarapani & Calahan, 2015). When creating a shared vision, it is important to involve stakeholders during development in order to encourage buy-in (Anthony, 2012; Ertmer et al., 2012; McLeod and Richardson, 2013). Once developed, administration must provide time and professional development for staff members to become proficient in the use of technology, and leaders must be prepared to use data when planning and assessing the effectiveness of teachers' technology use and their technology plan (Anthony, 2012; Sarapani & Calahan, 2015). Future technology professional development should include administrators in order to develop their skills and buy-in, to educate them in the ways in which technology can and should be integrated, and on how to build a shared vision.

Subject Culture. Subject culture barriers are those that are related to deep-seated school or organizational culture. Teachers are reticent to use technology that is incompatible with their school culture (Hennessy, Ruthven, & Brindley, 2005; Kress, 2011; Shiang-Kwei, et al., 2014). They are reluctant to be perceived as different from their peers. This was the subject culture identified by the ITRTs as being influential. Unless the school's culture is one embracing innovation and change, it preserves existing practice by design as teachers are conditioned to teach specific content using certain methodologies (Zhao & Frank, 2003). Future professional development with administrators needs to address the importance of school culture and how to facilitate its change to one of acceptance, innovation, and change.

Second Order Barriers to Professional Development Use. Overall, second order barriers were not mentioned as frequently by ITRTs. However, secondary ITRTs mentioned more second order barriers than first order barriers. Because second order barriers may have more impact on teachers' acceptance and use of technology than first-order barriers, it is vital that these challenges be identified and taken into account when planning and allocating ITRT resources.

Attitudes and Beliefs. Attitudes and beliefs were addressed by the ITRTs 15 times as contributing to teachers' not using them for professional development. Teachers' attitudes and beliefs toward technology were identified as barriers in 13 percent of the Hew and Brush (2007) studies. Attitudes and beliefs reflect the value teachers place upon technology and their pedagogical philosophy concerning teaching and learning. Two attitudes that were set apart from pedagogical considerations were resistance to change and feelings of inadequacy (Bennett & Maton, 2010; Chamber & Bax, 2006; Teo, 2011). These were the attitudes that were mentioned as barriers by the involved ITRTs in this study.

Future research should be aimed at surveying the involved teachers in order to investigate the reasons behind their attitudes toward technology, so these can be adequately addressed. It may be that they are resistant to change, they don't see a positive connection between technology use and student outcomes, they feel inadequate, or it doesn't match their pedagogical philosophy. Future professional development should be aimed at addressing these attitudes and beliefs by providing the necessary support to meet each teacher's needs with regard to feelings of adequacy and providing evidence of student success following technology use (Fethi and Inan 2010; Miranda and Russell 2012; Wright and Wilson 2011). When student achievement is perceived to be positively influenced by the proffered technology professional development, it is more likely to be implemented (Blackwell, Lauricella, and Wartella, 2014; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Karaca, Can, & Yildirim, 2013; Kim, Kim, Lee, Spector & Meester, 2013; Miranda and Russell, 2012; Pi-Sui, 2016). In addition, peer mentoring and the use of PLCs should be encouraged and facilitated as teachers who take advantage of PLCs have been found to experience positive changes in their attitudes toward technology as well as an increase in their use of technology (Cifuentes, Maxwell, & Bulu, 2011; Hew & Brush, 2007).

Knowledge and Skills. Teacher knowledge and skill level was mentioned 12 times as a barrier to ITRT use for professional development. Teachers' self-perceived, inadequate technology skills are well documented (Blackwell, Lauricella, and Wartella, 2014; Ertmer, et al., 2012; Inan & Lowther, 2010; Karaca, Can, & Yildirim, 2013; McLeod and Richardson, 2013; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Pi-Sui, 2016; Shiang-Kwei, et al., 2014). The current professional development model does not seem to support the skill acquisition of some of its teachers. One way that it could be enhanced is through the encouragement and facilitation of mentoring and peer collaboration. Much of what teachers learn about integrating technology is learned from peer networks, which allow for scalability of support as they remove the need for "experts" (Glazer, Hannafin, Polly, & Rich, 2009; Peeraer & Van Petegem, 2012). Teachers, who are mentored, integrate technology more frequently than those who are not (Lowther, Inan, Strahl, & Ross, 2008; U.S. Department of Education, 2016; Zhao & Bryant, 2006

Overarching Recommendations

In order to increase ITRT use, the effect of first and second order barriers must be reduced (Ebert-May et al., 2011; Kurt, 2013; Kopcha, 2010; Kopcha 2012; Yemothy, 2015). According to research, professional development and onsite assistance, like that provided by ITRTs, has been identified as the best way to do this (Beglau et al., 2011, Glazer et al, 2009; Juuti, Lavonen, Aksela, & Meisalo, 2009; Kopcha, 2012; Yemothy, 2015). ITRTs are seen favorably by teachers as technology trainers and creators of technology infused lessons (Nash, 2013). ITRTs provide a beneficial service that is ongoing and allows participants time to put in practice and reflect upon skills learned (Hammonds et al., 2013; Sawchuk, 2010; Thornton et al., 2009; Yemothy 2015). ITRT use enables teachers to gain confidence and improve their integration of technology (Knight, 2011; Lowther et al., 2008; Smith, 2012). This is because ITRTs provide onsite professional development that is less lengthy, helps participants avoid feeling overwhelmed, and allows for follow-up (An & Reigeluth, 2011; Bumen, 2009; Kovalik, Kuo, & Karpinski, 2013; Loveland, 2012; Overbay, Mollette, & Vasu, 2011; Yemothy, 2015). .

According to Lawless and Pellegrino's (2007) analysis of the body of research, opportunities that consist of training time plus follow-up are more successful. ITRTs should attempt to follow-up with their teachers after professional development sessions have occurred. Those who receive ongoing support and opportunities for collaboration or discussion of difficulties are more likely to continue to carryover skills learned (Thomas, Hassaram, Rieth, Raghavan, Kinzer, & Mulloy, 2012; Vavasseur & MacGregor, 2008). Providing follow-up may assist with barriers associated teachers' lack of knowledge and skills in classroom management or integration and address specific weaknesses in technology skills. In addition, it may also address resource barriers via technical support, and subject culture barriers via time to implement change.

According to Lawless and Pellegrino (2007), technology skills are best taught actively, situated within the curriculum, and attached to instructional design so that teachers are actively engaged in relevant activities in context (Buckenmeyer, 2012; Hew & Brush, 2007; Koehler, Mishra, & Yahya, 2007; McVee, Bailey, & Shanahan, 2008; Thomas et al., 2012). As a result, ITRTs need to be sure that their professional development services include direct instruction on how to integrate technology into the curriculum (Peeraer & Van Petegem, 2012; Stobaugh & Tassell, 2011; Zandvliet & Fraser; 2004). This would also require explicit instruction on how to design tasks that incorporate technology, classroom layout to facilitate technology use, and classroom management skills in a technology rich environment (Lim, et al., 2003; Rogers & Finlayson, 2004). When teachers are able to see how technology enhances their curriculum delivery, technology is perceived as valuable, teachers take more ownership over the resources, they feel more confident in their ability to integrate the technology, and believe that it will influence student achievement (Kubitskey, Fishman, & Marx, 2003). This would address barriers in teachers' knowledge and skills with regard to classroom management and how to integrate technology into the curriculum. It would also address teachers' attitudes and beliefs about teaching, learning, and technology. Finally, it may address subject culture barriers as the bonds between change and traditional practices become weakened.

According to Lawless and Pellegrino (2007), ITRTs also need to encourage and facilitate peer collaboration, mentoring, and community building. Much of what teachers learn about integrating technology is learned from peer networks, which allow for scalability of support as they remove the need for "experts" (Glazer, Hannafin, Polly, & Rich, 2009; Peeraer & Van Petegem, 2012). Teachers, who are mentored, integrate technology more frequently than those who are not (Lowther, Inan, Strahl, & Ross, 2008; U.S. Department of Education, 2016; Zhao & Bryant, 2006). Teachers who take advantage of PLCs have been found to experience positive changes in their attitudes toward and an increase in use of technology (Cifuentes, Maxwell, & Bulu, 2011; Hew & Brush, 2007). Peer collaboration opportunities address resource barriers related to a lack of technical support, time to create lessons, technological skills, classroom management, and the need for help with integrating technology into the curriculum. Collaborative opportunities might address subject culture barriers and teachers' negative attitudes and beliefs about technology.

According to Lawless and Pellegrino (2007), ITRTs must encourage and facilitate the formation of a common vision for student achievement. Whenever possible, during their professional development sessions, they must demonstrate a connection between what is being trained and student achievement. When student achievement is perceived to be positively influenced by the proffered technology professional development, it is more likely to be implemented (Blackwell, Lauricella, and Wartella, 2014; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Karaca, Can, & Yildirim, 2013; Kim, Kim, Lee, Spector & Meester, 2013; Miranda and Russell, 2012; Pi-Sui, 2016). This is particularly true when new methodologies are associated with increased student achievement scores on standardized tests (Geier, Blumenfeld, Marx, Krajcik, et al., 2008). Technology professional development that addresses a common vision for student achievement might also address barriers that affect teachers' attitudes and beliefs. It may also affect subject culture barriers by making sure that the vision and mission for all is unified and aligned with technology integration.

Conclusion

While ITRTs are not being used to capacity, I do believe it is important to reflect upon the fact that they are being used each and every week, so there is some buy-in and self-identified need on the part of many of their teachers. Teachers, every week at every school, are voluntarily giving up a portion of their limited planning time to meet with their ITRT. And, it would seem that decreased use of ITRTs over time and dips in new application assistance requests after they are introduced might indicate that teachers have gained skills at the hand of the ITRTs.

Based upon this research, one cannot assume that because teachers are or are not using the professional development services of ITRTs that quality technology integration is or is not occurring. The logical next step would require a survey of actual teacher practice to determine exactly how use or disuse of ITRT professional development services translates into classroom practice.

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Appendix A

Good Morning! As you know, I am working on completing my dissertation which requires a substantial research component. Part of my dissertation requires that I describe the current ITRT program in County X. I will be showing you several graphs that describe the data that you have collected over the past three years. I would like for you to comment on the findings. Were they surprising or not? Can you share anything that you believe influenced the data to look as it does? For example, are there any factors that you believe caused it to look the way it does? Your names will not be used and comments will only be attributed to level of school (elementary, middle, or high); however, direct quotes may be used. If at any time you feel uncomfortable, you have to right to stop participating and leave. In addition, you may request that I not use any of your statements. I will provide each of you with a transcript of the written comments and analysis based upon your observations. You have the right to request that any comments or observations contributed by you be stricken. Responses will be taped in order that I might later transcribe them for accuracy. Are there any questions? Is everyone comfortable with these conditions? If so, please fill-out and sign the Informed Consent form. Thank You! Let's begin.

Appendix B

Thank you for your invaluable help today. Remember, your names will not be used and comments will only be attributed by level of school; however, direct quotes may be used. You may request that I not use any of your statements. I will provide each of you with a transcript of any written comments and analyses used, based upon your observations, within two weeks. Please check them over to be sure that I have interpreted your responses accurately. You have the right to request that any comments or observations contributed by you be stricken. Please give me written notice, via email, if you wish to have your responses excluded from this body of research or if I have inaccurately portrayed your responses within seven days of receipt of the transcripts. Are there any questions? Thank you so much and have a great day!