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A Multiple Case Analysis of Technology Integration Knowledge by Practicing Elementary Teachers in an Urban Charter School

Kendra Lynn Minor
University of Central Florida

A MULTIPLE CASE ANALYSIS OF TECHNOLOGY INTEGRATION KNOWLEDGE BY PRACTICING ELEMENTARY TEACHERS IN AN URBAN CHARTER SCHOOL

by

KENDRA LYNN MINOR
B.S. Western Michigan University, 2002
M.A. University of Michigan, 2005

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Major Professor: Atsusi Hirumi

ABSTRACT

The purpose of this dissertation was to explore the perceived and demonstrated technological pedagogical content knowledge (TPACK) of practicing elementary teachers in an urban charter school setting. Contextual factors that influence teachers' abilities to apply technology integration knowledge were also identified. A qualitative research design with multiple case study strategy was used to study practicing teachers in a charter school setting in two phases.

The first phase of the study included nine participants and used the Teachers' Knowledge of Teaching and Technology Survey to garner insight on teachers' perceived technological pedagogical content knowledge. Descriptive statistical procedures were used to calculate a mean score for each subscale of the TPACK components. Of the nine teachers, two teachers volunteered to participate in the second phase of the study in addition to two administrators. Data collection methods included document collection, observations, and interviews. Within-analysis procedures were used to specify each participant as an individual case. Interviews with school administrators provided insight into contextual factors at the school. Lastly, cross-case analysis procedures were used to construct the final narrative.

The findings from Phase I indicated teacher scores related to statements concerning technology-related components: technology knowledge (Mean = 3.67, SD =.62), technological content knowledge (Mean = 3.67, SD=.45), technological pedagogical knowledge (Mean = 3.74, SD=.68), and technological pedagogical content knowledge (Mean = 3.6, SD=.94) were neutral. Findings from the within-analysis and

cross-case analysis revealed that both teachers used all of the components in practice with limited to no use of technological content knowledge. The findings from the within-analysis and cross-case analysis revealed that teachers: (a) had a solid foundation of technology knowledge, (b) had limited knowledge of technological content knowledge, (c) supported pedagogical goals, and (d) addressed student learning needs. In addition, the findings revealed that contextual factors related to the teachers' use of technology integration knowledge were resource-related. The discussion and implications highlighted the need for professional development and up-to-date resources for teachers in urban charter schools.

This work is dedicated to the Minor, Johnson, Wilson, Coleman, and Jones families

-We stand on the shoulder of giants-

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CHAPTER 1
THE PROBLEM AND ITS CLARIFYING COMPONENTS

Background of the Study

Technology use in the classroom has the potential to prepare students to thrive in the global society of the 21st century (Ertmer, 1999; Lowther, Inan, Strahl, & Ross, 2008; U.S. Department of Education, 2010). The importance of technology has been the focus of national initiatives and policy reports since the 1980s (Culp, Honey, & Mandinach, 2005; Lowther et al, 2008). In addition, national standards have documented the importance of technology use and address the commitment for teachers to use technology in the classroom (ISTE, 2008; Partnership for 21st Century Learning, 2011). Further, schools have received funding to acquire technology and to provide teachers with training to use technology effectively (Bakia, Means, Gallagher, Chen, & Jones, 2009). As a result, the technology infrastructure in schools has improved (Gray, Thomas, & Lewis 2010).

Researchers have found that technology use can increase student achievement (Hannafin & Foshay, 2008; Lowther et al, 2008; Lei & Zhao, 2007) and motivation (Keengwe, Schnellert, & Mills, 2012; Wang & Reeve, 2006). Researchers have also found that technology use has a positive influence on teaching practices (Becker & Ravitz, 1999; Rakes, Fields, & Cox, 2006). Warschauer and Matuchniak (2010) expressed the belief that the use of technology in K-12 classrooms has the potential to "compensate for unequal access to technologies in the home environment and thus help bridge educational and social gaps" (p. 180). However, although researchers have found

that technology improves student learning and motivation, questions continue to emerge about whether teachers are prepared to use technology effectively in their classrooms. Even with technology resources, equipment, professional development, and support, researchers have reported that teachers' use of technology is limited and not routine (Becker & Ravitz, 2001; Cuban, Kirkpatrick, & Peck, 2001; Cuban, 2009; Ward & Parr, 2010).

Several researchers have made efforts to identify factors that influence teachers' use of technology (Ottenbreit-Leftwich & York, 2006; Inan & Lowther, 2010; Levin & Wadmany, 2008; Zhao, Pugh, Sheldon, & Byers, 2002). Limited technology use has been observed due to factors including the school culture (Tondeur, Devos, Houtte, van Braak, Valcke, 2009; Zhao et al., 2002), resources (Hew & Brush, 2007), time (Bauer & Kenton, 2005; Karagiorgi, 2005) support from members of the school community (Hernandez-Ramos 2005), teachers beliefs (Ertmer, 2005, Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Hermans, Tondeur, Valcke, & Van Braak, 2008), and teachers knowledge of technology (Hughes, 2005).

Researchers have suggested that teacher's knowledge and pedagogical beliefs related to technology play a significant role in how a teacher uses technology in the classroom (Ertmer et al, 2012; Ertmer, Ottenbreit-Leftwich, & York, 2006; Koehler & Mishra, 2008; Prestridge, 2012). The focus of the current study involved understanding how teachers use their knowledge to integrate technology for teaching and learning. Researchers and educators have suggested that technology integration requires that teachers need more than knowledge of technology; teachers who can effectively integrate

technology also need to have knowledge of the interconnected relationship between technology, pedagogy, and content. Specifically, they are able to use technology, content, and pedagogy, e.g. select analogies, activities effectively to help learners understand topic-related concepts, ideas, and other subject matter. In addition, they are able to use the aforementioned components to help transform content in ways that allow students to connect with the content.

Research Problem

Researchers have indicated that teachers' knowledge of technology, pedagogy, and content influence their use of technology (Hughes, 2005; Koehler & Mishra, 2008). Recent studies also show that teachers, in general, have a positive perception of the three source of knowledge (Chai, Koh, & Tsai, 2010; Doering, 2009; Koh, Chai, & Tsa, 2013). However, teachers may not be able apply the knowledge in practice (Agyei & Voogt, 2011; Mouza, 2011). Researchers have also suggested that contextual factors, such as teachers' beliefs, student characteristics, and organizational structures and resources influence teachers' abilities to apply their knowledge of technology, pedagogy, and content in practice (Angeli & Valanidis, 2009; Harris, 2008; Kelly, 2008). The problem is few studies have explored the experiences of practicing teachers who are using and developing technological pedagogical content knowledge in the classroom, outside of the setting of a structured professional development program. In addition, little is known about the contextual factors, such as organizational structures, that influence how practicing teachers' apply knowledge of technology, pedagogy, and content in the

classroom to enhance student learning. After an exhaustive review of literature, the researcher could find only one study conducted in the context of the targeted population. Specifically, only one study assessed elementary teachers' knowledge of technology, content, and pedagogy in an urban charter school setting.

Rationale for Study

Some studies conducted in the 21st century on teachers' technology use have used technological pedagogical content knowledge (TPACK) as a framework to understand what knowledge and skills teachers need to use technology in teaching (Koehler & Mishra, 2009; Mishra & Koehler, 2006). According to Mishra and Koehler (2006), to be effective at integrating technology in their teaching practice, teachers must possess and be able to apply technological, pedagogical, and content knowledge. The authors posited that teachers must understand the multifaceted relationship between all three elements to develop appropriate and context-specific strategies using technology. Thus, without sufficient knowledge and skills, teachers cannot successfully integrate technology into the classroom in a manner that will lead to educational gains and adequately prepared students.

Although they are more than 500 published studies on TPACK, the existing literature has focused on pre-service teachers (Hofer & Harris, 2012). Because practicing teachers have experience with the classroom and curriculum, they use and develop technological pedagogical content knowledge differently than do pre-service teachers. In studies that researchers have conducted to examine in-service teachers' development or

use, they found that TPK was more prevalent than growth in TCK (Hofer & Harris, 2012). The literature base could benefit from more studies that provide evidence and examples of teachers working within various classroom contexts, with different experience levels, and at different grade levels. Such studies could enhance understanding of each of the subdomains, i.e., TCK and TPK, and teachers' applications of TPACK (Wetzel & Marshall, 2012).

Researchers have primarily used surveys to assess teachers' technology, pedagogical, content knowledge (Archambault & Barnett, 2010; Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009; Koh, Chai, & Tsai, 2010; Yurdakul et al., 2012). Specifically, the studies used self-report methodologies to capture teachers' perceptions of TPACK. According to Kereluik, Casperson, and Akcaoglu (2010) although valuable in accessing teachers' awareness of TPACK, self-reports are limited to measuring teachers' beliefs. It has been noted in studies that have used other methods of measurement, such as observations, that actual classroom uses may be different from teachers' self-reports captured by surveys (Agyei & Voogt, 2011; So & Kim, 2009). Some researchers (Hofer, Grandgenett, Harris, & Swan, 2011) have suggested the use of a number of different and reliable measurement strategies to provide a greater understanding of how teachers' apply TPACK.

Although a teacher's TPACK is a strong enabling factor that influences how a teacher integrates technology, researchers have shown that even when teachers have sufficient technology knowledge, they may use it differently in practice (Agyei & Voogt, 2011; Mouza, 2011). The aforementioned could be due, in part, to the educational

context in which teachers use technology. It has been acknowledged that the educational context or contextual factors, such as culture and school organizational structures, influence technological, pedagogical, and content knowledge (Angeli & Valanidis, 2009; Koehler & Mishra, 2008; Mouza, 2011; Niess, 2008). According to Koehler and Mishra (2008), technology integration is a "complex and ill-structured problem involving the convoluted interactions of multiple factors, with few hard and fast rules that apply across context and cases" (p. 10). Thus, technology integration requires a customized solution for each context (Kelly, 2008).

Besides assessing teachers' TPACK, more studies are needed that consider the influence of the context in which teachers practice (Kelly, 2010). The charter school environment provides a unique opportunity to explore elementary teachers' technological, pedagogical, and content knowledge. At the conclusion of the first decade of the 21st century, the number of students enrolling in charter schools had increased. The latest report from the National Alliance for Public Charter Schools (Growing Movement, 2013) indicates that "public charter schools are the fastest-growing sector of public education in the United States" (p. 2). In addition, the largest growing populations of charter school students were in urban areas. During the 2007-2008 school years, Florida had the third-highest charter school enrollment in the nation (Growing Movement, 2010). Further, among the 50 school districts in the United States with the largest charter school enrollment for the 2009-2010 and 2010-2011 school years, Florida's Orange County Public Schools experienced student growth of over 40%, one of the largest percentages of student growth for the period. Given the growing population of

students attending charter schools across the nation it is critical to understand the teaching and learning practices of these institutions.

Researchers have suggested that charter school teachers believe they are a part of a stronger professional community than traditional public schools (Cannata, 2007). In addition, charter schools have more flexibility to allow them opportunities to apply new ideas and innovative practices. The higher perceptions of community and flexibility in teaching practices may influence the use of technology, as researchers have found that peers and school leaders influence technology use.

Purpose of the Study

Practicing teachers must engage in appropriate uses of technology to prepare students with the skills needed for the 21st century. For teachers to use technology, they must have knowledge of technology, content, and pedagogy and be able to apply such knowledge in practice. In addition, teachers must have knowledge of the contextual factors that may influence their technology, pedagogy, and content in practice. The purpose of the study was to (a) explore practicing elementary teachers' perceived technological pedagogical content knowledge, (b) investigate how teachers demonstrate technology integration knowledge in their instructional practices, and (c) identify contextual factors that influence teachers' abilities to apply their the technology integration knowledge. The target population for the study was comprised of practicing teachers in an urban elementary charter school setting.

Research Questions

The following questions guided the study:

1. What are practicing elementary teachers in an urban charter school setting perceptions of each technological pedagogical content knowledge domain (TK, PK, CK, PCK, TCK, TPK, and TPACK)?
2. How do practicing elementary teachers in an urban charter school setting apply their technology integration knowledge (TK, TCK, TPK, TPACK) in their instructional practices?
3. What contextual factors do practicing elementary teachers identify as influencing their ability to apply their technology integration knowledge (TK, TCK, TPK, TPACK) in the context of an urban charter school?

Overview of Methods

The research design used for the current study was qualitative with a multiple case study strategy of inquiry (Creswell, 2007). The researcher chose qualitative research because it is best suited for studying individuals in their natural setting when the researcher is the key instrument and when collecting multiple sources of data (Creswell, 2007). The technique also aids in understanding the meaning of a problem or issue from the perspective of the participants (Creswell, 2007; Merriam, 2009). To understand aspects of teachers' technological pedagogical content knowledge, the researcher studied and gathered multiple forms of data by interviewing and observing teachers directly within their school setting and examining documents.

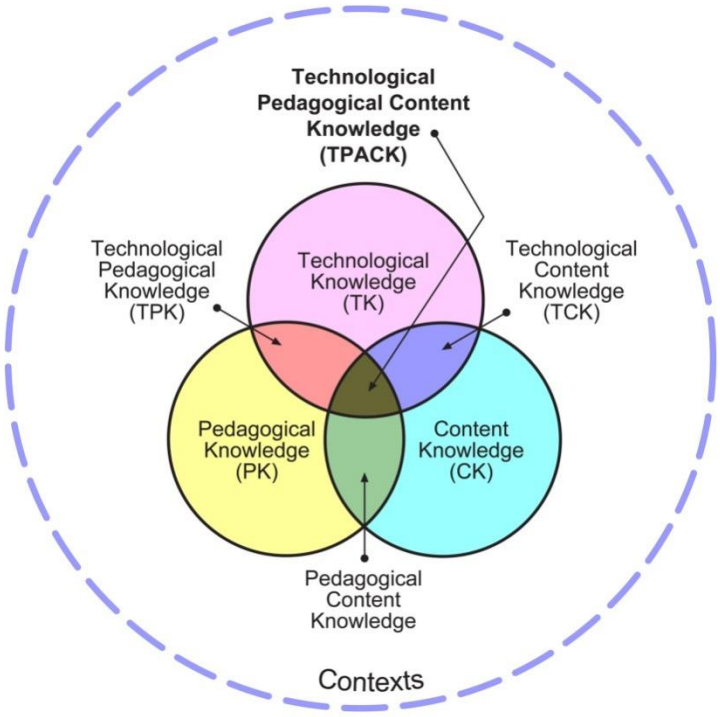
The researcher selected case study design to answer the research questions because it "investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p.18). Because the study was in the context of actual classrooms in an urban charter school, the case study approach provided the opportunity to describe the practices of teachers with technology.

In multiple case studies, the researcher replicates two or more comparable or contrasting cases using the same procedures for each case to study a phenomenon (Yin, 2009). For the current study, the researcher concurrently studied multiple cases of teachers with similar characteristics within the same charter school to show examples of aspects of teachers' technological pedagogical content knowledge in practice and understand what contextual factors influenced its use.

Overview of Theoretical Framework

The researcher used the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) to examine teachers' perceived knowledge and use of TPACK in practice. Several researchers have used the framework as a lens to study and assess teachers' knowledge and ability to integrate technology (Voogt, Fisser, Roblin, Tondeur, & van Braak, 2013). The framework builds on Shulman's (1986) pedagogical content knowledge (PCK) framework by adding technological pedagogical knowledge (TPK) technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). Mishra & Koehler (2006)

conceptualized TPACK by representing the model using a Venn diagram that includes three overlapping circles. Figure 2, shows how the three distinct types of teacher knowledge intersect at the heart of the diagram.



Note. Adapted with permission from "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge," by P. Mishra and M. J. Koehler, 2006, *Teachers' College Record, 108*(6), p. 1017-1054. Copyright by the Teachers College, Columbia University.

Figure 1. Venn Diagram of Technological Pedagogical Content Knowledge Framework

Thompson and Mishra (2007) stated that the visual "emphasizes, through the letters, the three kinds of knowledge (Technology, Pedagogy, and Content) and the notion that they form an integrated whole, a 'Total PACKage' as it were, for helping teachers take advantage of technology to improve student learning" (p. 38). The model

represents each of the factors of TPACK including the following: (a) technological knowledge (TK); (b) pedagogical knowledge (PK); (c) content knowledge (CK); technological content knowledge (TCK); (d) technological pedagogical knowledge (TPK); (e) pedagogical content knowledge (PCK); and (f) the combined knowledge of technology, pedagogy, and content (TPCK). The most important part of the diagram illustrates the intersection of the three interrelated types of knowledge: technology, pedagogy, and content. According to Kelly (2008), the intersections of the three types of knowledge are more important than the individual components alone. Teachers must learn to balance all three components together during instruction to integrate technology and support student learning. The current study focused on the four technology-related components: technology knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK).

In addition, the diagram shows the educational context as an important factor in which the TPACK framework is embedded. According to Kelly (2008), when teachers integrate technology, the context should also reflect teachers' awareness of an individual learner's physical, linguistic, social, psychological, and cultural aspects for acquiring knowledge, as well as the affordances and constraints of technology in planning for effective and equitable use (Kelly, 2008).

Significance of the Study

The problem of technology integration in classrooms is an important one. There is little doubt that new technologies will emerge along with new forms of knowledge needed to prepare students for their place in the 21st century society. The challenge of technology integration requires teachers to have technology, content, and pedagogical knowledge to integrate technology. In addition, teachers practice in diverse educational contexts that influence their use of technology. Each context presents its own set of challenges and various supports. If the educational context is not supportive of teachers' application of their technology integration knowledge, teachers may not use technology.

The current study extends the body of literature by including a less researched group of teachers, those in urban charter schools. As states and the federal government continue to provide support and funding for charter schools, more students will be educated in the context of charter school. Despite the growing interest in charter schools, there is little information on the organizational conditions and practices that promote learning, curriculum, and instruction that may lead to student achievement. Although a larger amount of literature has been published pertaining to technology integration, little research in the area of TPACK has targeted the aforementioned group of teachers. The researcher conducted the study to make a connection through research on TPACK, practicing teachers, and the influence of the educational context in charter school settings.

Second, the current study used several data collection strategies to further understanding various aspects of the TPACK framework, i.e., the educational context. Thus, the study may capture a collection of new understandings about both the supportive

conditions that elementary teachers need and the struggles they face as they use and develop technology integration knowledge in urban, charter school settings. In addition, the study may provide school leaders with valuable information to make funding decisions related to the acquisition of new technology. Further, the findings of the study may influence future professional development training for teachers using technological, pedagogical, and content knowledge framework as an essential component to help teachers integrate technology across various content areas.

CHAPTER 2
REVIEW OF THE LITERATURE

Introduction

Chapter 2 contains a review of the literature and related research in three major sections. The first section addresses technology use in K-12 schools, definitions of technology integration, and general factors that influence teachers' use of technology, including barriers and enablers. The second section contains background information leading to the development of technological pedagogical content knowledge (TPACK), models of TPACK, and current applications of in-service teachers TPACK in the literature. The final section presents a review of the literature on contextual factors that influence teachers' technological pedagogical content knowledge.

Technology Use in Schools

The importance of technology has been the focus of national initiatives and policy reports since the 1980s (Culp et al., 2005; Lowther et al., 2008). According to Culp et al., policies have centered around three themes: (a) capitalizing on the capabilities of technology to address challenges in teaching and learning, (b) using technology to change the quality of what and how students learn, and (c) using technology to prepare students for a technology-driven world for the country to maintain its position in the global economy. The policies have changed from support for students in gaining technical skills to the use of technology as a tool for students to develop 21st century learning skills. The U.S. Department of Education's 2010 National Education Technology Plan provided a

model of how technology can help prepare all students for the global economy of the 21st century. The plan called for a transformation in the education system by leveraging technology, "to provide engaging and powerful learning experiences and content, as well as resources and assessments that measure student achievement in more complete, authentic, and meaningful ways" (p. ix).

Scholars have also used national standards to document the importance of technology use and address the commitment for teachers to use technology in the classroom. Both the International Society for Technology in Education (ISTE, 2007) and the Partnership for 21st Century learning frameworks have recommended that students should master the use of technology as a tool to develop skills and knowledge needed for the 21st century. In addition, the standards outline the skills and knowledge teachers need to work in the 21st century classroom. The following standards, developed by ISTE (2008), support increased technological competency for teachers: (a) facilitate and inspire student learning and creativity; (b) design and develop digital age learning experiences and assessments; (c) model digital age work and learning; (d) promote and model digital citizenship and responsibility; and (e) engage in professional growth and leadership.

Schools have also received funding to acquire technology and to provide teachers with training to use technology effectively. For example, the Enhancing Education through Technology (EETT) program was established under the No Child Left Behind Act of 2001 to assist primary and secondary schools in using technology to improve student achievement (Bakia et al., 2009). To provide support for the effective integration of technology resources, the program provided $3.4 billion in federal funding for

educational technology between the years of 2002 and 2008 (Bakia et al., 2009). More recently, the blueprint for The Reauthorization of the Elementary and Secondary Education Act proposed providing funding to states that support effective use of technology to improve instruction and to address student-learning outcomes (U.S. Department of Education, 2010).

The focus on technology in K-12 classrooms has improved the technology infrastructure in schools. According to the latest study conducted by the National Center for Education Statistics (Gray et al., 2010), most public schools have access to a sufficient amount of technology resources, equipment, and support. The ratio of public school students to instructional computers with Internet access decreased from 12.1 to 1 when it was first measured in 1998 (Wells & Lewis, 2006) 3 to 1 in 2008 (Gray et al., 2010). Additionally, over 50% of teachers surveyed reported having access to other types of technology resources, including laptop carts, digital cameras, and interactive whiteboards. In addition, teachers have also had increased opportunities to gain technology skills, and a large number of schools have added the resource of a full-time staff person in the school whose only responsibility is providing technology support and/or technology integration. Of the teachers surveyed by the National Center for Education Statistics (Gray et al., 2010), 61% reported having participated in professional development activities that prepared them to use technology for instruction.

Although teachers have the support to use technology, they do not necessarily use technology as defined and envisioned in educational policies and by researchers (Culp et al., 2005). While, educational policies suggest teachers use technology to transform

teaching and learning, teachers tended to use technology to support their existing practices (Culp et al., 2005). The majority of uses of technology in K-12 schools, including uses by elementary school teachers, involve teachers engaging in administrative tasks, having students conduct research, and having students utilize drill and practice activities or tutorials (Gray et al., 2010; Tondeur et al., 2007). In addition, researchers have found that teachers in urban areas primarily use technology to support low-order thinking skills (Becker, 2001; Warschauer, Knobel, & Stone, 2004). According to Keengwe and Akyeampong (2010), urban schools have continued to show declines in technology use.

The researchers reported here measured teachers' use of technology in different ways. Some of the studies measured computer skills, frequency of technology use, and the types of technology used. Others reported the type of activities students and teachers performed. In addition, the measurements were captured using surveys. Although valuable, the studies did not address how teachers used technology to support content and teaching methods. Consequently, the researcher reviewed literature and research with a specific focus on technology integration. A presentation of results of the review are in the following section.

Technology Integration Defined

Conceptions of teachers' use of technology vary throughout the research literature, e.g., Bebell, Russell and O'Dwyer, 2004; Hew and Brush, 2007; Tondeur et al., 2007. According to Hew and Brush (2007), broadly defined technology integration is the

use of computing technology for instructional purposes. Inan and Lowther (2010) used three categories to classify teachers' use of technology: technology for instructional preparation, technology for instructional delivery, and technology as a learning tool. When using technology for professional use, teachers use technology for such things as preparing instructional materials, communicating or collaborating with peers, students and their parents, locating digital resources, and creating lesson plans (Bebell et al., 2004). When using technology for instructional delivery, the teacher or computer program present information to students, e.g., using drill and practice software or tutorials (O'Dwyer, Russell, & Bebell, 2004). When using technology as a tool, students use computer programs, e.g., spreadsheets and Web 2.0 tools, to expand their problem solving, communication, and collaborations skills (Morrison & Lowther, 2010). Hughes (2005) used three categories to classify teacher's technology use based on their technology-supported pedagogical practice: replacement, amplification, or transformation. Replacement occurs when teachers use technology as an alternative to accomplish instructional practice, goals, and student outcomes. Amplification occurs when teachers use technology to make instruction and learning more efficient and effective. Transformation occurs when teachers use technology to alter student learning strategies and instructional practices (Hughes, 2005). Others have classified technology use as high-level use and low-level uses. Researchers suggest that low-level technology use involves the use of teacher-centered practices, while high-level uses of technology involve the use of student-centered instruction or constructivist pedagogies (Becker, 1994; Ertmer, 2006). Best practices for educational technology use are high-level or

student-centered technology uses (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010).

Unlike the definitions provided above, Harris (2008) provided a definition for technology integration that did not emphasize a specific educational approach, philosophy, or goal. Her definition was based on the misalignment between educational technology leaders' visions and practitioners' actions. According to Harris, technology integration is the "the pervasive and productive use of educational technologies for the purposes of curriculum-based learning and teaching" (p. 253). Experienced teachers' decisions on how to use technology should be flexible and purposely chosen based on the context in which they teach.

The definition provided by Harris was used in the present study. Because the goals for technology integration vary across educational context, Harris's definition provided a less dependent and controlled definition to better understand how practicing teachers use knowledge of technology, pedagogy, and content to integrate technology in the context of an urban charter school. In addition, the focus of the current study was not on the forms of technology used, but how technology was used to support teaching and learning.

General Factors Influencing Technology Integration

A considerable amount of research has been dedicated to understanding the factors that influence the use of technology (Ertmer et al., 2006; Zhao et al., 2002, 2003). According to Zhao et al. (2002), factors that influence the use of technology in schools

are associated with (a) the school environment or the context where the technology is used, (b) the teacher, and (c) the technology-enhanced project or innovation. Zhao et al. (2002) found three factors within the school environment that support or constrain the use of technology. The factors include the human infrastructure, the technical infrastructure, and school support. The first factor, human infrastructure, refers to the extent to which the school has the organizational and cultural requirements, e.g., policies and procedures, technical staff, in place to support teachers' use of technology. The second factor, technical infrastructure, refers to the resources the school has in place to support the use of technology. The third factor, school support, refers to the extent to which teachers' use of technology is encouraged or discouraged by their peers. In addition, Zhao et al. (2002) found three factors associated with the teacher, including technology proficiency, pedagogical compatibility, and social awareness. The first factor, technology proficiency, refers to knowledge of how to operate the technology and its needed enabling conditions. The second factor, pedagogical compatibility, refers to how well the technology fits in with teachers' existing pedagogical beliefs. The third factor, social awareness, refers to how well the teacher is able to manage the social characteristics of the school culture.

Ertmer et al. (2006) characterized factors as barriers and enablers. Enabling factors describe the supporting conditions teachers need to integrate technology, and barriers hinder teachers' use of technology. Enablers and barriers have an inverse relationship. Thus, the presence of factors that enable teachers to use technology may lead to a reduction in barriers (Ertmer et al., 2006). Ertmer (1999) and Ertmer et al.

(2006) classified enablers and barriers into two categories: first-order or extrinsic and second-order or intrinsic. Ertmer et al. (2006) suggested a gradual process of addressing one barrier at a time rather than attempting to resolve simultaneous issues.

Barriers to Technology Integration

Barriers that influence technology use have been well documented within the literature (Ertmer, 1999; Hew & Brush, 2007). In a review of literature on technology integration in K-12, Hew and Brush (2007) identified 123 common barriers to technology integration among K-12 schools in studies published from 1995 to 2006. They identified six classes of barriers (resources, institution, subject culture, attitudes and beliefs, knowledge and skills, and assessment) to technology integration. According to Hew and Brush (2007), each barrier has a direct or indirect influence on technology integration with other barriers. Direct barriers include teachers' attitudes and beliefs about the use of technology, teachers' knowledge and skills, and the institution, i.e., school, and resources. Indirect barriers include subject culture and assessments. Direct barriers refer to first-order barriers, and indirect barriers refer to second-order barriers (Hew & Brush, 2007).

Lack of resources, school leadership, and assessments, are examples of first-order barriers (Ertmer, 1999; Hew & Brush, 2007). Researchers have shown that the pressure of high stakes testing provides teachers with little time to attempt new instructional methods (Boardman, & Woodruff, 2004), and teachers believe that the time involved in planning for technology use and integration is more time consuming than using direct

instructional approaches (Hew & Brush, 2007). Hew and Brush found that there is an indirect relationship between technology integration and assessment and a direct relationship between assessments and a teacher's attitudes and beliefs. The indirect relationship exists, because the type of assessment normally guides both how a subject should be taught and assessed and how technology should be used. Second-order barriers include teachers' beliefs and attitudes about teaching and learning and teachers' knowledge and skills needed to integrate technology effectively (Ertmer, 1999; Hew & Brush, 2007). Hermans et al., (2008) showed that teachers with traditional beliefs used computers to support more teacher-directed learning.

Beyond the issues outlined here, teachers in urban school settings have been further challenged with issues of equity and access. Students in urban settings usually lack the technology resources in their home settings. Those teachers who understand how to integrate technology into their classes may find it challenging to assign homework, projects, or activities designed to enrich or enhance student learning without isolating the students who do not have appropriate resources. Teachers in urban setting also have less professional develop opportunities.

Enablers (Conditions) for Technology Integration

In contrast, researchers have also identified several factors (or conditions) that enable teachers' use of technology. Factors that have been found to support teachers' use of technology include: constructivist, student-centered beliefs of teaching and learning (Ertmer et al., 2012; Ertmer & Ottenbreit-Leftwich, 2010; Hermans et al., 2008),

computer attitudes and experience (Hermans et al., 2008), school structure and culture (Tondeur et al., 2009), adequate resources, planning time, and support (Dexter& Anderson, 2002; Dexter, Anderson, & Ronnkvist, 2002), support from the school community (Hernandez-Ramos, 2005). In their review, Hew and Brush (2007) identified five categories of strategies to overcome barriers to technology integration: (a) having a shared vision and technology integration plan; (b) overcoming the scarcity of resources; (c) changing attitudes and beliefs; (d) conducting professional development; and (e) reconsidering assessments.

Dexter and Anderson (2002) suggested that one of the key features that make it possible for implementation of technology into the learning organization is creating a community-centered environment that provides teachers with an opportunity to build trust and collaborate with other community members. They found that teachers envisioning new kinds of student outcomes and getting feedback from their peers helped teachers learn to adjust their instructional practices. The authors concluded that teacher support and organizational leadership were critical for successful implementation of innovative technologies.

Professional development has been recommended as a strategy to overcome barriers to technology integration associated with teacher's attitudes and beliefs toward technology and teachers' skills and knowledge of how to integrate technology. According to Hughes (2005), teachers need to have a connection with pedagogical content knowledge upon which they can draw when planning to integrate technology into their teaching. The above-mentioned type of knowledge goes beyond knowing how to

operate technology. Teachers must have various types of knowledge to integrate technology

Pedagogical Content Knowledge (PCK)

Shulman (1986) observed that for several decades, teacher education focused on content knowledge (CK), knowledge of the subject matter. The focus later shifted to an emphasis on pedagogical knowledge (PK), knowledge of about the methods of teaching and learning. Shulman advised that knowledge of content or knowledge of teaching alone was not adequate for effective instruction. Shulman (1986) proposed a new model (Figure 1) that combined both teaching and content to create one form of understanding instead of focusing on content knowledge (CK) and pedagogical knowledge (PK) separately. He posited that pedagogy content knowledge (PCK) occurred at the intersection of knowledge of content and knowledge of pedagogy.

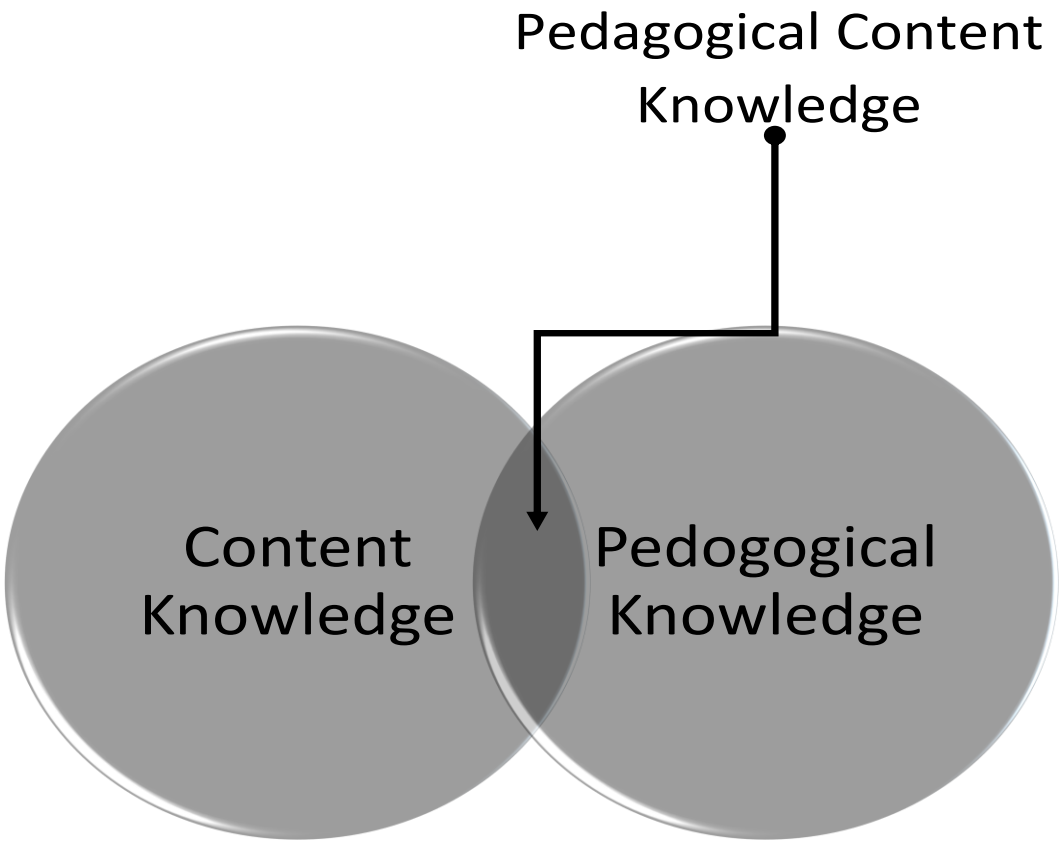


Figure 2. Shulman's Model of Pedagogical Content Knowledge (PCK).

Shulman indicated that pedagogical content knowledge signified "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented and adapted to the diverse interests and abilities of learning, and presented for instruction" (1986, p. 8). In other words, PCK makes it possible for teachers to transform content by finding ways that learners are able to understand and are customized based on their needs.

Development of Technological Pedagogical Content Knowledge (TPACK)

Decades after Shulman's (1986) seminal work, and as the use of new technologies began to play an important role in teaching, educational researchers expanded the discussion of pedagogical content knowledge to include technology knowledge (Hughes, 2005; Margerum-Leys & Marx, 2002; Mishra & Koehler, 2006; Niess, 2005; Pierson, 2001; Zhao, 2003). The aforementioned, researchers recognized that technology knowledge (TK) was isolated from pedagogical content knowledge (PCK). Using similar reasoning to that of Shulman, they blended content knowledge (CK) and pedagogical knowledge (PK) with technology knowledge (TK) to create technological pedagogical content knowledge (TPCK). Pierson was one of the first to use the term to describe effective technology integration. She investigated how teachers' technology use related to the teaching practice. Based on her findings, she argued for a locally defined definition of technology integration. She proposed adding technology knowledge to Shulman's framework. Others followed, using similar terms. For example, Niess (2005) used the term, technology-enhanced PCK, to describe the integration of knowledge of subject matter with technology and with teaching and learning that teachers need to develop.

Mishra and Koehler (2006) observed several issues with educational technology research. They recognized technology integration problems required that teachers needed to concentrate on more than just one factor at the same time. Thus, adding technology, content, or pedagogy separately was viewed as being insufficient to integrate technology. The authors posited that understanding how to use technology was less important than

understanding the relationship between the complex system of users, technologies, practices, and tools, and the contexts of teaching. In addition, they recognized the need for a theoretical foundation for educational technology. In 2005, Mishra and Koehler presented technological pedagogical content knowledge (TPCK) as an innovative framework to conceptualize the critical knowledge needed by teachers to integrate technology. In other words, teachers must apply their knowledge of technology, pedagogy and content to "design and implement curriculum and instruction while guiding their student's thinking and learning with digital technologies in various subjects" (Niess, 2011, p. 301). Mishra and Koehler (2006) merged Shulman's (1986) original concept of pedagogical content knowledge (PCK) with technological pedagogical knowledge (TPK) to form technological pedagogical content knowledge (TPCK). Unlike other approaches, they emphasized considering each component individually and in pairs: pedagogical content knowledge (PCK), technological content knowledge (PCK), and technological pedagogical content knowledge (TPCK) to understand them as thoroughly as possible (Mishra &Koehler, 2006).

In 2007, Thompson and Mishra modified the acronym from TPCK to TPACK to make it simpler to pronounce, use, and remember. In addition, the name change emphasized the three types of knowledge needed for effective technology integration. It also made it clear that each type of knowledge as an integrated whole, not in isolation, represented a "Total PACKage" as it were, for helping teachers take advantage of technology to improve student learning" (Thompson & Mishra, 2007, p. 38).

Models of Technological Pedagogical Content Knowledge (TPCK).

Several representations of the TPACK framework have been presented. Koehler and Mishra's (2008) framework considers each of the following factors individually as well as in pairs. The TPACK model consists of the factors previously discussed: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK) and the combined knowledge of technology, pedagogy, and content (TPACK). Figure 2, shown in chapter I, illustrates the intersection of the three interrelated types of knowledge: technology, pedagogy, and content. In addition, the diagram shows the educational context as an important factor in which the TPACK framework is embedded. To differentiate the seven factors of the Technological Pedagogical Content Knowledge Framework (TPACK) the following definitions are presented:

Content knowledge (CK): Content knowledge refers to the understanding the educator possesses on the topic or subject that the learner needs to acquire (Mishra & Koehler, 2006).

Pedagogical knowledge (PK): Pedagogical knowledge refers to knowledge of how to use instructional approaches and strategies with educational objectives and includes the knowledge of classroom management, and the ability to design and implement lessons, and evaluate student learning (Mishra & Koehler, 2006).

Technological knowledge (TK): Koehler and Mishra (2008) described technology knowledge in a similar manner as for fluency of information (FITness) proposed by the

Committee of Information Technology Literacy of the National Research Council (NRC, 1999). Technology knowledge is knowledge about how to use technology, in general, but also deals with the ability of information technology to assist or impede the achievement of a variety of goals or tasks.

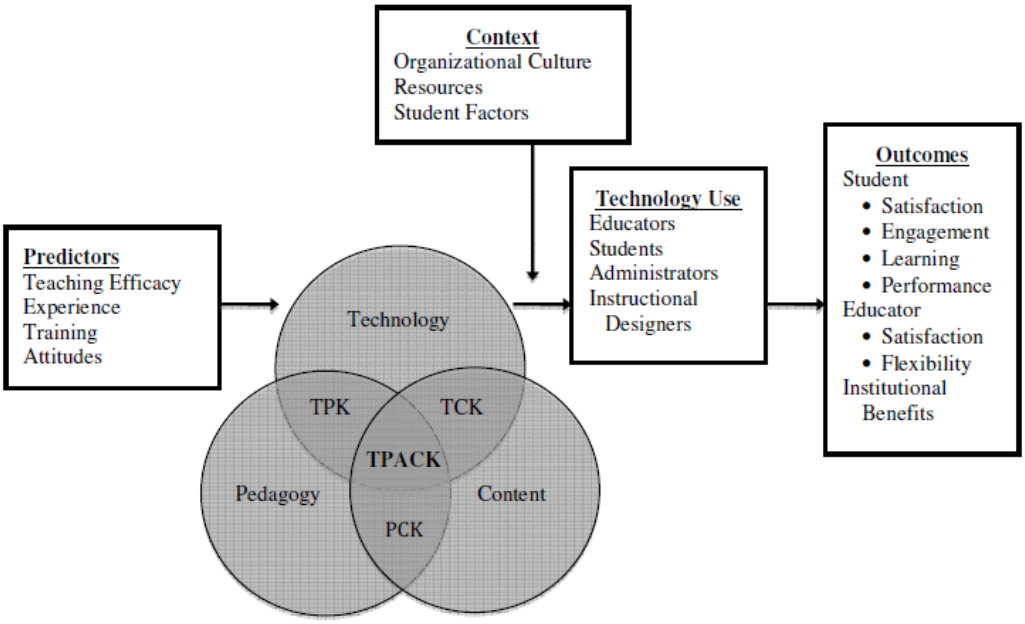
Technological content knowledge (TCK): Technological content knowledge (TCK) is knowledge about the way in which content can be changed by technology. Teachers need to know not only the subject matter they teach but also the manner in which the subject matter can be changed by the application of technology.

Technological pedagogical knowledge (TPK): Technological pedagogical knowledge (TPK) is knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change because of using particular technologies.

Technological Pedagogical Content Knowledge (TPACK): TPACK is the understanding that develops at the intersection of a teacher‘s technological knowledge, pedagogical knowledge, and content knowledge. Thus, effective technology integration is the result of a teacher‘s understanding of how to use technology within the boundaries of both teaching and content.

Several scholars (Angeli & Valanides, 2009; Lee & Tsai, 2010; Doering, Veletsianos, Scharber, & Miller, 2009; Kelly, 2008) have designed modified versions of Koehler and Mishra’s (2009) model to distinguish TPACK from the perspective of specific content areas, types of technology, and learning environments. For example,

Wilkin, Rubino, Zell, & Shelton (2012) proposed a model (Figure 3) that considers factors situated within an educational context in their model.



Source. Wilkin, Rubino, Zell, & Shelton, 2012

Figure 3. Technology Integration Model

Based on the researcher's perspective, contextual factors such as organizational culture, organizational and personal resources, and student factors have an influence on the role TPACK on technology use and classroom outcomes. In addition to technological, pedagogical, content knowledge, Angeli and Valanides' (2009) model included knowledge of students and the environmental context. In the process of integrating technology in classrooms, a teacher should consistently consider equity issues (Kelly, 2008).

TPACK Research: In-service Teachers

Since its inception, TPACK has been adopted as a theoretical framework to describe the various components of knowledge and practice associated with teachers' effective integration of technology across varying content areas. The available research regarding teachers' TPACK is narrowly restricted to pre-service teachers; however, some research has been conducted which provides insight into in-service teachers and their TPACK. What follows is an analysis of the existing literature on practicing teachers' technological pedagogical content knowledge and contextual factors that influence teachers' ability to use TPACK in practice.

Identifying Technological, Pedagogical, and Content Knowledge

Several studies focused on teachers' development of TPACK in the context of a formal learning experience designed and developed by the researchers (Doering, Scharber, Miller, & Veletsianos, 2009a; Graham et al., 2009; Harris & Hofer, 2011; Jimoyiannis, 2010; Mouza & Wong, 2009; Polly, 2010, 2011). Such studies have yielded mixed results on teachers' integrated knowledge of technological, pedagogical, and content knowledge (TPACK) and each of the subdomains. Doering et al.'s (2009) conducted a longitudinal research study to examine the impact of a professional development program that focused on developing experienced middle and high school geography teachers' technological, pedagogical, and content knowledge (TPACK). The professional development program exposed teachers to content-specific learning tools and resources. Through mixed-method strategies, the authors first analyzed pre/post

questionnaire responses to measure changes in the teachers' perceived TPACK. The researchers found statistically significant changes in teachers' TK, TCK, TPK, and TPACK. However, there were not significant changes in teachers CK, PK, and PCK. In addition, teachers believed that limited access to equipment, limited technology knowledge, and limited technology support and infrastructure were barriers to using technology for teaching geography.

In another study that focused on teachers' development of technological, pedagogical, and content knowledge (TPACK) through a formal learning experience, Mouza and Wong (2009) arrived at complementary conclusions. The authors used a case development strategy to help teachers learn to integrate technology. The authors analyzed written cases, online discussion entries, and transcripts from in-depth interviews to understand the way in which teachers implemented the technology integration plans in their classrooms and identified specific components of TPACK represented in teacher practice. Findings from the study suggested that teachers increased their growth in TPACK and experienced the greatest development in TPK.

Some researchers have had difficulty identifying all of the subdomains and have posited that some of the subdomains may not exist (Archambault & Barnett; 2010; Lux, 2010). Archambault and Barnett conducted a factor analysis to identify the seven factors described in the TPACK framework. The researchers collected responses from a survey of 596 K-12 online teachers who rated their agreement with given statements in each subscale. Results from the analysis revealed that participants reported only three of the seven factors: PCK, TCK, and TK. The authors concluded that the framework might be

helpful from an organizational standpoint, but that it might be difficult to separate each of the domains. In addition, the authors suggested that when experienced educators consider teaching a particular lesson, how they teach the lesson is considered a part of the content.

Hofer and Harris (2012), in a review of 12 studies on teachers' technological, pedagogical, and content knowledge before or during professional development training, found that TPK was more evident than TCK. They suggested that: (a) teachers' may attend more to pedagogy than to content, (b) teachers may not separate TCK from content knowledge, (c) teachers' technological content knowledge may be a subdomain of pedagogical content knowledge because some technological tools are embedded within curricular materials, and/or (d) teachers may not have access to a variety of tools or are unaware of the content specific technologies. The authors noted that "using more precise instruments, more focused interview prompts, more accurate stimulated recall techniques, and more effective data analysis methods to better understand both the composition and the complexities of teachers' applied TPACK" (p. 4707).

To describe differences of in-service teachers' technological, pedagogical, and content knowledge (TPACK), Niess, Suharwoto, Lee, and Sadri (2006) used five distinct stages (recognizing, accepting, adapting, exploring, and advancing) to describe the teachers' TPACK for teaching mathematics with spreadsheets. Niess, Sadri, and Lee (2007) extended the model through further research to describe teachers' knowledge, skills, and dispositions through five different levels of TPACK integration. Table 1

provides a description of each stage. Using the model, the researchers have been able to identify and evaluate teachers' technology integration.

Table 1

Levels of TPACK Integration

Stage	Description
Recognizing (knowledge)	Teachers are able to use technologies and recognize the alignment of the technologies with subject matter content, but are not yet integrating the technologies in teaching and learning in their content and at their grade level.
Accepting (persuasion)	Teachers form a favorable or unfavorable attitude toward teaching and learning content topics at their specific grade levels with appropriate technologies.
Adapting (decision)	Teachers engage in activities that lead to a choice to adopt or reject teaching and learning specific subject matter topics with appropriate technologies.
Exploring (implementation	Teachers actively integrate teaching and learning of content topics with appropriate technologies.
Advancing (confirmation)	Teachers evaluate the results of the decision to integrate teaching and learning content with appropriate technologies and are willing to make changes in the curriculum to take advantages of the affordances of the technologies.

TPACK and Contextual Factors

Koehler and Mishra (2008) argued that teaching with technology is situated in the context or the setting in which teachers teach. Therefore, teachers need to have knowledge of the students, the school, and available resources. The context is a crucial part of the TPACK framework. In attempts to understand teachers' use of TPACK in

practice, it is essential to know how such factors may influence teachers' abilities to integrate technology. In fact, several authors have identified contextual factors that constrain teachers' ability to use their knowledge to technology integration. After participation in a professional learning experience, Guzey and Roehrig (2009) found that contextual factors such as availability of technology tools and characteristics of student population constrained teachers' development of TPACK. Hofer and Swan (2008), in their interpretive case study research, explored each type of teacher knowledge (content, pedagogical, and technological) and their intersection using two sixth-grade social studies teachers. After analyzing interviews, teaching material, and student products, the researchers reported that although participating teachers were able to successfully use their knowledge in all domains, the teachers had trouble with TPACK. They suggested that the technology project itself constrained teachers in their use of TPACK in practice because they lacked prior experience using the technology. Mouza (2009) conducted a qualitative case study to investigated eight charter school teachers' ability to integrate technology with content and pedagogy after professional development. Although the teachers developed their knowledge of technology, content, and pedagogy, their beliefs about their students, the required curriculum, and limited resources influenced how they integrated technology.

Measuring Technological, Pedagogical, and Content Knowledge

Various tools have been used to identify in-service teachers' technological, pedagogical, and content knowledge (TPACK) including questionnaires, observation

instruments, and assessment rubrics to evaluate lesson plans, reflective journals, and interview protocols. The trend has been to use questionnaires to capture teachers' self-reports of TPACK (Archambault & Barnett, 2010; Lin, Tsai, Chai, & Lee, 2012). The self-report measures evaluated each of the seven factors included in the TPACK framework.

Some researchers (Hofer et al., 2011) have suggested that researchers should use a number of different and reliable measurement strategies to provide a greater understanding of how teachers apply TPACK in practice. Several reliable and valid measures are available to capture teachers' knowledge. For example, Harris, Grandgenett, and Hofer (2010) developed a rubric to assess TCK, TPK, and TPACK by evaluating lesson plans. In addition, Harris et al. (2012) developed structured interview questions to gain details that were typically absent in practicing teachers' instructional plans. The instrument aids in assessing the quality of TPACK evident in experienced teachers' instructional planning based on their responses to semi-structured interview questions.

Summary

The goal of Chapter 2 was to provide definitions of technology integration, describe general factors that influence teachers use of technology, including barriers and enablers, and discuss the technological pedagogical content knowledge (TPACK) framework and how it has been applied to identify and measure in-service teachers TPACK. The findings from the studies described in the chapter provide evidence that

teachers' integrated knowledge of technology, content, and pedagogy may vary. The progress teachers make in acquisition of the aforementioned knowledge is also varied and based on the stages of development of the individual.

CHAPTER 3
RESEARCH METHODS

Introduction

Chapter 3 contains a detailed description presents the methods and procedures used to conduct the study. It has been organized to include a restatement of the purpose of the study, a description of the research design, the setting, and the participants who took part in the research. The instruments used to collect and analyze the data and the procedures used to conduct the study are also explained in detail.

Purpose of the Study

The purpose of the study was to (a) explore the perceived technological pedagogical content knowledge of practicing elementary teachers in an urban charter school setting, (b) investigate how teachers in an urban charter school setting demonstrate technology integration knowledge in their instructional practices, and (c) identify contextual factors that influence practicing elementary teachers in an urban charter school setting ability to apply their technology integration knowledge.

Research Design

The current study employed a qualitative research design with multiple case study strategy of inquiry (Creswell, 2007) to construct multiple individual cases of practicing teachers in a charter school setting using technological integration knowledge in practice. According to Creswell (2007), qualitative research is best suited for studying individuals in their natural setting, when the researcher is the key instrument, and when collecting

multiple sources of data (Creswell, 2007). Researchers who have examined teachers' use of technology have relied on surveys and questionnaires to provide insight into how teachers use technology (Becker, 1994; Ertmer et al., 2006). As noted by Kereluik et al. (2010), self-report surveys do not show how individuals apply TPACK in the classroom. They are only helpful in understanding an individual's awareness regarding TPACK. Unlike quantitative research, which uses surveys, questionnaires, or other measurement tools to discover findings, the qualitative researcher is the primary instrument of data collection and analysis (Creswell, 2007). In the current study, to understand aspects of practicing teacher's technological pedagogical content knowledge, the researcher studied and gathered multiple forms of data by interviewing and observing teachers in their school setting and examining documents. In addition, the context of the charter school allowed the researcher to position the teachers within their natural setting and to understand how contextual factors influenced how they used technological integration knowledge in their instruction practices.

Secondly, qualitative research seeks to understand the meaning of a problem or issue from the perspective of the participants (Creswell, 2007; Merriam, 2009). The researcher used qualitative methods to enable the practicing teachers to describe and demonstrate how they used technology integration knowledge in their instruction practices and to identify what contextual factors influenced how they used technology integration knowledge. The researcher situated herself within the school and classroom environment and interacted with the participants to discover meaning from interviews, observations, and documents collected.

Lastly, qualitative research is used to develop a complex picture of the problem under study using "multiple perspectives, identifying the many factors in a situation, and sketching the larger picture that emerges" (Creswell, 2007, p. 39). To describe how teachers use technology integration knowledge, the researcher aimed to provide an in-depth analysis of the specific situation. Because there has been limited research on practicing teachers' technology integration knowledge in elementary, charter school settings, the researcher intended for the study to provide additional insight into how teachers in the context of an urban charter school use technology integration knowledge. In addition, it is hoped that the research may provide new understanding about contextual factors that influence teachers' technology integration knowledge, and provide insight for the school and researchers.

The strategy of inquiry for the study was a collective (Stake, 2005) or multiple-case study (Yin, 2009). Creswell (2007) described case study research as

> a type of qualitative approach in which the investigator explores a bounded system (a ***case***) or multiple bounded systems (***cases)*** over time, through detailed, in-depth data collection ***involving multiple sources of information*** (e.g. observations, interviews, audiovisual material, and documents and reports), and reports a case ***description*** and case-based themes. (p. 73)

Based on the bounded system of the teachers' classrooms, the researcher concluded that a case study approach was the most appropriate strategy to use in conducting the research. In addition, the research questions and the complex phenomenon of teacher technology integration knowledge was suitable for the case study

design. Further, the researcher selected case study design to answer the research questions because it "investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p. 18). Technological pedagogical content knowledge is a new concept. In addition, case study design allowed the researcher to "retain the holistic and meaningful characteristics of real-life events" (Yin, 2009, p. 4).

Because the study was situated in the context of actual classrooms in a charter school, the case study approach provided the opportunity to describe the practices of teachers with technology and discern how contextual factors influenced how teachers used technology integration knowledge in their instructional practice. In addition, the researcher aimed to capture and include the contextual conditions in which the teachers work as a part of the analysis. According to Yin (2009), case study research is helpful when asking "why" or "how" questions. The research questions used for the study were "how" questions, making the case study strategy appropriate for the study. Finally, the researcher selected case study because it is appropriate for studying a complex phenomenon (Yin, 2009). Researchers have documented the complex phenomenon of the interactions between pedagogical, technological, and content knowledge (Harris, Mishra, & Koehler, 2009; Koehler & Mishra, 2008).

In a collective or multiple-case study, multiple cases are selected to explain an issue or concern (Creswell, 2007; Stake, 2005). More specifically, the researcher replicates two or more comparable or contrasting cases using the same procedures for each case to study a phenomenon (Yin, 2009). The intent of the multiple-case study was

to study more than one case of teachers with similar characteristics within the same charter school to show examples of teachers' technology integration knowledge in practice and understand what factors influenced its use. Understanding captured from more than one case is greater than that drawn from a single case (Yin, 2009) and enhances the external validity of the findings (Merriam, 2009).

The researcher used qualitative methods to construct individual case studies of each teacher (within-case analysis). The researcher subsequently used thematic analysis following the constant comparative method (Strauss & Corbin, 1998) to compare the results of each case and construct the final analysis.

Research Setting

To achieve the necessary in-depth understanding of the phenomena, the researcher used purposeful sampling to select the site for the study. The researcher chose an elementary charter school that was located in an urban area and a part of an urban school district in central Florida. The researcher selected the charter school for several reasons. First, the researcher chose the site because she had worked with the school and teachers as a facilitator for professional development, had access, and had already established rapport with the school staff. Second, the researcher based the choice of school on the following school characteristics: (a) in operation for over three years, (b) strong leadership, (c) teacher professional community, and (d) adequate technology resources and support. Based on the school characteristics, it was assumed the school had overcome start-up obstacles commonly associated with charter schools and had

sufficient time to implement innovative instructional strategies such as technology integration. Furthermore, it was expected that because the school had adequate resources and supports that barriers to access had been lessened and teachers and students had opportunities to use technology integration knowledge within the classroom.

Participants

Teachers from the school were recruited to serve as participants in the study to provide useful and important information related to their daily work within the classroom. To achieve the detailed understanding of the phenomena, purposeful sampling was used to select teachers for the study. Purposeful sampling is used when the researcher wants to "discover, understand, and gain insight and therefore must select a sample from which the most can be learned" (Merriam, 2009, p. 77). Using purposeful sampling, the researcher selects information-rich cases based on some criteria (Patton, 2002). According to Patton (2002), information-rich cases are those that provide a sufficient amount of information related to the focus of the investigation. The criteria for the proposed study included: (a) teachers who have over three years of teaching experience, (b) teachers who have knowledge of technology, pedagogical, and content (c) teachers who have participated in professional development that focused on the use of technology as a teaching tool, and (d) teachers who use technology several times a week for instructional purposes. Due to the characteristics noted, the researcher assumed that the teachers selected would likely have an understanding of content, pedagogy, and technology as well as knowledge of the school environment. Moreover, it has been

shown that teachers who have more years of teaching experience and tenure at a school are more likely to use technology in meaningful ways (Russell, 2007). The researcher administered a survey to obtain all of the teachers' perceptions of each technological pedagogical content knowledge domain (TK, PK, CK, PCK, TCK, TPK, and TPACK), demographic information, professional development experiences, and perceived leadership, technical, and peer-support for the use of technology at the school. From the population of nine teachers, five teachers who met the criteria and agreed to participate in the study were contacted to participate in the second phase of the study. Three teachers volunteered to participate; however, one teacher did not use technology on a regular basis. Therefore, the researcher used two teachers as cases for the study.

In addition to selecting teachers to participate in the study, the researcher asked administrators from the school to participate in the study. Administrators included the school principal and the Director of Curriculum, Instruction & Assessment. The principal, Dr. Jones (pseudonym) had been the principal at the school for nine years. The director of curriculum, instruction, and assessment, Mrs. Wilson (pseudonym), had been employed at the school for 10 years. Information from the school administrators was used to help in answering Research Question 3 by providing insights on contextual factors influencing teachers, e.g., how TPACK is supported at the school. To provide background information and a context for the study, interviews were conducted with administrators.

Data Collection

Several forms of data collection strategies exist for qualitative research including participant observation, interviewing, document collection (Glesne, 2006), and audiovisual material (Creswell, 2007). Case study research design requires a variety of data collection strategies to create a thorough description of the case (Creswell, 2007). Six types of data collection are recommended for specifically for case studies: (a) documents, (b) archival records, (c) interviews, (d) direct observations, (e) participant-observations, and (f) physical artifacts (Yin, 2009). To obtain an in-depth understanding of the phenomenon, data collection for the study included the following: (a) survey; (b) pre-observation interviews with teachers; (c) document reviews; (d) direct classroom observations; (e) post-observation interviews with teachers; and (f) interviews with school administrators. The collection of multiple sources helped the researcher triangulate the data, provide an extensive description of each case, and surface all potential variables (Creswell, 2007) and "contributes to the trustworthiness of the data" (Glesne, 2006, p. 36).

Data were collected using three different instruments: a questionnaire, semi-structured interview questions, and an observation tool. Table 2 displays the sources of data, purpose of data collection, research questions, and instrumentation related to each data collection strategy.

Table 2

Data Collection: Sources, Purpose, Research Questions and Instrumentation

Source of Data	Purpose of Data Collection	Research Question	Instrument
Survey	Establish participants for the study. Identify teacher's self-reports of TPACK, demographic information, and perceived leadership, technology, and peer support.	1	TPACK Survey
Document Review	Provide support for observations. A detailed record of how teachers plan to apply TPACK and use technology in the classroom during observations. Provides triangulation.	2 3	
Teacher Interview (Pre-observation)	Provide support for written lesson plans and observations. Establish rapport, discuss procedures for the study. Understand teacher's accounts of TPACK. Understand teacher's perceptions of factors influencing technology use. Provides triangulation	2 3	Structured interview
Teacher Interview (Post-observation)	Helps with member checking. Helps to clarify what was learned during the observations. Helps with triangulation of the data	2 3	Semi-structured interview
Administrator Interview	Helps to provide information on the setting. Support/challenge factors from the lens of administrators. Describe the research setting. Provides triangulation	3	Semi-structured interview
Observation	Describe the setting, behavior, events, and processes. Provide support/challenge from interviews data. Record of teacher/student actions throughout lesson implementation. Provides Triangulation.	2 3	Technology Integration Observation Instrument (TIOI)

As shown in Table 2, every data source contributed to answering the research questions in the study. Comparable questions were used for more than one source to collect data on aspects of participants' technological pedagogical content knowledge and contextual factors. Therefore, each source of data added to the validity of the study through triangulation and contributed to the development of a collective picture of the problem under study from multiple perspectives.

Instrumentation

Survey

The researcher used a questionnaire to answer the first research question. The survey consisted of items from the Survey of Teachers' Knowledge of Teaching and Technology developed by Schmidt et al. (2009). In addition to questions related to TPACK, the survey included demographic questions and perceived level (strong, moderate, low) of leadership, technology, and peer support for technology use at the school. Schmidt et al. (2009) surveyed PK-6 pre-service teachers to address their self-assessment of TPACK on a five-point Likert-type scale. Although, other researchers (Archambault & Crippen, 2009) have developed surveys that address teacher TPACK, the researcher contended that the PK-6 population used by Schmidt et al. (2009) was well matched to the population for the current study. In a test of validity, the construct validity of the items from the questionnaire ranged from 3.67 to 9.00 for each of the knowledge types, with five of the seven subscales scoring 7.88 (Schmidt et al., 2009).

Cronbach's alpha reliability estimate of the instrument ranged from 0.75 to 0.93 (Schmidt et al., 2009). In addition to providing data to respond to the first research question, the survey was used to help establish which teachers met the criteria for the second phase of the study and provided background information for each of the cases chosen for the study. The survey is located in Appendix A.

Documents

Documents were used to address Research Question 2 and provide a method for triangulation. The researcher reviewed written instructional plans to support or challenge teachers' verbal description in interviews. In addition, written instructional plans provided a detailed record of how teachers planned to apply TPACK and use technology in the classroom during observations. According to Glesne (2006), documents increase the breadth of observations and interviews by supporting, challenging, or enhancing what is seen and/or heard. As such, documents in the study enhanced the researcher's understanding of teacher TPACK by providing both descriptive historical and contextual information during interviews and seen during observations.

Interviews

Pre-observation interviews using structured interview prompts developed by Harris et al. (2012) were used to answer the second and third research questions and to support or challenge teachers' written instructional plans (Appendix B). The use of structured interviews allows issues to emerge during the conversation. The interviews

give participants the opportunity to explain the true meaning of the documents as they relate to their intended use. The structured interview questions developed by Harris et al. (2012) were created to gain details that are typically absent in practicing teachers' instructional plans. The instrument was designed to assess the quality of technology integration knowledge (TK, TCK, TPK, and TPACK) evident in experienced teachers' instructional planning based on their responses to semi-structured interview questions. The instrument was found to be a valid and reliable instrument to assess TPACK. Construct validity of the instrument was supported by five of six expert reviewers (Harris et al., 2012). Face validity was confirmed by experienced technology-using teachers. The instrument's interrelated reliability was calculated using Intraclass Correlation Coefficient (.870) and computed using a second percentage score agreement procedure, internal consistency (93.6%). In addition, internal consistency within the rubric, computed using Cronbach's Alpha, was .895. Further, test-retest reliability (percentage agreement between scorings of the same videos) was 100%. The interview questions developed by Harris et al. (2012) asked teachers to describe what contextual factors they perceived as influencing their TPACK in practice. The interview protocol used in the present study is located in Appendix C.

Following observations, the researcher conducted follow-up interviews with teachers to verify what was learned during the observations. Researchers have provided support for follow-up interviews, Glesne (2006) stated, "Interview questions that develop through participant observation are connected to known behavior, and their answers can be therefore better interpreted" (p. 49). In addition to semi-structured interview

questions, during observations, the researcher wrote questions about what was taking place in the classroom and verified her understandings in follow-up interviews with teachers. The aforementioned strategies, permitted the researcher to share her understanding of the data collected during the observations and served as a member check, allowing teachers an opportunity to validate and correct any misunderstanding of the researcher's interpretations.

In addition to collecting data from teachers, the researcher collected data from administrators at the school. According to Glesne (2006), data collection from multiple data sources helps increase confidence in the research findings. Interviews were conducted with administrators to support/confirm contextual factors that influence teachers' technology integration knowledge.

Observations and Field Notes

Observations using the Technology Integration Observation Instrument (TIOI) developed by Hofer et al. (2011) were conducted to address Research Questions 2 and 3 and provide an additional method for triangulation. Observations allow the researcher to record behavior as it occurs (Creswell, 1994). The instrument, based on different aspects of TPACK, is displayed in Appendix D. It was intended to assess the quality of technology integration knowledge observed during instruction. During each observation, the researcher recorded the type of technology being used, the curriculum topics, instructional strategies, and learning activities. The instrument was found to be a valid and reliable instrument to assess the quality of TPACK for pre-service teachers.

Construct and face validity of the instrument was supported by seven expert reviewers (Hofer et al., 2011). The instrument's interrelated reliability (.802) was calculated using Intraclass Correlation Coefficient and computed using a percentage score agreement procedure (90.8%). In addition, internal consistency computed using Cronbach's Alpha was .914. Further, test-retest reliability was 93.9%. Although, the aim of the research was not to assess the quality of technology integration knowledge, the researcher relied on the instrument and rubric as a guide to understand how technology integration knowledge was used.

In addition, the researcher videotaped and took field notes during observations to describe the participants, events, and actions to document the context in which teachers integrate technology. The field notes helped the researcher explain contextual factors influencing how teachers used their technology integration knowledge. Video recordings enhanced observations by providing a permanent record of the observation for the researcher to return to numerous times during analysis (Glesne, 2006). Thus, the researcher had numerous opportunities to gain new insights and confirm emerging themes. Following observations, informal interviews were conducted. During the informal interviews, teachers were asked to describe their perceptions of the quality of the lessons.

Procedures

The researcher initially met with participants during a staff meeting at the school. During the meeting, the researcher explained the study and answered questions related to

the study. After answering questions, the researcher asked the teachers if they were willing to participate. Nine participants agreed to participate in the first phase of the study. Before data collection, the researcher gained approval from the University of Central Florida Institutional Review Board (Appendix F). The researcher also obtained permission and access to the school to conduct the research from the principal of Carter Charter School (Appendix G). After receiving approval, teachers and school administrators were given a document explaining the research, the purpose of the study and the procedures that would be followed in the conduct of the study (Appendix H).

The survey (Appendix B) was administered in an online format to nine teachers. Teachers who met the criteria for the study were contacted and asked to participate in the second phase of the study. Teacher lesson plans were collected before observations to add another dimension to the study. Pre-observation interviews were conducted with two teachers using the protocol located in Appendix C. To capture teachers' responses to every question, the interviews were recorded.

Following interviews, the researcher requested available times and dates to conduct classroom observations. Prior to observations, the researcher sent a reminder email with a schedule for all observations dates and times. Observations were conducted with two teachers over the course of three weeks using the protocol located in Appendix E. The researcher made four 60-minute visits to each classroom to capture two or more complete lessons.

Each visit was videotaped so that the observation could be viewed and analyzed after the observation. Teachers, not students, were videotaped. During observations,

interactions were captured using the Technology Integration Observation Instrument (Hofer et al., 2011). In addition, the researcher used descriptive field notes to capture interactions and conversations taking place as they occurred and any related contextual factors that were observed during a lesson such as issues with technology. Post-observation interviews took place after each classroom observation or during the teacher's planning period. During the post-observation interviews, teachers were asked to clarify what was learned during the observations, what modifications they would make if any, and to describe their perceptions of contextual factors that influenced how they used their technology integration knowledge in practice.

Interviews with administrators took place within the same time range. Administrator interviews were conducted using the protocol located in Appendix E.

Data Analysis

In qualitative research, data collection and analysis are completed at the same time in an iterative and continuous process (Creswell, 2007; Merriam, 2009). According to Merriam, "Without ongoing analysis, the data can be unfocused, repetitious, and overwhelming in the sheer volume of material that needs to be processed" (p. 171). The goal of the data analysis process is to answer the research questions by making meaning of what is seen or heard. During the process, the researcher consolidates, reduces, and makes interpretations to begin to understand the data and convey the findings of the study. The researcher moves "back and forth between concrete bits of data and abstract concepts, between inductive and deductive reasoning" (Merriam, 2009, p. 171). Creswell

(2007) described the recursive process as a data analysis spiral in which the researcher takes a nonlinear approach, moving in analytical circles in and out of the data.

Generally qualitative data analysis involves three strategies: (a) preparing and organizing the data, (b) coding to reduce the data into themes, and (c) comparing and making connections (Creswell, 2007). To prepare the data, the researcher established a system to store survey, interview, observation, and document data. In addition, each piece of data was assigned a code and labeled so that it could be easily be retrieved when needed. To aid reliability, Yin (2009) recommended setting up a formal case-study database to store and organize the data. The researcher used Computer Assisted Qualitative Data Analysis Software (CAQDAS), ATLAS.ti, to create a case-study database to store all of the data. In addition, an inventory of the entire data set was created to help the researcher track the collected data. Each interview was transcribed verbatim; documents, i.e., lesson plans, were collected electronically; and observations were captured using the Technology Integration Observation Instrument. Field notes were reviewed prior to leaving the school building and a second time after they had to check on the accuracy of the description and categorization of observed behaviors and events. All of the collected data were coded, labeled, and transferred to ATLAS.ti.

Two phases of analysis are necessary for a multiple case study (Merriam, 2009). In the first phase, a within-case analysis of each individual case is conducted. During the second phase, a cross-case analysis is conducted to build generalities across cases.

Phase I: Survey

Research Question 1

During the first phase of the analysis, for specific insight on elementary teachers' perceived technological pedagogical content knowledge in the urban, charter-school setting, the researcher used survey data. The researcher calculated a mean score for each participant on each of the variables. Descriptive statistical analysis was appropriate considering the sample size of teachers (n = 9); statistical measures that suggest generalization would be inappropriate for the study.

Phase II: Within-Case Analysis

During the second phase of the analysis, the researcher used within-case analysis procedures, specifying each participant as an individual case. After transferring the data to ATLAS.ti, the researcher read the data for one teacher at a time, using each source to answer each research question. The researcher read each interview transcripts, observation data, and field notes, documents, relevant notes, and made comments in the margins. The researcher then began developing initial categories and codes. After reviewing all of the data sources for one teacher, the researcher coded each data source. Using the codes, the researcher began to identify concepts, themes, and patterns to create an overall picture of the case.

Research Question 2

For specific insight as to how teachers use technology integration knowledge (TK, TCK, TPK, and TPACK), the researcher used written instructional plans, transcribed interviews, records from the Technology Integration Observation Instrument, and field notes to record teacher practices as they were manifested in the teaching environment. The researcher reviewed each of the data sources by watching the video from observations and reading transcripts several times and coding them. The researcher used the technology integration knowledge (TK, TCK, TPK, and TPACK) subdomains to code written instructional plans, interview notes, and observations. The researcher removed data not relevant to teachers' use of technology integration knowledge (TK, TCK, TPK, and TPACK) in practice from the area for later analysis.

The researcher developed a coding scheme using TPACK articles and studies to describe and identify evidence of each type of technology integration knowledge (Cox & Graham, 2010; Graham, Borup, & Burgoyne, 2010; Mouza, 2011) in each case. The description of each construct and coding scheme used for the study is illustrated in Table 3.

Table 3

Construct Codes, Description and Evidence

Construct Code	Description	Evidence
TK	Teacher operated technology effectively.	Operating computer hardware Using standard software tools (e.g., MS Word, PowerPoint, Internet browsers, e-mail) Installing and removing peripheral devices (e.g., USB drives, microphones) and software Troubleshooting equipment Using appropriate vocabulary (e.g., technology terms)
TCK	Teacher used digital/emerging technology to investigate, represent, or transform topics or subjects specific to the content area independent of pedagogical strategies Selection of technology based on the nature of the content or content-specific goals or learning outcomes	Using video, Audio, a website, Web 2.0, blog internet to represent/transform/or investigate a topic or subject specific to a content area (e.g. math, history, science, and etc.) E.g. Using technology to construct graphs or diagrams, the writing of number sentences, or the presentation of a written or oral explanation.
TPK	Teacher used digital/emerging technology to support general pedagogical (instructional) strategies that are not specific to a content domain.	Classroom management Collaboration Assessment Productivity/effectiveness Improve teaching materials and content Active learning Presentation/display of information Project-based learning Practice/feedback Authentic real-world experiences Student presentation Student research Interaction Discussion Drill and Practice Holding students accountable for equipment used Developing strategies for assessing student work with technology Knowing about the existence of a variety of tools for particular tasks Knowing about the time required to teach with particular technologies Ability to envision potential student problems with particular

Construct Code	Description	Evidence
		technologies and plan relevant activities to support those students
		Generating alternatives in the event of technological failures
		Ability to explain a computer procedure to students (e.g., through modeling)
	Used technology to address general learner characteristics	Using technology to address:
		Learning style/preference
		Developmental/age appropriateness
		Learner motivation
TPACK	Used technology to facilitate subject-specific pedagogical method.	Teachers uses technology to facilitate subject-specific strategies:
		Science (inquiry, experiments . . .)
		Language arts (balanced literacy . . .)
		Math (inquiry, graph analysis . . .)
		Social studies (primary source . . .)
		Improved/new pedagogy
	Used technology to transform a content representation to facilitate learning	Visual representation
		Multimodal representation
		Dynamic representation
		Accurate representation
		Professional representation
	Used technology to address learner content knowledge	Prior content knowledge
		Correction of misconception
		Improvement in content understanding
		Prior knowledge/skill with technology

Research Question 3

For specific insight into contextual factors, the researcher used interview transcripts, field notes, and video recordings to identify a priori codes derived from the literature related to factors that influence teachers' technology integration knowledge (TK, TCK, TPK, and TPACK) in practice. The researcher read and reviewed each of the data sources several times before coding. Using ATLAS.ti, the researcher was able to code and make notations by highlighting certain sections of the text.

Phase II: Cross-case Analysis

Following the within-case analysis, the researcher conducted a cross-case analysis using the individual cases developed from the within-case analysis. Using the results from each individual case, the researcher synthesized the information to construct one final narrative. The researcher searched for similar and conflicting patterns and themes across cases associated with teachers' use of technology integration knowledge (TK, TCK, TPK, and TPACK) in their instructional practice. In addition, the researcher completed the cross-case analysis to identify similarities and differences in what the teachers reported and what contextual factors influenced their technology integration knowledge (TK, TCK, TPK, and TPACK) in practice.

Limitations

The current study provides several examples of how teachers at an elementary charter school used their knowledge of technology integration as they implemented their lesson plans; however, the study is not without limitations. One limitation of the study was the fact that the researcher conducted the study at one charter elementary school. The school was located in a low-income neighborhood with a majority of African-American students. If the study included other charter schools in the area there may have been a greater amount of diversity in the teachers, students, and technology resources. Consequently, because the study was conducted at one location, the results may not be generalizable.

A second limitation of the study was the type of data collected. In the first phase of the study, the researcher collected data using a survey with a limited number of participants. The second phase of the study used data from interviews and observations. The researcher's presence during observation may have had an influence on teachers' instructional practices and use of technology.

A third limitation of the study was the timeframe for data collection. First, due to state mandated testing, observations and interviews occurred within the last four weeks of the school year after student had completed state mandated testing. As such, the researcher had a difficult time obtaining a larger number of participants for observations. The first phase of the study involved nine teachers, and the second phase of the study included only two experienced teachers. Although, a multiple case study does not require a specific number of participants, the intent of the study was to gain a broader perspective across multiple cases. Second, the timeframe limited the number of observations and interviews the researcher was able to conduct. Conducting additional observations may have enriched the results of the study to show more uses of technology integration knowledge in practice. Also, due to the timeframe of observations and interviews, both teachers may not have conducted typical lessons plans. For example, one of the teachers conducted lessons to prepare her students for the next grade level.

Another limitation of the study was the fact that the researcher was familiar with the teachers and had worked with them as part of a prior professional development initiative. In addition, the researcher believes that technology should be integrated in the learning environment in ways that enhance the learning experience. The researcher's

experience and belief may have led to bias during the interview process and in interpreting the findings of the study. However, the researcher made every effort to present adequate evidence, based on the data, to support the findings of the study.

Validation Strategies

Creswell (2007), described eight frequently reported validation strategies used in qualitative research including: prolonged engagement in the field, triangulation, peer review or debriefing, negative case analysis, clarifying research bias, member checking, rich, thick description, and external audits. He recommended using at least two of the strategies. For the purposes of the proposed study, the researcher used various validation strategies throughout the study including the following: (a) rich, thick description of the case; (b) member checks; (c) triangulation; and (d) clarification of researcher bias through a statement of positionality. Member checking helps to validate the creditability of the researcher's findings or interpretations by asking the participants to give their views. After observing participants, the researcher consulted with participants to discuss the accuracy of the data. A rich, thick description allows readers to determine if the findings may apply in other settings. By interviewing administrators, the researcher provided a more detailed description of the setting. Triangulation is the use of "multiple data-collection methods, multiple sources, multiple investigators and/or multiple theoretical perspectives" (Glesne, 2006, p. 37). The researcher accomplished, multiple data-collections using (a) interviews with teachers, (b) document reviews, (c) observations, and (d) interviews with school administrators. In addition, internal validity

can be established by clarifying the bias the researcher brings to the study (Creswell, 2007). Glesne defined clarification of researcher bias as "reflection upon your own subjectivity and how you will use and monitor it in your research" (p. 37). To accomplish the verification process, the researcher created a positionality statement.

Positionality Statement

As a researcher, I am interested in understanding the factors that influence student-centered technology use to develop strategies and processes for professional development and maximize student learning. In my educational background, I have had personal experiences of both effective and ineffectual uses of technology. As an instructional designer, I have been taught and have had experience designing instruction to facilitate the learning processes, which has included the use of technology. My work has been facilitated by knowledge of how and why people learn (learning theories) as well as how to stimulate or otherwise facilitate learning (instructional theories). The fact that I am able to use previous knowledge to apply specific theories and use technology when appropriate, as well as determine when they are appropriate, affect how I view the role of instruction in teaching. The experiences described may contribute to a kind of bias.

Additionally, in the future, I will likely be involved in educating pre-service and in-service teachers and, as such, have an especially keen need to understand the subject. Specifically, I am interested in how technology can be used as a pedagogical tool to

increase student achievement and what common factors contribute to the success or failure of technology use during classroom instruction.

I was led to the current research effort through participation as a member of the University of Central Florida's Center for Research and Education in Arts, Technology, and Entertainment's (CREATE) team. During the 2011-12 school year, teachers and faculty at Carter Charter School partnered with CREATE to help teachers discover how to establish a project-centered learning environment and to integrate technology, the computer, and web-based tools such as Web 2.0 into teaching and learning. As a member of the team, I visited the school to learn about what technology resources were available and conducted short interviews to identify the teachers' current use of technology, professional development practices, and demographic information. The information gained was used to specify the learning goals, specify the subject matter (content and tools), and select resources to support instruction, design learning activities, and develop the materials for the workshop. Each member of the team, including the researcher, helped to facilitate discussion and activities. The meetings consisted of the following: discussion on the usefulness of project-centered instruction in education; exploration of technology tools and resources that teachers could use to create lesson plans, classroom management with technology, and introduction of instructional materials that teachers can use to develop their own project-centered learning activities for classroom use. An evaluation of the professional development workshop was conducted at the end of the year, through an informal focus group. The purpose was to determine the impact of UCF/CREATE's partnership on teacher knowledge and perceptions related to technology

integration in the classroom as well as teachers' intentions to use the technology tools presented during the workshop in their school and classrooms. Having played a key role in planning and creating the professional development workshop, and interacting with the participants, I was interested in evaluating teachers' use of technology and investigating the factors that constrained or supported such use. As a researcher, I was particularly interested in teachers' descriptions of their experiences using the technology to support student-centered instruction.

Ethical Considerations

All research involving human participants conducted through the University Of Central Florida (UCF) requires review and approval through the Institutional Review Board (IRB). To meet IRB approval the researcher created and followed a Human Research Protocol (HRP) that describes each of the research steps.

Summary

In the present chapter the researcher provided a detailed account of the methods and procedures for the study including: (a) the setting and population, (b) research design and (c) instruments, (d) procedures, (e) data analysis (f) validation strategies, and (g) ethical considerations. Overall, the study was a multiple case study conducted to explore how practicing elementary teachers' perceived technological pedagogical content knowledge and how they used technology integration knowledge in their instructional practices in one charter school. In addition, the study highlighted the contextual factors

that influenced the practicing elementary teachers' ability to apply their technology integration knowledge.

CHAPTER 4
ANALYSIS OF THE DATA

Introduction

The subsequent chapter presents a summary of the analysis of the data collected from surveys, observations, interviews, field notes, and artifacts. The purpose of the qualitative multiple case study was to (a) explore practicing elementary teachers' perceived technological pedagogical content knowledge, (b) investigate how teachers demonstrate technology integration knowledge (TK, TCK, TPK, and TPACK) in their instructional practice, and (c) identify contextual factors that influence teachers' ability to apply their technology integration knowledge (TK, TCK, TPK, and TPACK). The study took place over four weeks between May 10, 2013 and June 8, 2013. Nine participants took part in the first phase of the study. Four participants, two teachers and two administrators, participated in the second phase of the study. Although, three teachers volunteered to participate in the second phase of the study, only two met the criteria; the third possible contributor did not use technology on a regular basis. Thus, the second phase of the study was limited to the two teachers and two administrators.

The present chapter is organized in two sections and contains reports on Phases I and II of the research. The first section contains a description of the school setting and the participants followed by results from the survey of teachers' self-reported levels of technological pedagogical content knowledge, and lastly a description of the context from the school administration. Combined, the aforementioned descriptions and survey results form the core response to Research Question 1 and a portion of Research Question 3. In

the chapter's second section, the findings from the within-case and cross-case analyses of the separate cases of two individual experienced teachers at an elementary charter school are detailed. The aforementioned information will inform the core response to Research Questions 2 and 3. Following are the three research questions which guided the study:

1. What is the technological pedagogical content knowledge of practicing elementary teachers in an urban charter school setting?
2. How do practicing elementary teachers in an urban charter school setting apply their technology integration knowledge (TK, TCK, TPK, and TPACK) in their instructional practices?
3. What contextual factors do practicing elementary teachers identify as influencing their ability to apply technology integration knowledge (TK, TCK, TPK, and TPACK) in the context of an urban charter school?

Phase I

In Phase I of the study, survey data were used to garner demographics and describe participants' perceived levels of leadership, technology knowledge, and peer support, in addition to teachers' self-reports of TPACK. The researcher calculated a mean score for each participant for each of the variables.

The School Setting and Participants

To maintain confidentiality of information, the researcher assigned a pseudonym to each of the participants and the school setting used in the study. The school setting

rested in the southeastern region of the United States, in a central Florida school district. Carter Charter School (pseudonym), named after a prominent African-American official, was a small, local public, charter elementary school, the only urban charter school located in ABC (pseudonym) school district. Although a public charter school, self-managed and independent of the local sponsoring school district, it had to meet the academic accountability standards set by the local sponsoring school district. Any interested student eligible to attend public school in the school district was also eligible to apply to attend Carter Charter School.

After much controversy, Carter opened its doors in 2000 to provide a neighborhood school for the surrounding community. In 2012, now in its 13th year of operation, the school served mainly students living in the neighboring area. The school had a total enrollment of 131 students in PreK-5. PK-3 classes averaged 18 students per class; grades 4 and 5 experienced mean class sizes of 20 students. African-Americans accounted for 99% of the student population with nearly 98% living at or below the poverty line and eligible to receive free/reduced lunch. Of the student population, 9% were students with disabilities (SWD), and 8% of the students were gifted. No students in the school were classified as English Language Learners (ELL). During its first year of corrective action (2011-12), Carter moved from an F grade to an A grade for the 2012-2013 school year.

The primary strategies of the school included: (a) adoption and highlight of "health and wellness" as the primary curriculum focus; (b) commitment to creating a setting in which students develop higher-order thinking skills using problem solving and

critical thinking activities; and (c) support of technology as a core feature of the school's integrated health and wellness curriculum (Carter School, n. d.).

According to the school's website, one of goals for the use of technology is to, "produce "techno-literate" children who will incorporate the new technology learned in school into their daily living patterns" (Carter School, n.d.). Furthermore, the school's improvement plan includes implementation of the International Society for Technology in Education (ISTE) standards (2008) as a professional development strategy for reading through a professional learning community (PLC). As such, there was a strong commitment by the school leadership for teachers to use project-centered instruction and technology in their pedagogical practices to enrich student learning and motivation.

At the time of the study, Carter Charter School had nine teachers. Teachers certified through the state of Florida Department of Education taught all classes, and 78% had advanced degrees. The focus at the school was on professional learning by analyzing student achievement through data. The principal made frequent and consistent visits to each classroom to conduct classroom observations and reviewed teachers' lesson plans on a weekly basis. Feedback based on information gathered from the observations was provided to teachers to help improve instructional practice and student performance. The information gathered helped shape professional development methodology. Additionally, the school collaborated with a local university to support its professional learning community and to learn ways in which to enhance teachers' knowledge of new technologies, technology integration skills, and instructional practices.

The school had a number of technological resources. A computer laboratory with new technology consisting of 25 Dell computers and five Apple computers were donated to the school in 2010. Teachers made reservations to use the shared computer laboratory. Each classroom had four Dell desktop computers for students' use and one desktop for the teacher's use, along with a document camera (ELMO) and projector. In addition, the school had a portable cart that held 24 netbooks, three tablets, and 6 Kindle Fire E-readers. Other technological resources at the school included an interactive white board, personal response system/clicker technology, digital video cameras, MP3 players, digital pens, and web cameras. A local cable company provided the school with free high-speed internet service. The school had a contract with a technology consultant to help in maintaining and updating hardware.

Every year the Florida Department of Education requests principals and technology coordinators from every public school district to provide information, through the online Florida Innovates Technology Survey, about how teachers and students use technology throughout their school. Data for Carter Charter School revealed that students used drill and practice software, research/reference tools, and integrated learning system programs several times a week. The data also indicated that the majority of teachers regularly used technology for administrative tasks, email, analysis of student assessment information, and conferencing. The survey found perceived funding constraints to be the primary barrier to using digital instructional materials at the school.

Population and Sample

All nine teachers at Carter Charter School participated in the first phase of the study. Each of the teachers completed the Teachers' Knowledge of Teaching and Technology Survey. Table 4 provides a summary of the demographic data for the nine participating teachers, including gender, race, teaching experience (in years), highest level of education, type of degree held, and hours of professional development that targeted technology use. Teachers from grade levels PreK-5, as well as the school's Science, Technology, Engineering, and Math (STEM) teacher and Health and Wellness teacher, were surveyed. Of the teachers participating, all nine were female. Seven participants had earned a master's degree. Two teachers had earned a bachelor's degree and were enrolled in a master's degree program. Teachers who had master's degrees reported they specialized in the following areas: education leadership (2), administration and leadership, elementary education (3), special education, early childhood education.

Five participants were African-American/black, and four participants were Caucasian/white. Teaching experience ranged from five years to over 10 years. Five teachers had received National Professional Board Certification. Most of the teachers reported having participating in technology-related professional development training, ranging from no training to 30 hours. Table 4 displays the demographic, professional and personal characteristics of the participating teachers.

Table 4

Personal and Professional Characteristics of Participants

Characteristics	Frequency	Percentage
Gender		
Male	0	--
Female	9	100.0
Race		
Caucasian/White	4	44.4
African-American/Black	5	55.6
Hispanic/Latin	0	--
Native American	0	--
Asian	0	--
Pacific Islander	0	--
Arab or Other	0	--
Years of Teaching Experience		--
1 to 5 years	2	22.2
6 to 10 years	3	33.3
10 or more years	4	44.4
National Professional Board Certified		
Yes	5	55.6
No	4	44.4
Highest Level of Education		
Bachelors	2	22.2
Masters	7	77.8
Doctorate	0	--
Hours of Professional Development		
0 hours	3	33.3
1 to 5 hours	4	44.4
6 to 10 hours	1	11.1
11 to 15 hours	0	--
16 to 20 hours	0	--
21 to 25 hours	0	--
25 or more	1	11.1

In addition to providing demographic information, the questionnaire asked teachers to select their perceived levels (strong, moderate, low) of leadership, technology, and peer-support for technology use at their school. Table 5 shows the frequencies and percentages of teachers' perceptions in each area. As shown in Table 5, six of the teachers (66.7%) reported that the level of leadership support at the school was moderate. Six of the teachers (66.7%) reported that the level of technology support at the school was strong. Five of the teachers reported that the level of peer support was moderate (55.6), and three teachers reported that peer support was strong (33.3%).

Table 5

Teachers' Perceptions of Support

Characteristics	Frequency	Percentage
Leadership		
Strong	1	11.1
Moderate	6	66.7
Low	2	22.2
Technology		
Strong	6	66.7
Moderate	3	33.3
Low	0	0
Peer Support		
Strong	3	33.3
Moderate	5	55.6
Low	1	11.1

Teachers' Knowledge of Teaching and Technology

The first research question was used to investigate teachers' self-reported technological pedagogical content knowledge. The researcher asked participants to self-evaluate the extent to which they agreed or disagreed with statements in relation to their knowledge of each of the seven subscales of TPACK. For each subscale of TPACK, the researcher analyzed responses to the Teachers' Knowledge of Teaching and Technology Survey to gain insight into the first research question. The instrument contained 46 items teachers' self-assessments of the seven TPACK domains: 6 TK items, 12 CK items, 7 PK items, 4 PCK items, 4 TCK items, 9 TPK items, and 4 TPACK items. Each item response value was scored based on the following five-point Likert scale where 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. For each construct, the researcher averaged each participant's response. For example, the questions under TPK (technological pedagogical knowledge) were averaged to produce one TPK score. Table 6 shows the mean score for each subscale of TPACK from the Teachers' Knowledge of Teaching and Technology Survey for each participant.

Table 6

Mean Scores for Teachers' Knowledge of Teaching and Technology

Teachers	TK	CK	PK	PCK	TCK	TPK	TPACK
1	4.14	4.92	4.86	5.00	4.00	4.63	5.00
2	4.29	4.33	5.00	3.75	4.00	3.88	4.00
3	3.71	3.92	4.71	4.00	3.75	3.88	4.00
4	4.43	4.08	4.83	4.00	4.00	3.63	4.00
5	3.57	3.5	3.86	3.25	3.00	3.5	2.75
6	3.86	4.00	4.00	3.25	3.25	4.00	3.25
7	3.29	4.50	4.86	4.25	3.00	2.75	3.00
8	3.29	4.33	4.86	4.75	4.00	4.63	4.50
9	2.43	4.00	4.86	4.50	4.00	2.75	2.00

Note. TK= Technological Knowledge, CK = content knowledge, PK = pedagogical knowledge, PCK = pedagogical content knowledge, TCK = technological content knowledge, TPK = technological pedagogical knowledge, TPACK = technological pedagogical content knowledge.

In addition, the researcher calculated a mean score and the standard deviation for each component of TPACK. Table 7 shows the mean score, range, and the standard deviation for each component of TPACK.

Table 7

Mean Scores for Technological Pedagogical Content Knowledge (TPACK) Components

Components	N	Minimum	Maximum	Mean	Standard Deviation
TK	9	2.43	4.43	3.67	0.62
CK	9	3.50	4.92	4.18	0.40
PK	9	3.86	5.00	4.65	0.42
PCK	9	3.25	5.00	4.08	0.61
TCK	9	3.00	4.00	3.67	0.45
TPK	9	2.75	4.63	3.75	0.68
TPACK	9	2.00	5.00	3.61	0.94
Valid N (listwise)	9				

As shown in Table 7, the mean scores for each of the components were as follows: technology knowledge (Mean = 3.67, SD = .62), content knowledge (Mean = 4.18, SD = .40), pedagogical knowledge (Mean = 4.65, SD = .42), pedagogical content knowledge (Mean = 4.08, SD = .61), technological content knowledge (Mean = 3.67, SD = .45), technological pedagogical knowledge (Mean = 3.74, SD = .68), and technological pedagogical content knowledge (Mean = 3.6, SD = .94). The results for PK, CK, and PCK were at the high end of the scale, and PK was the highest knowledge component reported, indicating that the teachers mostly agreed with statements related to pedagogical knowledge, content knowledge, and pedagogical content knowledge. In other words, the teachers in the current study believed that they had a solid knowledge of the topics and/or subjects that their students needed to attain (CK), how to use instructional approaches and strategies (PK), and how to use content and instructional strategies to meet the needs of their students (PCK). In contrast, the results for TPK,

TCK, TK, and TPACK were somewhere in the middle of the scale. This finding indicated that the participants neither agreed nor disagreed with their knowledge of how to use different technologies (TK), how to use technology to transform or represent the content, how to use technology with their instructional strategies, and/or how to use technology with teaching and learning to help students understand the content.

Phase II: Within-case Analysis

The current section presents the qualitative results of the analyses performed to answer Research Questions 2 and 3. The second question investigated how practicing elementary teachers in an urban charter school setting applied their technology integration knowledge in their instructional practices, focusing on the technology (TK, TCK, TPK, and TPACK) subcomponents in the TPACK model. The third research question, investigated the influence of contextual factors. The processes of analyzing and coding the qualitative data were described in Chapter 3.

The present section contains case reports that provide a brief background and description for each of the individual cases (participants), a description and discussion of their written lesson plans and details and discussion of their actual implementation of the lessons. Contextual factors are highlighted throughout each of the case reports. Examples, quotations and interpretations are provided for support. The examples of each lesson provide support for the teachers having applied their knowledge in practice.

An analysis was performed for both teachers' technology integration knowledge practices and contextual factors that influenced their use. The written lesson plans and

interview protocols served as instruments to gather insight into each teacher's instructional planning and her understanding of content, pedagogy, and technology. The classroom observations provided a lens for extracting each teacher's actual instructional practices in terms of content, pedagogy, technology, and context. Data from the written lesson plans, interviews, and observations were used to analyze how teachers' technology integration was reflected in their actual practices.

The Case of Mrs. Brownstone

The following case report provides a brief summary of Mrs. Brownstone's (pseudonym) background, classroom context, discussion of her written lesson plans, and actual implementation of the lessons. Contextual factors are reported throughout the case report.

Mrs. Brownstone taught second grade at Carter Charter School. She was an African American female with a bachelor's degree in education, currently working on a master of education degree in urban education. She had taught elementary school for 12 years. Based on results from the survey, she perceived her TPACK as follows: technology knowledge (Mean = 4.43), content knowledge (Mean = 4.08), pedagogical knowledge (Mean = 4.83), pedagogical content knowledge (Mean = 4.00), technological content knowledge (Mean = 4.00), technological pedagogical knowledge (Mean = 3.63), and technological pedagogical content knowledge (Mean = 4.00). Of all of the participants, she had the highest mean score for technology knowledge (TK). Only one of her mean scores for one of the components, technological pedagogical knowledge

(3.63), was slightly below the mean for the group (3.74). Mrs. Brownstone described the level of support for technology as strong, and the level of leadership and peer support as moderate.

Mrs. Brownstone reported that she used technology consistently throughout most of her lessons in mathematics. In her classroom, she had access to five desktop computers for student use and one computer for teacher use, a LCD projector, and a document camera. In addition, she was also one of three teachers at the school that received an iPad to use in the classroom. Beyond the classroom, she could sign up her class to use the computers and equipment in the computer laboratory and portable laptop cart.

Plan for TPACK.

Mrs. Brownstone was the first teacher to respond to the researcher's invitation to participate in the second phase of the study. During the initial interview, Mrs. Brownstone provided a copy of two step-up lesson plans for mathematics. One lesson covered multi-step subtraction and the other lesson was on division. Both lessons were intended to familiarize students with mathematical concepts that they would need while progressing through third grade. Each written lesson plan included the lesson components, resources, and timing for each component of the lesson, instructional strategies, and daily activities. Resources included digital and non-digital technologies such as YouTube videos, desktop computers, software, interactive whiteboard, i.e., Promethean Board, websites, manipulatives e.g., blocks, and worksheets. In addition,

each lesson plan provided the related state standards and learning goals for mathematics. Mrs. Brownstone included guided, independent, and small group instruction in her lesson plans. Activities incorporated, primarily, teacher-directed and some hands-on guided practice. Finally, the lesson plans built-in student assessment strategies.

The written lesson plans provided a detailed record to which the researcher could refer during observations and data analysis. As the researcher reviewed the lesson plans, she used the interview protocol to gain an understanding of the documents as they related to Mrs. Brownstone's intended use.

Lesson 1. The first lesson plan that Mrs. Brownstone described focused on students learning basic division. She described the lesson, primarily, in terms of the content, instructional strategies, and how technology was integrated. Mrs. Brownstone began by explaining how the content included in the lesson plan related to the state benchmarks for third-grade mathematics. The information was also incorporated into the lesson plans she provided. The strategies Mrs. Brownstone described indicated that she had a solid grasp of the content and curriculum, as she had taught it in previous years. She stressed the importance of students understanding the meaning of division and the process for doing division (sharing in equal groups). She indicated that based on pre- and post-test results, her students struggled to arrive at a thorough understanding of the concept of division.

Mrs. Brownstone's teaching approach for the lesson was teacher-directed; her descriptions of the activities used in the division lesson suggested continual, direct student instruction. Because division was a new concept, she chose her teaching

approach based on the level of her students' knowledge. After reviewing, pre- and post-test results, Mrs. Brownstone adjusted her instructional strategies to accommodate her students' level of understanding of the content. Mrs. Brownstone emphasized that she wanted to spend significant time giving explicit instructions, followed by guiding students though hands-on activities, and allowing them to use manipulatives to gain a conceptual understanding of the process. Mrs. Brownstone stated, "I want students to know what 'I am doing division' means."

Mrs. Brownstone decided to include digital and non-digital technologies, including videos, music, and manipulatives, to help students develop an understanding of the concept. She used a mathematics song to help engage students and help them recall information. She noted several times that the music helped students learn the content even when they were not mindful of it. Engaging music and videos, according to Mrs. Brownstone, "helps students to retain the content." She integrated a content-related video from Teacher Tube in the lesson to explain and reinforce the concept of division as well as demonstrate the process of division. She chose the video because she believed that using the same video several times throughout the lesson would reinforce the concept of division and help students retain the content. In addition, she highlighted the importance of using a video to meet the needs of children with different modality strengths, especially to assist students who were visual learners. She explained that the video helped her visual learners stay engaged and focused on learning the content. Overall, Mrs. Brownstone emphasized "lack of resources" as an overarching challenge to incorporating more technologies into her lesson. Although, she indicated she would like

to see her students engage in independent practice and interactive activities with technology more often, Mrs. Brownstone explained she designed the lesson based on the limited technology at the school. She wanted to provide students with an opportunity to touch the interactive whiteboard, to engage and motivate her students. Instead, she included the use of manipulatives in her lesson plan to provide students with hands-on division practice.

Lesson 2. The second lesson plan that Mrs. Brownstone described focused on students learning multi-digit subtraction with and without regrouping. She, again, described how the content, teaching practices, and technology she used in her lesson plan supported her instructional practices. Mrs. Brownstone began by providing the learning goal for the lesson, which was also included in the written lesson plan.

Similar to her first lesson plan, her approach for the current lesson was also teacher-directed. The explanations of her instructional strategies focused on her directing students, providing a structure for students to follow, and guiding students through the process in a logical order. Mrs. Brownstone explained that as she designed her lesson plan she divided each step for multi-digit subtraction into small parts to teach individually. She indicated that she began the lesson with a review of two-digit addition to build on students' prior knowledge. She wanted students to understand that the process for multi-digit subtraction was similar to two-digit addition.

The lesson plan that Mrs. Brownstone designed included the use of digital and non-digital technologies. Mrs. Brownstone intended to use technology for several reasons including enhancing students' understanding of multi-digit subtraction,

explaining the subject matter, and motivating students. When she planned the lesson, she decided to use non-digital technology, e.g. a place-value chart, as an instructional strategy she could use to model and explain how to set up a multi-digit subtraction problem. She also included a video that she found on Teacher Tube. Mrs. Brownstone explained that the instructor in the video also explained how to set up and solve two-digit subtraction problems. She noted that she based her decision to include a video on the learning goals for the lesson. She explained,

> When I pick my videos, they are not random videos, they are specific to the learning goal that is being taught that day, exactly what I want the students to be able to learn. So, it wasn't just a random subtraction video. It's to really point out the goal for that specific day.

In addition, Mrs. Brownstone emphasized that the videos gave students further explanations and, in some cases, the instructor in the video used different strategies to teach the concept. She believed that it helped to have another teacher explain the concept to strengthen students' conceptual understanding of the subject. In addition to the videos, Mrs. Brownstone intended to use the interactive whiteboard for part of the lesson. She planned to use the interactive whiteboard to model the procedure of multi-digit subtraction and have students interact using the pens.

Mrs. Brownstone explained that her use of technology in the lesson was as a tool to increase her students' academic motivation. She suggested that her students seemed more engaged when her lessons included the use of technology. In addition, she suggested that technology allowed students to practice the concepts independently.

Although she would like to see her students use technology for independent practice, she indicated that many of her students did not have computers in their homes. As a result, she did not assign homework that required students to use technology to learn content. In addition, she indicated that with only five computers in the classroom, it was a struggle for her to allow all 20 of her students the time to use the computer every day. The scenario limited her students to computer access only once a week. Mrs. Brownstone stated, "I try to rotate . . . a group each day but still it's only once a week they are getting to go on the computer. . . I have to really design my lesson keeping those limitations in mind."

The descriptions of the written lesson plans provided insight into Mrs. Brownstone's perceived teaching practices and knowledge of content, pedagogy, and technology prior to classroom observations. The initial interviews assisted the researcher in understanding how she used her technology integration knowledge in practice.

Lesson Plan Implementation.

After concluding the interview and thanking her for her time and volunteering to participate, the researcher worked with Mrs. Brownstone in planning days for classroom observations. Mrs. Brownstone indicated that the upcoming week would work best. Mrs. Brownstone arranged her classroom schedule in individual periods dedicated to different subjects or activities. She indicated that she used technology the most during her mathematics lessons, and it would be ideal for the researcher to observe during the one-hour mathematics block. Observations took place during the week of May 13. The

researcher observed her instructional practice during the scheduled 60-minute period for mathematics, conducting four observations, three of which took place in the classroom and one in the computer laboratory. Mrs. Brownstone's lesson occurred on consecutive days while she was teaching two different step-up lessons, one on division and the other on multi-digit subtraction. The first and second observations were a continuation of the division discussed in the initial interview. The third and fourth observations were of multi-digit lessons. During each observation, the researcher noted the learning objectives for each lesson, instructional strategies, and digital and non-digital technologies. In addition, the researcher recorded how and why the particular technologies used in the lesson "fit" the instructional strategies and content of the lesson. Mrs. Brownstone provided further clarification on the implemented lesson in follow-up interviews.

Classroom Context.

Mrs. Brownstone had the largest class in the school. Her classroom was spacious, with blue and yellow walls covered with pictures, charts, class schedule, and student artwork. She organized the shelves of books and learning materials around the classroom. In addition, she posted the learning goals and objectives on the whiteboard so that students knew what to expect as well as what the teacher expected of them. There were four to five student desks arranged so that students could sit next to and across from each other in groups. According to Mrs. Brownstone, students sat together in cooperative learning groups based on who functioned well together socially. In one of the corners of the classroom, there was a small quiet area, which Mrs. Brownstone referred to as the

"safe place." The safe place was an area where students could go to be by themselves. A whiteboard was in front of the classroom. In front of the whiteboard, Mrs. Brownstone had a cart with a laptop and projector. In the back of the room, there were five student computers facing the center of the room.

The researcher arrived at Mrs. Brownstone's classroom at the start of each school day to set up the video equipment. Each morning, students dressed in their school uniforms, entered the classroom. Mrs. Brownstone and the teacher assistant, Mrs. Day (pseudonym), greeted them as they went to their seats. After getting situated and writing in their journals, students recited the Pledge of Allegiance and the Carter Student Creed. Shortly after, Mrs. Brownstone had students gather in the front of the room for the morning meeting in which she led students through a practiced routine and short activity. After the morning meeting, Mrs. Brownstone used the "Cast-a-Spell" time to have students finish the next round of a spelling bee competition. Following the spelling bee, Mrs. Brownstone began her math instruction. She primarily taught in front of the classroom, although she would step back at times and walk around the classroom during student activities. The teacher assistant, Mrs. Day, helped during student activities. On some days, a volunteer grandmother was present to help with small tasks such as sharpening pencils and filing papers.

Mrs. Brownstone: Lesson 1.

The first lesson the researcher observed Mrs. Brownstone teaching was the lesson on division. Mrs. Brownstone had introduced the concept of division in the previous

week. The researcher observed a continuance of the lesson over a period of two days. During observations, the researcher recorded the curriculum goals, instructional strategies, and digital and non-digital technologies for each lesson using the Technology Integration Observation Instrument (TIOI). In addition, the researcher wrote field notes regarding contextual factors in the classroom.

On the first day, Mrs. Brownstone began the lesson by engaging students in a whole group instructional setting. To spark student interest, she began with a review of multiplication, using a hip-hop multiplication song played from her iPad. As the song played, students danced and sang along to the music. Mrs. Brownstone put the music on pause several times and asked students to solve a multiplication problem that played in the song. After allowing students to answer, she reminded them that they must listen to the song to help them store the information in their memory. Mrs. Brownstone used music as a strategy to spark students' interest in multiplication. The aforementioned strategy was consistent with what she described in her written instructional plan. Mrs. Brownstone explained that she used the music to engage students and reinforce student learning of multiplication. The former comment illustrated Mrs. Brownstone's knowledge of technology, pedagogy, and content, which represented her *technological pedagogical content knowledge*. She demonstrated knowledge of the general pedagogical goals and content-specific goals for utilizing technology in the activity. In the example, she demonstrated knowledge of the use of song to transform and represent the concept of multiplication to facilitate recall of multiplication problems and improve content understanding. Instead of using a lecture to represent multiplication, music

provided an innovative approach to represent multiplication. In addition, Mrs. Brownstone also recognized that the songs sparked students' interest in multiplication and used it as a motivational strategy, which illustrated her *technological pedagogical knowledge*. Her consideration to use music was independent of the content. Further, Mrs. Brownstone's ability to find and selects songs on YouTube and play them using an iPad illustrated how she used her *technological knowledge.*

After the warm-up, Mrs. Brownstone explained the purpose of the lesson to the class. To connect the forthcoming lesson with the previous day's lesson, she prompted students to repeat the concept of division. As she spoke, Mrs. Brownstone used her arms to make a visual representation of the division sign. The following excerpt is representative of the dialogue:

> Mrs. Brownstone: When we talk about division, everybody say the word division.
>
> Students: Division.
>
> Mrs. Brownstone: The basic part of division, when we are dividing we are sharing off. I want everybody to say it, when we are dividing. . . .
>
> Students: When we are dividing, we are sharing off.

The excerpt shows she was able to use her *pedagogical knowledge* to build a meaningful connection to introduce the lesson.

The goal of the first activity was to prepare students to do basic division without any help. Mrs. Brownstone used a direct instruction strategy to explain the meaning of division. She began by modeling how to work a division problem on the whiteboard.

Mrs. Brownstone thought aloud as she worked through the problem. To begin, she recapped an example discussed the previous day. Mrs. Brownstone wrote the example, 12 ÷ 3, on the whiteboard. She took out 12 "apples," i.e., manipulatives, and modeled the process by sharing the apples among three students at their desks. She distributed all of the apples one by one. Once, she distributed all of the apples to each student, Mrs. Brownstone asked each student to share with the rest of the class the number of apples they received. Each student responded four. She then prompted all of the students in the class to solve the problem. Figure 4 provides an illustration of the apple activity.

Figure 4. Brownstone Lesson 1: Apple Activity

The use of manipulatives to represent and model the concept of sharing or distributing in division was an indication of how Mrs. Brownstone used *pedagogical*

content knowledge. Although, Mrs. Brownstone used non-digital technology, the instructional tools, i.e., manipulatives and whiteboard, in the activity, were appropriate to represent the topic.

Reflecting on the activity, Mrs. Brownstone explained in her initial interview and again in the follow up interview that she would have preferred to use the Promethean Board so that students could actually see the manipulatives or objects move and interact with the technology. Mrs. Brownstone seemed very familiar with the software for the Promethean Board, i.e., interactive whiteboard technology, and how to operate and apply it, which represents her *technological knowledge*. She explained that she believed students needed to see the manipulatives moved around to understand the concept of distributing, which she could have done with the Promethean Board. In addition, she explained she would have liked to use the active expression equipment, i.e., student response system, to give students a chance to interact with the lesson. Not having the Promethean Board in her classroom influenced her decision not to use it for the activity. Mrs. Brownstone's knowledge of how to operate the Promethean Board's software represented her *technological knowledge*. Mrs. Brownstone's knowledge of how the use of the Promethean board objects to support the content-specific activity and representations represented her *technological pedagogical content knowledge*. In the example, the Promethean board objects facilitated the representation of sharing in basic division. Mrs. Brownstone believed that using the technology would allow students to interact using the objects to develop their knowledge. Her knowledge of how to use

technology to increase student interaction represented her *technological pedagogical knowledge.*

To wrap up the activity, Mrs. Brownstone checked for understanding by polling students to check their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not understand, 2 = I understand some, but have some questions, 3 = I understand, and can do it by myself, 4 = I understand and can help a friend. The majority of students responded by showing four fingers; however, a couple of students raised one or two fingers. Using her *pedagogical knowledge*, Mrs. Brownstone praised students who raised their fingers showing that they were not at a level four. Giving praise to students encouraged and motivated them to share their misconceptions. She stated, "I really would like to see when people show me that they are at a 1. That tells me. . . you know I need some help, Mrs. Brownstone, I still can't get this." She then gave a student an opportunity to explain what he did not understand. Clearing up the misconception, she explained the relationship between the process of subtraction to division and the process of multiplication to division. She also demonstrated the procedure to students and provided additional clarification. Mrs. Brownstone's use of formative assessments here and throughout the lesson was evidence of how she used her *pedagogical knowledge*. She used the assessment method to examine student understanding throughout the lesson. Checking for understanding allowed her to determine if students were mastering the learning objectives and to adjust her instructional strategies when students did not understand. In the example, she used

her *pedagogical content knowledge* as she employed an alternative strategy to improve the students' understanding of division.

Continuing on, Mrs. Brownstone engaged students in a whole group instructional setting. She expanded on the previous example and discussed how students could use models to solve division problems. As Mrs. Brownstone talked, she connected her iPad to the projector. She projected a new example of a division problem that she had created using PowerPoint. As she "walked" students through the example, she engaged them by asking questions throughout the presentation. In her follow up interview, Mrs. Brownstone explained that she had anticipated that some students would have questions on that part of the lesson. Based on pre- and posttest results taken the prior week, she found that students did not understand the concept of how to distribute evenly. She created the PowerPoint so students could visually see how to distribute and to clear up misconceptions. The demonstration indicated how Mrs. Brownstone used her knowledge of her students and their needs to develop instruction. In the activity, Mrs. Brownstone's use of technology, pedagogy, and content knowledge, illustrated her *technological pedagogical content knowledge*. In the example, Mrs. Brownstone believed students needed a visual representation of how to distribute, which she represented using PowerPoint to model a new problem. Her use of modeling was the pedagogical strategy, but the division problems were the visual representations of the topic. In addition, she used her *technological pedagogical content knowledge* in the activity to correct misconceptions and improve content understanding.

For the next activity, Mrs. Brownstone allowed students to engage in independent practice using manipulatives to solve a division problem with a partner. Before starting the activity, she provided guided practice. Mrs. Brownstone hooked up the document camera and projected a worksheet. Pointing to the worksheet, she explained to the class that when they did division in third grade they would see it as a word problem, resembling the one on the screen. Mrs. Brownstone then explained that they were going to start out by dividing into equal groups. Next, she used an example to model what students needed to do for individual practice. For her example, she told students that she had 14 "cookies" and 2 plates. Each plate had the same number of cookies. She asked, "How many cookies are on each plate?" She placed the 14 cookies, i.e., manipulatives, on the document camera and drew two plates on a piece of paper to project from the document camera. Moving on, she explained that she must distribute the cookies equally on the two plates. She then explained and wrote out what the expression and equation looked like. Then she placed the cookies, one by one, on the two plates, counting aloud, "1, 2, 3, 4, 5, 6, 7." Students counted along with her, "1, 2, 3, 4, 5, 6, 7." Mrs. Brownstone then explained that 14 divided by 2 equals 7. She verbalized, "I had14 cookies and I shared them up into two plates, each plate, there I put 7 cookies." Figure 5 illustrates the activity.

Figure 5. Brownstone Lesson 1: Cookie Activity

To wrap up the activity, Mrs. Brownstone polled students to check their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not understand, 2 = I understand some, but have some questions, 3 = I understand, and can do it by myself, 4 = I understand and can help a friend. The majority of students responded by raising four fingers. Mrs. Brownstone's knowledge of how to operate the document camera represented her *technological knowledge*. Mrs. Brownstone's knowledge of how the use of the document camera and manipulatives could support the content-specific activity represented her *technological pedagogical content knowledge*. In the example, the document camera and manipulatives facilitated the representation of sharing in basic division. Her use of modeling was the pedagogical strategy, and the document camera and manipulatives provided visual representations of the topic.

Moving on to the practice activity, Mrs. Brownstone asked students to work with a shoulder partner to practice the skill using a similar division problem for independent exercise. Within groups and using manipulatives, Mrs. Brownstone tasked students with making sense of the following problem: $12 \div 3$.

She told the class that they must distribute 12 "stickers" equally among three students. They were to find out how many stickers each student should receive. Mrs. Brownstone instructed students to use their dry markers to draw three circles on their dry erase boards to distribute the twelve stickers.

As students worked independently, Mrs. Brownstone and Mrs. Day walked around the classroom to provide guidance if needed and check for progress. After five minutes, Mrs. Brownstone asked a student to come to the front of the room and demonstrate what she had done by using the document camera. Figure 6 illustrates the students' work.

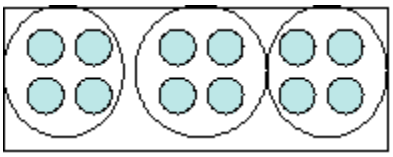


Figure 6. Brownstone, Lesson 1: Sticker Activity

After the student demonstrated and explained her work to the rest of the class, Mrs. Brownstone asked the whole class if the answer was correct. All of the students agreed that the answer was correct. In the activity, Mrs. Brownstone's used her knowledge of technology, pedagogy, and content knowledge, illustrating her

technological pedagogical content knowledge. She facilitated a student's use of the document camera to demonstrate how she had worked out the division problem. Facilitation was the pedagogical strategy and distribution in division was the topic-specific activity. The document camera facilitated the representation of dividing into equal groups. In addition, the document camera was used to provide a visual representation of the topic.

For the remainder of the period, Mrs. Brownstone had students work with their partners to complete the remainder of the problems on the worksheet, using the manipulatives to assist when needed. During our interview, Mrs. Brownstone explained that she would have liked to wrap up the lesson for the day using a video, but she did not have access to a laptop. She needed a laptop to play the video.

The next day, Mrs. Brownstone continued with the division lesson. At the beginning of the lesson, she wrote the learning goal and objectives on the whiteboard and connected the projector and iPad. Using her classroom management skills, she signaled to gain the classes' attention. She paused to capture some of the student's attention and then announced the learning goals to the class. She explained:

> Our learning for today, students, will understand basic division using models. By the time this lesson is finished, you should be at least at a 3 or 4 with your understanding of basic division. We are getting ready for third grade. . . this is a step-up lesson of what division is going to look like in third grade.

Mrs. Brownstones' connection of the learning goals with the third grade curriculum pointed to her expertise and comfort level with the subject matter and *content*

knowledge. At the beginning of the lesson, Mrs. Brownstone engaged students in a whole group instructional setting using a video to review the previous day's lesson on basic division. As she prepared the video, Mrs. Brownstone explained to the class that based on the pre/post test scores, some students still needed to have an in-depth understanding of basic division.

Using the iPad, Mrs. Brownstone projected the video on the screen. The video was an animated lesson from You Tube (http://www.youtube.com/watch?v=TScopM-a0b0**)** showing the steps in basic division process. As Mrs. Brownstone explained in her initial interview, she chose videos based on the learning goals for the lesson. Her knowledge of how the video supported the learning goal and selection of technology to support the learning goals represented her *technological content knowledge*. In addition, she used videos to spark student interest, which is an example of her use *of technological pedagogical knowledge*. Her use of videos in general was not related to the content. As the video played, the researcher observed that all of the students seemed attentive and engaged while watching the video. Throughout the video, Mrs. Brownstone paused several times to describe and discuss the concepts. In addition, she provided further explanation and extended the concepts related to the process of division. For example, she put the video on pause to make a gesture to depict the sign of division.

> She then asked all of the students to make the division sign. She explained: When you get to third grade we will refer to this as an operation, the operation sign is the same thing for division. If you hear the word, operation sign, it is referring to the operation sign for division. You will hear that phrase, the

operation sign for division or the operation sign for multiplication or the operation sign for subtraction or the operation sign for addition.

In the excerpt, Mrs. Brownstone used her *pedagogical content knowledge* to model the representation of a division sign visually. In addition, she was able to connect the topic to the third grade curriculum, thereby representing her *content knowledge*. As she indicated, she had taught the content in previous years. Mrs. Brownstone also took an opportunity to pause the video to check for understanding and provide feedback. To check for understanding, she paused several times to ask knowledge level questions to engage students and reinforce the concepts discussed in the video. She also provided time for students to ask questions. As students asked questions, she provided explanations to answer student questions and clear up any misconceptions. In addition, Mrs. Brownstone gave students an opportunity to come to the whiteboard to work out examples used in the video.

In our initial interview, she explained that she used the video to reinforce concepts as well as to enhance student comprehension of the material through visual representations. She elaborated in the follow-up interview that she wanted her students to have an in-depth understanding of the concept. She explained that some of her students were concerned with getting the right answer instead of focusing on comprehending the process involved to obtain the right answer. Mrs. Brownstone suggested that the video strengthened the students' understanding of how to share in equal groups. She believed having the visual representations of people and things helped with student's conceptual understanding versus procedural knowledge. She believed the strategy to use visual

representations were important, especially for her low performing students, to see the visual because division could be an abstract concept. In the activity, Mrs. Brownstone's use of technology, pedagogy, and content knowledge, illustrated her *technological pedagogical content knowledge*. In the example, Mrs. Brownstone believed students needed a visual representation of how to distribute, which she represented using a video. In addition, she used the technology as a pedagogical tool to help students develop an in-depth understanding of the concept, which also represented her *technological pedagogical content knowledge*.

For the next activity, continuing to engage students in a whole group instructional setting, Mrs. Brownstone explained to the class that they were going to review one of the word problems from the previous day. She projected a worksheet using the document camera and read the word problem aloud to the students. Again, demonstrating her classroom management skills, Mrs. Brownstone paused to direct students to pay attention and listen. After she had everyone's full attention, she demonstrated how to solve a problem on the worksheet. As she demonstrated, she used a think aloud technique as she worked through the problem using the document camera. The use of instructional strategies such as demonstrating, modeling skills, and modeling thinking revealed that Mrs. Brownstone was able to use her *technological pedagogical content knowledge* to improve students' content understanding and correct misconceptions. To wrap up the activity, Mrs. Brownstone polled students to check for their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not

understand, 2 = I understand some, but have some questions, 3 = I understand, and can do it by myself, and 4 = I understand and can help a friend.

For the next activity, Mrs. Brownstone informed students they would do a quick check to finish the rest of the problems on the worksheet. Mrs. Brownstone instructed the students to work independently using manipulatives, which she referred as "white chocolate." She tasked students to use the marker, glue, and construction paper on their desks to create a division expression. After writing a division expression, she tasked them with creating a model that reflected the expression. In our follow-up interview, Mrs. Brownstone expressed that if she had the technology, she would have facilitated students using an iPad to manipulate objects. The comment illustrated Mrs. Brownstone's knowledge of technology, content, and pedagogy, representing her *technological pedagogical content knowledge.* In the example, she demonstrated knowledge of the existence, components, and capabilities of the iPad as well as indicating how she may have changed her instruction by providing a visual representation using the technology. Her use of facilitation as a pedagogical strategy was specific to the topic, students practicing division with manipulatives.

Before allowing students to work on their own, Mrs. Brownstone gave a demonstration of how they were to complete the task. She shared a model that she created on the document camera using manipulatives. In her example, she used 12 divided by 3 as her expression. For her model of the division expression, she drew three circles, i.e., plates, and demonstrated how to share up her 12 pieces of white chocolate using manipulatives. Similar to the previous activity, Mrs. Brownstone's knowledge of

how to operate the document camera represented her *technological knowledge*. Her knowledge of how to use the document camera and manipulatives to support the content-specific activity represented her *technological pedagogical content knowledge*. In the example, the document camera and manipulatives facilitated the representation of sharing in basic division. Her use of modeling was the pedagogical strategy. In addition, the document camera and manipulatives provided a visual representation of the topic.

After the demonstration, students worked independently to model an expression. While the students worked, Mrs. Brownstone and Mrs. Day walked around checking on students' progress and answering questions. The researcher observed that instead of writing an expression, a few students wrote an equation. When Mrs. Brownstone noticed, she asked students to write the expression and not the equation. She then explained the difference between an expression and equation. As they walked around the classroom, the teachers praised students for following directions and staying on task. The teachers redirected some students, but most students were on task. Mrs. Brownstone had students work on the project for approximately five minutes before she called on two students to share with the class. She asked the students to write their division expressions to model, using the document camera, and then explain their work. One student demonstrated the model of her expression (15 divided by 3). The following dialogue took place:

> Student: I have 5 chocolates and 15 chocolates and I want to share it up with three people, I take each one and I drop them in each group, 1, 2, 3. . . . I just went on and on until I have 0 left.

Teacher: Excellent job! So you had zero left over, great job. Thank you, great job [claps] great example, so I will put the example up here [hangs example on the board], okay.

The excerpt demonstrated Mrs. Brownstones' attempt to have students express and demonstrate their understanding and ability to divide with models, one of the learning goals for the lesson. In the next excerpt, she used a student's example as an opportunity to extend the concept. Before the next student explained his model using the document camera, Mrs. Brownstone informed the class that he did something different. She stopped for a moment to get everyone quiet before the student shared his way of reasoning about division. Below is an excerpt from the student-teacher dialogue referring to the problem.

Teacher: So now, I have mathematician James. He says you know what Mrs. Brownstone, I want to do something different. So, mathematician, James, what did you do?

Student: I did 10 divided by 3.

Teacher: 10 divided by 3; can you tell us what happened, James?

Student: So I had three groups, and then I had 1,2,3,4,5,6,7,8,9 but I needed 10 so I have one left over.

Teacher: What did he do with the one that was left over? What did you do with the one left over?

Student: He said that he had one over.

Teacher: He had one left over. But why couldn't he just take this one left over and say, you know what I'm going to give it to this person? What if he, can I take this off James?

Student: Yes.

Teacher: What if he said 'You know what, I'm going to give it to Josiah, Josiah is cool so I'm going to give it to Josiah'?

Student: I know they won't be equal. It won't be equal.

Teacher: What James said you know what I'm just going to stick this one in and give, I know that Jose likes chocolate so you know what I'm going to give Kevin three, I'm going to give Mark three and I'm going to give Jose 4 because Jose, he likes chocolate. What was going on with that, Kevin?

Student: You can't put four in the middle because if each person to get equal, to get the same amount of chocolate, you have to give them the same amount but only Jose has four and the rest have three.

Teacher: So is that equal share?

Student: No.

Teacher: That is not equal share and in division, it is a correct phrase for us to use left over. This is the way that you do it in fourth and fifth grade. You will see they are using this phrase over or remainder. You are not going to throw it away but you put your left over to the side. So he was able to distribute out 9 of that 10 equally, okay?

Using her *content knowledge*, Mrs. Brownstone explained the new concept of having a remainder. Then, she modeled how to complete the division problem using the document camera to improve the students' understanding of the concept. In addition, it showed her ability to guide student learning. In the activity, Mrs. Brownstone used technology, pedagogy, and content knowledge, illustrating her use of *technological pedagogical content knowledge*. In the example, she facilitated students' use of the document camera to explain the model they created. Mrs. Brownstone's facilitation of student's use of document camera was the pedagogical strategy to allow students to present their work. The students presented content representations using technology specific to the topic. In addition, Mrs. Brownstone used the technology to improve student's understanding of the content, which also represented her *technological pedagogical content knowledge.*

In the last activity for the day, Mrs. Brownstone had students complete an assessment to check for their understanding. The researcher noted that the last activity on the written lesson plan was for students who comprehended how to do division problems, to work in centers using the Study Island or www.ixl.com software on the computers. During the follow-up interview, Mrs. Brownstone explained that there was not enough time to have students work in centers. The statement represented her knowledge of technology. In addition, her knowledge of different software that students could use to practice division problems represented her *technological content pedagogical knowledge*. Mrs. Brownstone's use of the technology in the example was for students to practice to improve their understanding of the content.

Mrs. Brownstone: Lesson 2.

The second lesson the researcher observed Mrs. Brownstone teaching was on multi-digit subtraction. She taught the lesson over a period of two days. The researcher used the Technology Integration Observation Instrument (TIOI) to take notes on the curriculum goals, instructional strategies, and digital and non-digital technologies used in each lesson.

On the first day, the lesson took place in the computer laboratory. The goal for the first day of the lesson was to begin to cover multi-step subtraction; which was the initial introduction of the concept to the class. The students entered the classroom a few minutes after the start time for the mathematics period. After students entered the classroom, two students got in an altercation. Mrs. Brownstone directed the two students to the office. Using her classroom management skills, she signaled to gain the rest of the class's attention. In our follow-up interview, Mrs. Brownstone explained the difficulty of transitioning from the classroom to the computer laboratory as follows:

> Once you move them from their structure, it takes a while to kind of get them re-adjusted and get them focused again. Many times, I have to get them focused for me to start teaching because there is so much going on. . . . they get so excited because. . . a lot of them do not have computers. So they just want to get on the computers. Sometimes it is a distraction just trying to get them focused.

The statement was an indication of Mrs. Brownstone *technological pedagogical knowledge.* She used her classroom management skills and knowledge of possible student disruptions in a computer setting to prepare to manage the class. After students

settled down, Mrs. Brownstone directed them to sit one by one on the floor in front of the Promethean Board. Mrs. Brownstone explained that they would be working on subtraction in a similar fashion as they would in third grade. Mrs. Brownstone continued by providing a structured overview. She explained what the class would accomplish and how they would get the work done for the day:

> We have 16 more days to go, and I am going to review the way that we have learned subtraction before, the basic subtraction, and then we are going to take subtraction to the next level. We are going to work with some three to four digits numbers today. So we are going to. . . work with subtraction; following that, we are going to do centers; we are going to do a basic quick check, and then you are going to do centers on the computer.

The excerpt shows that Mrs. Brownstone was able to use her *pedagogical knowledge* to build a meaningful connection to introduce the lesson. Before beginning the lesson, Mrs. Brownstone provided additional direction on what would take place for the day. While setting up the computer to use Promethean Board, Mrs. Brownstone explained to students that later in the lesson they would work as partners on one computer, because some of the computers did not work well. In the process, Mrs. Brownstone redirected a few students who were not paying attention. She instructed students to focus on the details of what she would be doing on the PowerPoint. She explained that focusing on the details would help them really understand how to solve subtraction problems with three to four digit numbers. She continued, and explained that she would be using the Promethean Board. As a reward, she announced that students

who paid attention would have an opportunity to use the Promethean Board. In the above mentioned comment, Mrs. Brownstone used technology and pedagogy to facilitate student motivation, providing an example of her use of *technological pedagogical knowledge (TPK)*. She motivated students by rewarding them for paying attention in order to use the technology.

Lastly, she announced the learning goal to the class. She stated, "Our learning for today. . . is to work on regrouping with subtraction." As she talked, Mrs. Brownstone turned on the Promethean Board. Mrs. Brownstone was able to start the equipment without interrupting or interfering with the flow of her instruction. Mrs. Brownstone's ability to operate the Promethean Board represented her use of *technological knowledge*. During the follow-up interview, Mrs. Brownstone explained a few issues that she had experienced with setting up the technology. She explained that the board freezes, is slow to load, and changes what is loaded. Her knowledge of technology or *technological knowledge* prompted her to come in to work early to set up the technology. However, she explained that she did not get to finish because a parent come in for a parent teacher conference.

Continuing with the lesson, after the Promethean board powered on, the students reacted in a large outburst to a picture of one of their classmates displayed on a PowerPoint slide. After quieting students, Mrs. Brownstone began the first activity by engaging in a whole group instructional setting. The goal of the first activity was to introduce the concept of multi-digit subtraction. She started the activity by asking students to recall what they learned about subtraction earlier in the year. She explained

that they would be focusing on the details and learning how to borrow when subtracting multi-digit numbers.

As she continued to instruct, Mrs. Brownstone tried to use the interactive pen on the Promethean Board; however, the pen did not work. The brief technology failure and interruption, led to a slight class disruption. After trying several times to get the pen to work, Mrs. Brownstone decided to use the computer keyboard to change the PowerPoint slides. She continued providing explanations on subtraction and borrowing when subtracting multi-digit numbers. Mrs. Brownstone explained during the follow-up interview, if she had had the time, she would have checked to see if the pen worked when setting it up in the morning. In addition, she could have gotten another pen from the schools' administrative assistant, Mrs. Ware (pseudonym). Mrs. Brownstone indicated that Mrs. Ware was the unofficial technology person at the school and managed most of the technology. She also highlighted that she could not continue to try to get the interactive pen to work in the middle of instructing. Moving on, after no success getting the interactive pen to work again, Mrs. Brownstone chose a student to be the technology person. She requested the student to use the arrow on the computer to change the slide when directed. Mrs. Brownstone's ability to continue teaching and generate an alternative strategy when the technology did not work represented her *technological pedagogical knowledge.*

For the remainder of the activity, Mrs. Brownstone continued engaging students in a whole group instructional setting. She concluded the activity by reviewing two-digit subtraction. She used several examples from the PowerPoint to guide students through

the procedure. As she worked through the problem, Mrs. Brownstone modeled her thinking. Although she did a large percentage of the talking, she connected the students by asking for input. For example, she used the following rhyme to explain when to borrow, "more on the floor, we have to go next door". Then, she instructed the students to repeat the phrase. As she worked out each problem, Mrs. Brownstone intermittently praised students for participating. The activity illustrated Mrs. Brownstone's use of technology, pedagogy, and content, which was representative of her *technological pedagogical content knowledge.* In the example, she used the technology as a pedagogical tool to model concepts so students would be able to practice the skill and improve their content understanding.

Mrs. Brownstone began the next activity by reading a story problem from the PowerPoint. She expressed to students that when they reached third grade they would see story problems and they would have to set the problem up by themselves. Subsequently, Mrs. Brownstone explained how to set up a subtraction problem, reinforcing the concept that the biggest number always goes on top. Next, she displayed a subtraction problem using a place-value chart and also modeled how to work the problem using the chart. The pen was still not working, so she used the computer to work the problems using the writing tools to make marks on the Promethean Board. As she worked the problem, she continued to remind students to follow along with her. Finishing up, Mrs. Brownstone explained to the class that it was important to use the place-value chart to solve a problem. Mrs. Brownstone emphasized that if they were not

given a place-value chart, they should draw the chart themselves. Figure 7 illustrates the place-value chart activity.

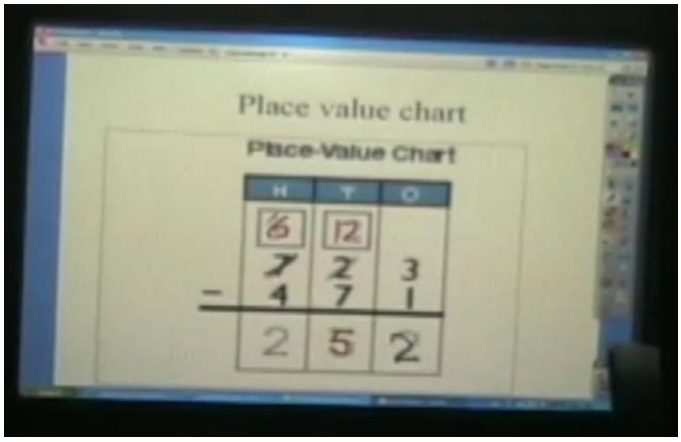


Figure 7. Brownstone Lesson 2: Place-value Chart

During the discussion, Mrs. Brownstone had to ask two students to stop making distracting noises. To wrap up the activity, Mrs. Brownstone polled students to check for their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not understand, 2 = I understand some, but have some questions, 3 = I understand, and can do it by myself, 4 = I understand and can help a friend. In the activity, Mrs. Brownstone's knowledge of how to operate the hardware and software represented her *technological knowledge*. The activity also illustrated Mrs. Brownstone's *technological pedagogical content knowledge*. In the example, she used the PowerPoint and place-value chart as pedagogical tools to model how to solve a problem to improve students' content understanding.

For the next activity, Mrs. Brownstone continued the discussion on using the place-value chart strategy. She began by displaying a blank place-value chart. Using the place-value chart, she modeled, using the Promethean Board, how to set up a multi-digit subtraction problem (See Figure 8). During the demonstration, she called on students to tell her where each number went. For the remainder of the activity, Mrs. Brownstone and the students worked through the problem together. She asked for input as she wrote and guided the students through the problem. As she and the students worked through the problem, Mrs. Brownstone provided explanations and clarified misconceptions. She periodically praised students for participating.

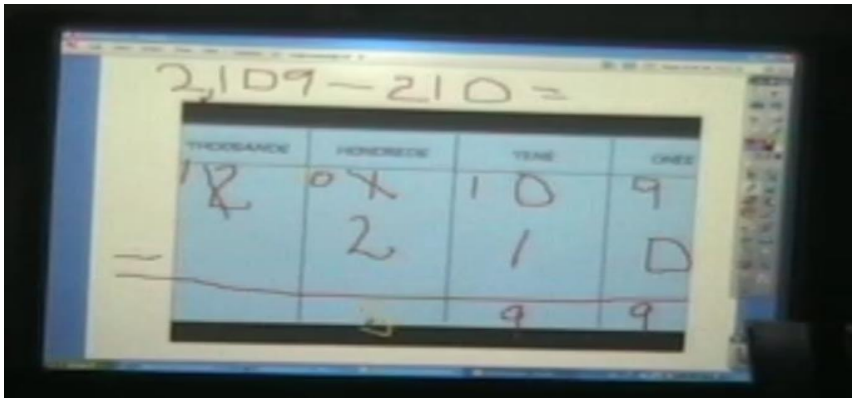


Figure 8. Brownstone Lesson 2: Using a Place-value Chart in Subtraction.

In these activities, to support students' learning how to subtract using a place-value chart, Mrs. Brownstone used her *technological pedagogical content knowledge*. She used the Promethean Board and PowerPoint as pedagogical tools to facilitate the

topic-specific activity. In addition, the technology provided a visual representation of subtracting using a place-value chart. Her use of modeling was the pedagogical strategy.

For the next activity, Mrs. Brownstone had students work with a partner to do a quick check. She placed groups of two students at each computer. As students took their seats, Mrs. Brownstone passed out a laminated place-value chart to each group. She then provided instructions for the quick check activity. She tasked students to use their place-value chart to solve the following problem: 2891-399.

As the students worked, Mrs. Brownstone and Mrs. Day walked around, checked on students' progress, and answered questions. The researcher observed that students did not utilize the computers for the lesson. Meanwhile, Mrs. Brownstone wrote the problem on the place-value chart displayed on the Promethean Board. After three minutes, she signaled for students to stop. To close out the lesson for the day, Mrs. Brownstone called on two students to share their work on the Promethean Board. As students worked on the Promethean Board, Mrs. Brownstone showed them how to use the tools. After the students worked and solved the problem, Mrs. Brownstone reviewed the problem, explaining how students got the answer to the quick check problem. She concluded the lesson by recapping key concepts of the lesson. Mrs. Brownstone's ability to show students how to operate the tools on the Promethean Board demonstrated her use of *technological knowledge*. In addition, Mrs. Brownstone used *technological pedagogical content knowledge*. In the example, she facilitated students' use of the Promethean Board to share their work. Mrs. Brownstone's facilitation of student use of the Promethean Board was the pedagogical strategy to allow students to present their work. The students

presented content representations using technology specific to the topic. In addition, Mrs. Brownstone used the technology to improve students' understanding of the content. The method also represented her technological pedagogical content knowledge.

The researcher observed that Mrs. Brownstone could have completed many of the activities in the classroom using the document camera or with PowerPoint rather than with the Promethean Board. In addition, the researcher did not observe any activities that required students to interact with the technology. In the follow up interview, Mrs. Brownstone recognized that it would have been better to deliver the lesson in the classroom. She explained that she could have used PowerPoint and manipulatives to represent some of the key concepts in the lesson. In addition, she explained that she would have shown a video. She also noted introducing the place-value chart using the Elmo.

Mrs. Brownstone described the technology, i.e., interactive pens, not working correctly as a barrier. Without the pens, she was not able to use the manipulative objects on the Promethean Board which impeded the level of student interaction she had planned. In addition, she implied that the Promethean Board itself was a deterrent, because it was an older version and it had not been serviced in over two years. She added, not having the Promethean Board in teachers' classrooms, caused delays and classroom management issues.

Another barrier that she described was teachers not signing up to use the computer laboratory. She believed that she had to rush to get through the lesson because another teacher who had not signed up to use the laboratory was waiting. Lastly, she

believed the outdated computers in the lab were a hindrance because some of the computers would freeze, shut down, and did not have updated software. Some of the computer issues led to classroom management problems because students would react to their computers improper functioning. Overall, Mrs. Brownstone was able to adjust to the impediments. She explained being able to make decisions on the spot allowed her to continue the lesson with only a few modifications. In addition, when she planned a lesson using the computer laboratory, she always had a backup plan in case the technology did not work.

Before starting the mathematics lesson on the second day, Mrs. Brownstone had the students do a brain energizer. Students recited the brain energizer as a group and danced as she called some of their names. After the brain energizer, Mrs. Brownstone had to pause to speak to a few students who were disruptive. After gaining the students' attention, she wrote the learning goal and objectives on the whiteboard. As she wrote, she verbally told students the learning objectives and purpose for the lesson. The learning goals are highlighted in the excerpt from Mrs. Brownstone's transcript, which follows:

> Today our learning goal. . . by the time this lesson is finished students will understand how to subtract multi-digit numbers. Students. . . (brief interruption). . . understand how to subtract, 3 to 4 digits numbers. Sometimes you will hear me refer to this as multi-digit numbers

The learning goals highlighted what students needed to know and be able to do and set the tone for learning. After announcing the learning goals, Mrs. Brownstone gave

a brief overview of the lesson and recapped the lesson from the previous day. She explained the importance of the order for subtraction and demonstrated how to solve a couple of problems on the whiteboard. Mrs. Brownstone's explanation and her interaction with her students follows:

> Mrs. Brownstone: When we are subtracting, we are giving away, we are using the operation subtract to give away. . . just to review our content. Today we are going to focus mostly on regrouping subtractions. And there are some key things that we talked about yesterday that when we are subtracting we need to remember. When we are subtracting we always put the bigger number on the top, the order in which we subtract, it matters.
>
> When we did addition it was easy, we did 5 + 3 is 8, in subtraction it doesn't work that way, the order matters, the order matters. If I need to subtract 8 by 5, if I do 5 subtract 8, that is not going to work, we need something different; it is not the same. So it is very important to keep in mind that order matters. When we are subtracting order matters and I want everybody to say that.
>
> Students: Order matters, when subtracting order matters.
>
> Mrs. Brownstone: We have to put the bigger number on the top, whether it is a single digit or a multi digit number. That is a quick review of the basics of subtraction. The other key part of subtraction is regrouping. When do we borrow? A part of this lesson we are going to keep this in mind that by the time this lesson is finished we will be able to answer this question: when do we regroup? when do we borrow?

Although Mrs. Brownstone did most of the talking, she continued to engage students by having them repeat the key concepts. In the excerpt, Mrs. Brownstone reviewed and reinforced the key concepts: the larger number goes on top, and order matters. The excerpt provides an example of Mrs. Brownstone's *content knowledge*. In addition, the strategy of providing an overview to students was an example of her *pedagogical knowledge*. As Mrs. Brownstone continued, she introduced another key concept of subtraction. She explained that another key concept in subtraction was regrouping or borrowing. She reminded students to keep the learning goal for the day in mind and wrote the question, "When do we regroup" on the board. As she continued to review and explain the concept of regrouping, Mrs. Brownstone connected the projector to the iPad.

Engaging students in a whole group instructional setting, Mrs. Brownstone began the next activity by playing a hip-hop subtraction music video from her iPad. As she started the music, Mrs. Brownstone reminded students to listen and pay attention while the song played for the first time. She told them that they could sing along when the song played for the second time. As the song played, Mrs. Brownstone connected the projector to have the video ready when the song played for the second time. However, the projector did not work, so she continued to instruct using the whiteboard. Mrs. Brownstone's use of a music video that was engaging to students, illustrated her *technological pedagogical knowledge*. Further, her ability to find and select songs on YouTube illustrated her use of *technological knowledge*. In addition, Mrs. Brownstone's knowledge of how the music video could be used to support the content-specific activity

represented her *technological pedagogical content knowledge*. In the example, the music video transformed the representation of the content, making it multi-model. Mrs. Brownstone recognized that the music video would appeal to multiple senses. Moving forward, she underlined the question on the whiteboard, "When do we regroup?" She repeated the question aloud, "When do we regroup?" The researcher observed that a few students raised their hands to answer the question. However, Mrs. Brownstone had her back turned so she may not have seen the raised hands. On the whiteboard, she wrote a subtraction problem. She modeled her thinking as she guided students through the problem. As she worked the problem, she asked students for their input. In addition, she used and emphasized the strategies and concepts she used to solve the problem. She continued the activity by working another subtraction problem. To wrap up the activity, Mrs. Brownstone checked for understanding by polling students to check their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not understand, 2 = I understand some, but have some questions, 3 = I understand, and can do it by myself, 4 = I understand and can help a friend. The majority of students responded by showing four fingers; however, a couple of students raised one or two fingers. Mrs. Brownstone called on a student to ask a question. After answering the student's question, she continued by explaining the key concept of regrouping. Mrs. Brownstone had students speak with their shoulder partner to answer the question, "When do we regroup?" After a couple of minutes, she asked students to share. The researcher observed several students raising their hands. She called on a student to answer the question, "When do we regroup?" After the student answered, Mrs.

Brownstone repeated the answer for the rest of the class to hear. She wrapped up the activity by repeating the key concepts and explaining that students would use the same concepts in the third grade when subtracting 3 or 4 digits numbers and sometimes 5 or 6 digit numbers.

For the next activity, Mrs. Brownstone had students do a quick check. She explained that they were now going to move toward 3 to 4 digit numbers. As she talked, she wrote, 3,645 subtract 1,483 on the whiteboard. Using the numbers on the board as an example, she began to explain step-by-step the procedure for subtracting 3-and 4-digit numbers. First, she explained the strategy of using the place-value chart to subtract. She drew a place-value chart on the whiteboard and modeled how to write the numbers on the chart. After she wrote the numbers on the chart, she called on students to discuss what she did and explain why.

Mrs. Brownstone: Person 3, yellow table, what number did I put on the top?

Student: 3,645.

Mrs. Brownstone: Why did I put 3,645 on the top, Person 2, blue table? Why did I put that number on the top?

Student: Because it is the biggest number.

Mrs. Brownstone: Because it is the biggest number, you always put the bigger number on the top.

To wrap up the activity, Mrs. Brownstone checked for understanding by polling students to check their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not understand, 2 = I understand some, but

have some questions, 3 = I understand, and can do it by myself, and 4 = I understand and can help a friend. Mrs. Brownstone called on a student to explain what he did not understand. She answered the student's questions and provided additional explanation to clear up other students' misconceptions. Mrs. Brownstone continued with the activity by modeling how to solve the problem on the place-value chart. As she worked through the problem, she modeled her thinking and stressed the strategies and concepts she used to solve the problem. Mrs. Brownstone called on different students to answer questions and help her solve the problem. Students called out answers and told her what to do next to solve the problem. As students answered, Mrs. Brownstone asked them to explain their reasoning. As she completed and before moving on the next activity, Mrs. Brownstone polled students once more to check for their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not understand, 2 = I understand some, but have some questions, 3 = I understand, and can do it by myself, and 4 = I understand and can help a friend.

For the next activity, Mrs. Brownstone had students practice doing multi-digit subtraction. Before having students do the practice activity on their own, she began with a review with the whole class. She asked students to write 2,162 on their whiteboard in expanded form. A few students interrupted because they did not have whiteboards. Using her classroom management skills, Mrs. Brownstone stated, "If you do not have a white board, you raise your hand to get my attention. That is the proper procedure." After giving students a couple of minutes to write on their whiteboards, Mrs. Brownstone continued with the activity. She asked a student to come to the whiteboard to write 2,162

in expanded form. The student wrote the expanded form of the four-digit number on the board, 2000+100+60+2, showing the sum of values of each digit. Before moving on, Mrs. Brownstone cleared up a misconception for one of the students. She explained that plus signs are required when writing in expanded form.

Mrs. Brownstone began to prepare students for the next activity. She started by sharing a subtraction word problem that she had created. She used students in the class as part of the story. An excerpt of the story follows:

> Say that Zach had $323, all of that money for the store. And he is feeling really good and says, "You know what, I'm going to purchase something for Misha because she has been a really good student." So, Zach decided to give Misha some of his money. So, he purchases something for Misha that is $129.

As she described the story, Mrs. Brownstone wrote the problem on the board. As she wrote, Mrs. Brownstone emphasized the importance of using a place-value chart to solve the problem. She continued by sharing and modeling a strategy students could use to create their own place-value charts. Using the example on the board, she made columns, drew a line above the numbers, and wrote ones, tenth, and hundredths on top of the line to create a place-value chart. The example is illustrated in Figure 9.

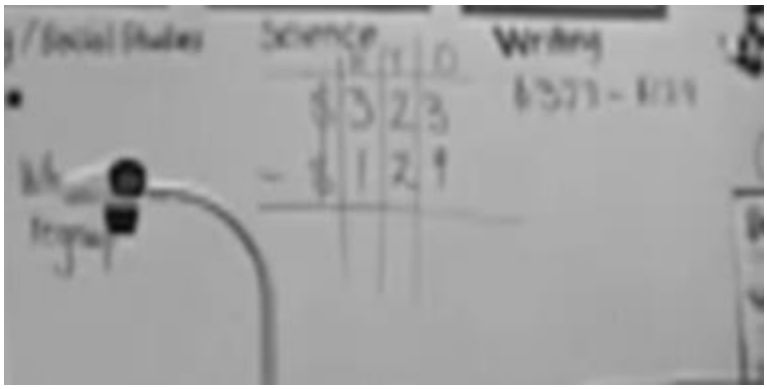


Figure 9. Brownstone Lesson 2: Using a place-value Chart in Multi-digit Subtraction

Mrs. Brownstone continued and asked students to work with their shoulder partners to solve the problem using their dry erase board. First, she asked the tallest of the shoulder partners to write the problem on the dry erase board. While the students were working, Mrs. Brownstone and Mrs. Day walked around and checked on students' progress. After students wrote the problem, Mrs. Brownstone asked students to work together to solve the subtraction problem. The teachers continued to walk around and provide assistance. After a couple of minutes, Mrs. Brownstone signaled for students to hold their charts up once they were finished. She signaled again to gain the attention of all the students. She praised students who were working well together. Mrs. Brownstone continued by asking two students to come to the front of the class to help solve the problem. She asked the rest of the students to pause. As the students worked the problem on the whiteboard, Mrs. Brownstone checked their answers. She then reviewed the problem with the entire class. As she did so, she called on different students to answer questions and guide her through the process. As she wrapped up and before moving on the next activity, Mrs.

Brownstone polled students to check for their level of understanding on a scale of 1 to 4. Each response was based on the following scale where 1 = I do not understand, 2 = I understand some, but have some questions, 3 = I understand, and can do it by myself, and 4 = I understand and can help a friend.

Moving on to the next activity, Mrs. Brownstone explained that the class would be working on a quick check and then concluding the lesson with a video before going into centers. She explained that the video feed went "dead" and that she would try to bring it back up. In the meantime, Mrs. Brownstone had students work by themselves to complete an assessment. Mrs. Brownstone passed out a worksheet and gave the students directions for its completion. The students worked individually to complete multi-step subtraction problems on a worksheet. As students worked on the assessment, Mrs. Brownstone connected the projector to the iPad.

After 13 minutes, Mrs. Brownstone signaled for students to stop and place their worksheets in their folders. When she had all of the students' attention, she introduced the last activity. She explained that they were going to revisit the lesson in digital form. She reminded students to pay attention and started the video. The instructor in the video explained how to perform multi-digit subtraction. The video discussion included the following concepts: order matters in subtraction, the bigger number should always be on top, always start with the ones column. As the video played, Mrs. Brownstone asked students questions about the concepts covered in the video. All of the students were attentive, and there were no disruptions while the video played.

The instructor in the video modeled two examples: how to subtract a multi-digit number without borrowing and with borrowing. The instructor in the video also modeled two strategies for borrowing or regrouping. The researcher observed that one of the strategies that was modeled was a new strategy students could use to borrow. In our follow-up interview, Mrs. Brownstone explained that because there was an introduction to a new strategy, she should have shown the video earlier in the lesson to clear up any misconceptions. She explained that the video enhanced her instructional strategy because some of the key concepts she had taught earlier were being reinforced. Mrs. Brownstone explained that she would give students an opportunity to practice using the new strategy as she continued the lesson. In addition, she believed the students increased their level of engagement more with the video than when she was giving instruction. She believed the effects in the video grabbed their attention. As reflected in previous activities, Mrs. Brownstone used her *technological knowledge* to locate videos and operate the iPad. She used her *technological pedagogical content knowledge* to address students' content knowledge. In the example, she used the video as a pedagogical tool to facilitate the representation of solving multi-digit subtraction problems. Her use of modeling was the pedagogical strategy, and the document camera and manipulatives were the visual representations of the topic. In addition, her use of the video to grab students' attention and increase engagement reflected her *technological pedagogical knowledge*. As noted earlier, her use of videos, in general, was not related to the content.

The lesson concluded the researchers' case report of Mrs. Brownstone. The researcher observed that Mrs. Brownstone was very comfortable and familiar with the

content of the math. In addition, she was knowledgeable and used different instructional strategies throughout the lessons. Overall, the findings of the within-case analysis demonstrated how Mrs. Brownstone used her technology integration knowledge (TK, TPK, TCK, and TPACK) in the classroom. The researcher found several examples of how Mrs. Brownstone used each of the components of knowledge as she implemented both of the lessons.

The results of Mrs. Brownstone's within-case analysis supported the findings from the survey. An analysis of documents and observations showed that Mrs. Brownstone demonstrated all components of TPACK; however, her use of TCK was limited. Her most frequent uses of TK for teaching were to operate and select software and hardware such as the projector, iPad, and document camera. She also regularly used videos which she found on YouTube. Mrs. Brownstone's primary instructional strategies using technology included modeling and presenting information represented her use of TPK. The focus of Mrs. Brownstone's use of TPACK was to provide visual representations, correct misconceptions, and address content understanding. Although Mrs. Brownstone perceived herself as having a high level of technological content knowledge, the researcher only observed one instance of TCK in which she stated that she selected technology based on the nature of the content or learning goals.

Throughout the study, Mrs. Brownstone stated that she desired to use her technology integration knowledge more frequently to engage students than she currently did. However, barriers influenced her use of technology integration knowledge. The researcher found that the most significant barriers were resource related. Appendix A

shows the codes placed in the different categories in the lessons from Mrs. Brownstone's classroom. The lessons highlighted the range of different activities, pedagogical strategies, and technologies that she used when implementing the lessons.

The Case of Mrs. Oak

The following case report provides a brief summary of Mrs. Oak's background, classroom context, discussion of her written instructional plan, and actual implementation of the lessons. The researcher reported contextual factors throughout the case report.

Mrs. Oak was a White female with a bachelor's degree in education and a master's degree in education with a specialization in elementary education. She was the Science Technology Engineering and Mathematics (STEM) resource teacher and taught Grades K-5. She had six years of teaching experience. Based on results from the survey she perceived her TPACK as follows: technology knowledge (Mean = 3.86), content knowledge (Mean = 4), pedagogical knowledge (Mean = 4), pedagogical content knowledge (Mean = 3.25), technological content knowledge (Mean = 3.25), technological pedagogical knowledge (Mean = 4), and technological pedagogical content knowledge (Mean = 3.25). Only two of her mean scores, technology knowledge (Mean = 3.86) and technological pedagogical knowledge (Mean = 4) were above the mean for the group (3.67) and (3.73). Mrs. Oak described the level of support for technology, leadership, and peer support at the school as moderate.

As the STEM resource teacher, Mrs. Oak taught all grades at Carter Charter School. In her classroom, she had access to five desktop computers for student use and

one computer for teacher use, a LCD projector, and a document camera. Beyond the classroom, she had access to sign up her class to use the computer laboratory which contained 25 netbook computers, an interactive whiteboard and 20 laptop computers on a portable cart.

Plan for TPACK

Mrs. Oak was the second teacher to respond to the researcher's invitation to participate in the second phase of the study. The researcher met with Ms. Oak on May 17 and discussed the instructional plan that she would be implementing in her classroom for the week. During the initial interview, Mrs. Oak provided a copy of an instructional plan that included lessons for Grades k-6. The instructional plan included lesson components, activities, and assessment strategies. The lessons engaged students in individual and whole group instructional settings. Resources included digital and nondigital technologies such as websites and presentation software (MS PowerPoint), journals, and worksheets. In addition, the instructional plan provided the related state benchmarks for each grade and content area.

The written instructional plan provided a record to which the researcher could refer during observations and data analysis. As the researcher reviewed the instructional plan, she used the interview protocol to interview Mrs. Oak to gain an understanding of the documents as they related to her intended use. Mrs. Oak described the details for four different lessons primarily focused on science content. Three lessons were science focused, and one lesson focused on technology skills. She described the lessons

primarily in terms of the content addressed, teaching approaches, and how she integrated technology. Mrs. Oak began by explaining how the content included in the instructional plan related to the state benchmarks for science. The information was also included in the written instructional plan she provided. The benchmarks for students in kindergarten, first, and second grades included life science concepts. The benchmark for students in the fourth grade included physical science concepts. The researcher noted Mrs. Oak did not discuss or include the benchmarks for technology in the instructional plan, although students used technology to write, research, communicate, and create.

Mrs. Oak's teaching approach for the lessons was teacher-directed with a direct instruction instructional strategy. The instructional components she described included presentation of information, interactive instruction, modeling, guided practice, and independent practice. Because she taught different grade levels, the content and instructional components varied. Mrs. Oak emphasized that she often modeled and allowed time for independent practice. She explained that during independent practice she answered questions and provided feedback.

Mrs. Oak decided to include digital and non-digital technologies in the instructional plan. She suggested that technology allowed students to practice their computer skills independently, allowed her to model her work, and helped to reinforce concepts. Two of the lessons included a song. She explained, "I really like to use music at the beginning of my lessons, because I think it helps them hold on to the vocabulary better. It helps them remember little bits of information and pieces of vocabulary far past where they might remember it when you are just doing a lesson or reading about it". In

addition, she highlighted the importance of using the projector to display the song lyrics for students to be able to follow along with the song. She explained that seeing the song lyrics on the projector screen helped students follow along and focus on learning the content. In addition, when she planned the lesson, she decided to use the iPad and projector to display images and to model her work to students. She explained that it was helpful to search for and display images with which students were more familiar.

In general, Mrs. Oak highlighted that for the most part, although limited, she had resources that supported her lessons, but the inefficiency of a "technology supported classroom" was a challenge. Mrs. Oak explained that in most cases she was able to implement the lessons with the technology available at the school such as the computer netbooks and projectors. In addition, she reported the school recently installed more bandwidth, which was helpful, especially when students did independent practice. However, issues such as the arrangement of the room and location of technology hindered her instructional strategies. She explained that the arrangement of the room only allowed her to plug in the projector in one area. She pointed out that having the projector and the computer behind the area where students worked required her to move behind students. She believed that having a projector attached to the ceiling would allow her to operate it from the front of the class. Being in front of the class would allow her to maintain visual contact while teaching, and students would be better able to see her. She also added that with current room arrangement, one of the tables in the class did not have a good view, so when doing anything that involved video or reading with the projector,

students who sat at the far table had to move to a seat in the front of the room so that they could have a better view.

The descriptions of the written instructional plan provided insight into Mrs. Oak's perceived teaching practices and knowledge of content, pedagogy, and technology prior to classroom observations. The initial interviews assisted the researcher in understanding how she used her technology integration knowledge in practice.

Instructional Plan Implementation

The researcher conducted observations May 17 to May 23. The researcher observed four classroom activities, all taking place during the scheduled 60-minute period in which students visited Mrs. Oak's classroom. During each observation, the researcher noted the learning objectives for each lesson, instructional strategies, and digital and nondigital technologies. In addition, the researcher noted how and why the particular technologies used in the lesson "fit" the instructional strategies and content of the lesson. Mrs. Oak provided further clarification on the implemented activities in follow-up interviews.

Classroom Context

Mrs. Oak's classroom was spacious; her room had six tables with four to five chairs at each table. A cart with a projector was in the middle of the room. In the front of the room, next to the entrance was a table with student journals. Two bulletin boards were hanging on the walls, and books were on shelves in the back of the room. Situated

near the books was the "safe place." Mrs. Oak's desk and the whiteboard were in the front of the room. There was a table against the back wall of the room with a microscope and some lab equipment. Next to the table were five student computers, which faced the center of the room.

The researcher arrived to Mrs. Oak's classroom early to set up the video equipment. As students entered, Mrs. Oak would greet them at the door. On two days, the researcher observed that Mrs. Oak brought in the computer cart before students arrived. One day, she had fifth-grade volunteers help her prepare the computers for student use. She taught in front of the classroom and in the middle of the class behind the projector. The researcher recorded the curriculum goals, instructional strategies, and digital and non-digital technologies for each activity using the Technology Integration Observation Instrument (TIOI). In addition, the researcher wrote field notes regarding contextual factors in the classroom.

Lesson 1. The first observation was of the kindergarten class. The goal of the lesson was for students to practice typing and writing a letter. Students entered the room and sat at their assigned seats; each table had an assigned color. Netbook computers were already on each table. Prior to students' arrival, Mrs. Oak had the computers turned on and set up. During the follow-up interview, Mrs. Oak explained that a few fifth-grade students had volunteered to help prepare the computers. As students entered, Mrs. Oak wrote on her behavior chart in the front of the room. She gave students a point based on their behavior. As student entered and sat at their seats, they immediately started working on a computer. Mrs. Oak walked around and provided guidance and feedback.

Mrs. Oak continued to provide tools and resources to students as needed, ensuring that all students had the BBC website and typing program (http://www.bbc.co.uk/schools/typing/) and had one of the games on the website up and running on their computers. After making sure all of the students were on the correct website, she set a time limit for the activity and focused students on completing the task within the allotted time. As the activity continued, Mrs. Oak provided corrective action for student behavior. She told one student to close his computer for being off task. Exerting classroom management skills by holding students accountable for equipment used was an example of Mrs. Oak's use of *technological pedagogical knowledge.* As students worked, Mrs. Oak rewarded some students a point for focusing on the task. She continued to walk around and assist students who were having a problem locating and signing on to the website.

During the activity, Mrs. Oak used her *technological knowledge* to help a couple of students who were having computer issues. She gave another computer to a student who could not launch the computer activity. She helped another student who was having computer problems and explained that one way to troubleshoot was to shut down the computer and turn it back on. After 10 minutes, she gave the class a "time check" and powered on the projector and computer. Mrs. Oak continued to help, praise, and discipline students as they worked. She instructed students who were off task to close their computers because they were being unsafe.

As students began to complete the activity, Mrs. Oak asked students to report their progress. One student told Mrs. Oak that he had finished an entire level, and she

gave him an award. During the activity, the alarm sounded, and Mrs. Oak asked students to stop working. She then informed them that she would walk around to see how far they had gotten in completing the activity. As she checked students, Mrs. Oak praised the students for their work. She announced that one of the students finished an entire level, gave the student a prize and shouted "hip hip hooray" along with the entire class. The class repeated the verbal congratulations as Mrs. Oak continued to check student work and count the number of levels each student completed. During the follow-up interview, Mrs. Oak indicated that she thought the typing program was a great application to help students develop skills. However, she believed students could improve more if they were able to hear the sound from the program. Mrs. Oak clarified that she had students turn the sound off on their computers to keep the noise level down and not distract other students. She indicated that her preference would be to have headphones for every student because the game actually provided brief explanations on how to type. She explained,

> The computer sings to students when they do it right and computer will say "type on me" and blink the right key if they tap on the wrong key. So those auditory cues make that particular program stronger. But I can't really take advantage of them because I don't have headphones for everybody, and I can't have everybody have their sound up, because then, you know, it would just be very chaotic.

The activity was an example of Mrs. Oak's use of technology, pedagogy, and content to facilitate student's learning, which represented her use of *technological pedagogical content knowledge* (TPACK). In the example, she facilitated student's use

of an educational game to assist in developing their typing skills as they played. She used the technology as a pedagogical tool to help students develop typing skills. Mrs. Oak recognized that digital games were an effective way to assist students in building skills through repetition and feedback during practice. The game provided visual and auditory cues when student performed the incorrect action and reinforced correct performance through praise. In addition, students had several opportunities to practice skills as they moved up to different levels. Mrs. Oak also recognized that digital games were an effective way to assist students in visualizing an action. The game was an approach for students to picture the keyboard so they could relate that to typing the correct keys. In addition, Mrs. Oak's use of technology and pedagogy to facilitate student motivation represented her use of *technological pedagogical knowledge (TPK)*. In the example, she motivated students by praising their performance on the educational game. Her emphasis was on the pedagogical strategy of motivation. Mrs. Oak described the lack of resources, not having headphones, as a factor that influenced her ability to use the full affordances of the technology.

After recognizing each student, Mrs. Oak moved on to the next activity. She asked students to sit on the floor in front of the projector screen. Mrs. Oak sat in a chair in front of the class and explained the next activity. To connect the forthcoming lesson with the previous day's lesson, she recapped the activity the students worked on last week that was writing letters to teachers for teacher appreciation week. Subsequently, she explained to the students that they were going to continue a discussion on how to write a letter in "MS Word." Proceeding with more details, Mrs. Oak informed the class

that they would review how to write a letter together, and then students would write their own letters. After introducing the activity, she moved forward with guided practice.

In beginning guided practice, Mrs. Oak left her chair, walked to the computer, and outlined the steps for opening "Word." In the activity, Mrs. Oak used her *technological knowledge* to maneuver MS word. In addition, she used her *technological pedagogical knowledge* to explain and model the procedures to operate MS Word. In that instance, Mrs. Oak's ability to demonstrate to students how to complete tasks in the word processing software was independent of content. The emphasis was on the pedagogical strategy of modeling.

Next, Mrs. Oak explained and modeled how to write a letter in MS Word. Figure 10 provides an illustration of the activity.

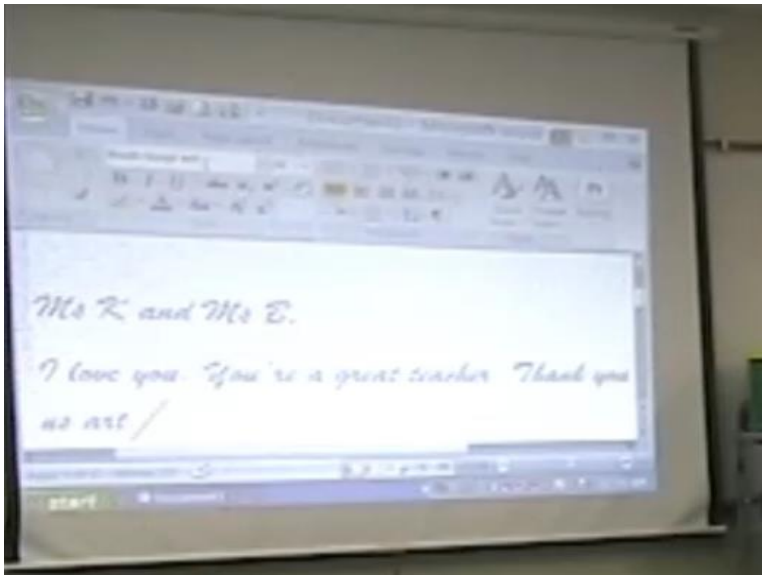


Figure 10. Oak Lesson 1: Typing a Letter

She began by asking one of the students what he would like to type in the letter to the teacher who won the Teacher of the Year award. At that point, Mrs. Oak walked to the whiteboard to draw similarities between writing a letter and typing a letter. Continuing to type, she asked the students to spell one of the words in the letter. She asked the students to raise their hands if they wanted to add something else to the letter, chose one of students, and typed the suggested sentence. As Mrs. Oak continued typing, she asked the students what step she should take next. The students responded, and Mrs. Oak completed the action in the document.

Mrs. Oak continued to instruct while standing at the projector screen. She asked the students what should be placed at the very end of a letter. With no response from students, she read the letter and asked the students again. At that moment, Mrs. Oak had to pause to reprimand a student. She then reminded the rest of the students that they needed to listen and pay attention. Moving on, Mrs. Oak returned to the computer and added a closing to the letter. She continued to explain how to customize the letter using the formatting tools in MS Word. Mrs. Oak finished the guide practice by asking students to raise their hands if they were ready to work. In the activity, Mrs. Oak's use of technology, pedagogy, and content knowledge to facilitate student's learning represented her use of *technological pedagogical content knowledge*. In the example, she used Microsoft word and a projector to model how to compose a letter.

During the follow-up interview, Mrs. Oak discussed the guided practice activity. She explained that using modeling and demonstrating the steps so students could see them on the projector helped with their ability to apply the information during

independent practice. Conversely, some students who still did not understand after she modeled needed one-on-one instruction. Mrs. Oak conveyed that having an additional person in the classroom to provide students with one-on-one assistance using the technology and learning the software would have better supported the lesson. In addition, she expressed that the lesson would have been better delivered using the desktop computers and the Promethean board in the computer laboratory. Mrs. Oak explained that during the guided practice she would have modeled the steps and let students repeat them on the Promethean Board before going to their seats. The comment illustrated Mrs. Oak's knowledge of technology and pedagogy which represented her *technological pedagogical knowledge.* In the example, she demonstrated knowledge of the existence, components, and capabilities of the Promethean Board and how she could have changed her instruction if she had used different technology. Her use of guided practice was not specific to the content.

Mrs. Oak indicated that being in the computer laboratory would have made it easier for the students to work because of the larger keyboards and screens on the desktop computers. She stressed that students in kindergarten and first grade were still developing their fine motor skills. The example was an indication of Mrs. Oak's knowledge of technology and pedagogical strategies to support learner characteristics, and represented her *technology pedagogical knowledge*. In the example, she was aware of the desktop computers and the developmental appropriateness of students using the technology. Scheduling of the computer laboratory influenced her ability to use the

knowledge in practice. Mrs. Oak reported that she did not use the computer laboratory because another teacher was using it at the time.

In beginning independent practice, Mrs. Oak had students return to their seats to work independently on the activity. As students began working on writing their letters, she walked around offering students help as needed. While students worked, Mrs. Oak spoke with a student about his behavior and gave him an alternative assignment. She reminded the rest of the class to stay seated and raise their hands for assistance. Mrs. Oak reprimanded a couple of students for accessing the internet, which was not a part of the steps she presented for writing a letter. Holding students accountable for equipment used was an example of her *technological pedagogical knowledge.* She continued to provide one-on-one assistance to the students who needed it. Mrs. Oak told the students that she would help them when they raised their hands as instructed. One student asked a question. In response to the student's question regarding whether or not one can erase "things" in MS Word, she discussed new topics. Standing at the projector screen, Mrs. Oak explained how to use the backspace button and how to move the cursor and use the backspace to erase the desired portion of the MS word document. During the activity, Mrs. Oak used her *technological knowledge* to operate MS word. In addition, she used her *technological content pedagogical knowledge* to explain and model the procedure to demonstrate how to use MS Word.

Wrapping up the activity, Mrs. Oak announced to students that they only had 10 minutes left to work. She announced she would save the first letter on a jump drive and student who finished first could use the free time to play ABC mouse. At that time, Mrs.

Oak set the timer and continued to offer students one-on-one assistance as needed. After 10 minutes she saved each student's work and dismissed the class. During the follow-up interview, Mrs. Oak explained that she could not decide how to approach saving each student's document, the last step of the day. She expressed that it was time consuming for her to go to each student's computer and save his or her work. However, she anticipated that if students saved their own work, they would do it incorrectly, which would lead to work being lost. Mrs. Oak's knowledge of the time it takes to save information was an example of her *technological knowledge*.

During the follow-up interview, Mrs. Oak conveyed that she was pleased with the instructional strategies and technology used to accomplish the learning goal. At the end of the lesson, she was content with what students produced and that they were able to navigate through MS Word and type a something. Mrs. Oak explained, "I wanted them to get into the program and use Microsoft Office and the computer to communicate and every single one of them had a letter at the end, which I was able to save."

Mrs. Oak described supports from the school that influenced her ability to use her technology integration knowledge in practice. She specified having working laptops and having more bandwidth installed at the beginning of the year as factors that improved the flow of the lesson. Mrs. Oak indicated that not having the laptop cart plugged in was a minor barrier which led to some of the computers shutting down for some of the classes later in the day and added that the cart was usually plugged in.

Lesson 2. The second observation was with the second-grade class. The goals for the day were for students to practice typing and share a presentation that they created

during previous class sessions. Before students arrived, Mrs. Oak connected the iPad to the projector. She projected the customized ClassDojo website for the class from her iPad. The website was a behavior management tool that allowed her to track and generate data on the behavior of every student in the class. Students arrived and sat in their assigned seats and table. Mrs. Oak, standing at the front of the class with the projector screen down, explained what the class would be doing for the day. In addition, she let students know she would be tracking their behavior using the ClassDojo as they worked. Reflecting on student behavior, Mrs. Oak reported that she learned how to use ClassDojo during professional development with UCF CREATE over a year ago. She indicated that she began to use the website immediately following professional development. Mrs. Oak highlighted that she created a ClassDojo page for each of her classes, and that it was effective at helping her manage student behavior. She highlighted that the website was a big incentive for her students because they liked to see the positive points that they earned.

In the activity, Mrs. Oak used technology and pedagogy to facilitate classroom management which was representative of her use of *technological pedagogical knowledge*. In the example, she used the ClassDojo to assist in managing and tracking student behavior. The pedagogical activity of classroom management was independent of any content taught in the lesson. In addition, Mrs. Oak used the technology to enhance the effectiveness of classroom management. Tracking student behavior using the technology provided affordances such as the behavior chart that might not have been

possible using traditional methods. In addition, Mrs. Oak's knowledge of ClassDojo website and ability to operate the application represented her *technological knowledge*.

For the first activity, Mrs. Oak engaged students in independent practice. She spent the first few minutes of the class distributing computers. She invited students who were sitting quietly in their seats to come to the front of the room to get their computers so that they could begin typing practice. As she called for students, one by one, to get their computers, she removed the computers from the cabinet. Because of the large number of students in the class, Mrs. Oak asked a few students to use a desktop. She asked students who had their computers to type in the username and password which she had written on the whiteboard. The researcher observed that most students with a computer focused on completing the activity, and students who were waiting to get their computers chatted with their classmates. As Mrs. Oak continued to distribute the computers, she praised students who were quiet and following directions. She gave each of the students a computer with an assigned number. While handing out computers, she noticed a student typing randomly, walked over to him and took the computer from him, indicating he was not being safe. She explained:

> You know what the right thing to do when your computer screen comes up. If your computer does not come up the way it normally does, you may raise your hand. You could break this computer by typing random commands. That is not safe.

The excerpt demonstrates Mrs. Oak's ability to hold students accountable for the equipment used and was an example of her *technological pedagogical knowledge.*

After students were online, Mrs. Oak announced they had 10 minutes left to work. The researcher observed that most of the students were on task as they worked on their computers. As students completed a level, the computer game played a song. After 10 minutes, Mrs. Oak asked students who had completed a level to raise their hands and she walked around the room to check. When she finished checking, Mrs. Oak asked the rest of the class to give the student who completed a level, a hip hip hooray! Subsequently, all of the students shouted "hooray," and Mrs. Oak gave an award to the student for finishing. Most of the students in the class received a hip hip hooray! As it had in the first lesson, Mrs. Oak's use of technology and pedagogy to facilitate student motivation represented her use of *technological pedagogical knowledge (TPK)*. In the example, she motivated students using the educational game. Her emphasis was on the pedagogical strategy of motivation.

Wrapping up the independent practice activity, Mrs. Oak pulled the projector screen down and asked students to exit out of the game and go to their home screens. While walking back to the projector and computer, Mrs. Oak praised students who were following directions. Once at the computer, she opened the ClassDojo website and displayed it on the projector screen. She selected a few students to track their behavior and gave them an award for following directions.

For the next activity, Mrs. Oak announced to the class they were going to start sharing their PowerPoints. At that point, she asked students who knew their PowerPoint was incomplete to raise their hands to get an alternate assignment. Mrs. Oak encouraged students by indicating that it was permissible to have an alternate assignment. A few

students raised their hands and went to the front of the class to get an alternative assignment. At the same time, Mrs. Oak gave the directions for the alternate assignment. As students received their alternate assignments, they returned to their computers. The researcher observed that over half of the students in the class asked for an alternate assignment. As she finished distributing the assignments, Mrs. Oak explained that the rest of the students should have their PowerPoints completed for a grade.

During the follow-up interview, Mrs. Oak provided further context for the activity, giving an account of the lessons leading up to the current lesson. She shared a list of activities that students had worked on for the last several weeks including: finding, sizing, and saving pictures; researching animals; adding pictures; selecting layouts and formatting using MS PowerPoint program. Mrs. Oak reported the content for the PowerPoint was on animal diet and habitat. The activity for the day's lesson was for students to present the PowerPoint that they created to the rest of the class.

In addition, Mrs. Oak noted that there were requirements for the content and format of students' PowerPoint presentations. She explained that if students did not meet those requirements, they received an alternate assignment. The requirements for students to present were to have (a) at least four or five slides, (b) a slide with information about their animal's habitat and diet, (c) fun facts about their animal, and (d) a title slide with a picture. She reported that some students had an alternate assignment because they had to start their PowerPoint over every week. She explained that some students did not save their work or they saved a blank presentation with the same title and lost their work. In addition, she mentioned that some students "played around" on the internet instead of

doing research and finding the specific pictures they needed. Mrs. Oak's ability to envision potential student problems with particular technologies and plan relevant activities to support those students illustrated her *technological pedagogical knowledge*. Mrs. Oak indicated on the days students worked on the project, a volunteer parent helped provide one-on-one assistance to help students with PowerPoint.

In preparation for the presentations, Mrs. Oak asked the students who had a PowerPoint to have it opened on their computers. She noticed that a couple of students were still editing their PowerPoint and assigned them the alternate assignment. Mrs. Oak had the entire class sit in front of the projector screen and wait for the presentations to begin. The researcher observed that some of the students talked and goofed around as they waited. Continuing to get ready to have students present, Mrs. Oak sat in a chair in front of the room and raised her hand to quiet the students. Though she praised students who were sitting quietly and demonstrating the correct behavior, it took a few minutes to get the entire class to pay attention. After she had the attention of all students, Mrs. Oak picked up the first presenter's computer and walked over to the projector to connect it. As she connected the computer to the projector, she explained that she was going to track students in the ClassDojo and added disruption points for a few students. Five students presented their PowerPoint projects; students shifted through their PowerPoint projects, discussing the animals they choose to research. After each student presented, Mrs. Oak disconnected his or her computer and connected the next presenter's computer. Figure 11 provides one of the screen shots from a student's PowerPoint presentation.

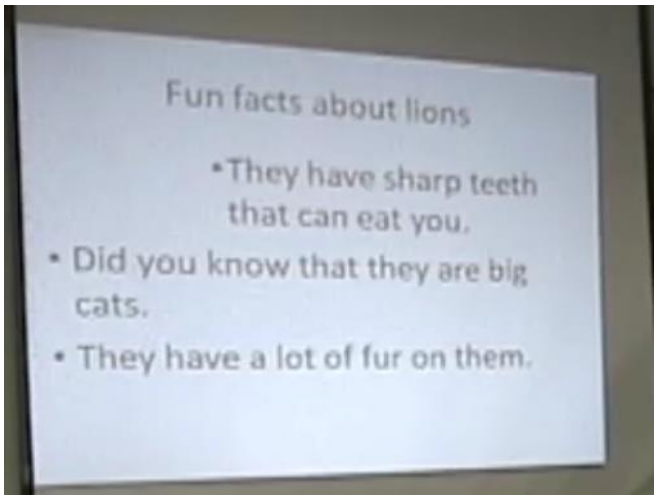


Figure 11. Oak Lesson 2: PowerPoint Presentation

The researcher observed that students who were not presenting were engaged as they listed to the presenter. However, students talked between the presentations. Applause followed each presentation. Following the presentations, Mrs. Oak thanked the students and dismissed the class. In the activities, Mrs. Oak's use of technology, pedagogy, and content knowledge, illustrated her *technological pedagogical content knowledge*. In the example, she facilitated students' use of PowerPoint to present information on animal habitats. Facilitation of students' use of PowerPoint was the pedagogical strategy to guide students as they presented their work. The students presented content specific to the topic of animal habitats using technology.

Reflecting on the lesson, during the follow-up interview, Mrs. Oak expressed the belief that her instructional strategies and the technology enabled students to complete the project from beginning to end. She indicated, however, that there were components she would modify in the future. She explained, "I haven't decided yet if it will be totally

technology based or if I'm going to do some book research and then do the technology piece." Mrs. Oak, indicated that although students could do research on the internet; they had not developed their digital literacy skills. She explained that there was a lot of information available which was not necessarily at the correct reading level; and that students did not know how to make sure their information was from a reliable source.

Mrs. Oak also explained a few ways she would modify the lesson. She suggested that she might use a WebQuest instructional strategy to help students to achieve the learning goals. Mrs. Oak explained that she would give students a pre-determined list of animals and children-friendly websites like National Geographic Kids, and PBS Kids, that had a lot of animal information. She added that the information would be on a webpage that students could access which would potentially safeguard them from going to inappropriate websites. The statement revealed Mrs. Oak's knowledge of technology, pedagogy, and content which constituted her *technological pedagogical content knowledge*. In the example, Mrs. Oak described how she would adjust her pedagogical strategies based on students' prior knowledge to improve their understanding of the content they found on the internet. Another modification Mrs. Oak explained was first having students do research with assigned readings from the science content books in her classroom prior to using the internet. After the assigned readings, she would allow them to use the computer to conduct additional research.

Mrs. Oak described some of the barriers she had overcome. She reported that there were 25 students in the class and only 20 laptops. She explained that three students used the desktop computers. Because one of the student desktops did not have

PowerPoint, Mrs. Oak had one student use her desktop computer, and two students shared one computer. She noted that it was "not a big deal" for students to share, but it was difficult for students in their age group. Another barrier was the size of the class in general. She explained that with such a large class, it affected the amount of time she was able to work one-on-one with students. Mrs. Oak's knowledge of the amount of time needed to teach with technology represented her *technological pedagogical knowledge.* She believed that having more working computers, an assistant and/or less students, or dividing the class in half would have made a difference in the amount of work students could produce. Mrs. Oak's ability to use other options to solve technological obstacles represented her *technological pedagogical knowledge*.

Notwithstanding the modifications and barriers, Mrs. Oak indicated that she was satisfied with the lesson and believed students benefited from working on the project. She indicated that the students who completed the project gained experience using the internet for research, finding information about their animals, and creating a PowerPoint presentation. Additionally, she believed that students supported their own and their peers' learning as they created their presentations. Mrs. Oak stated that some students benefited from seeing examples of their classmates' work because it motivated them to try out different formats and designs in PowerPoint. Overall, she believed the project prepared students so that they would be more adept at completing independent projects using PowerPoint in the third grade. The aforementioned comments showed Mrs. Oak's *technological pedagogical content knowledge*. In the example, she was aware of how the

technology and the assignment increased both students' content knowledge and technology skills.

Lesson 3. The third observation was of a fourth-grade class. Mrs. Oak explained that the learning goal for the day was that students understand that speed is distance divided by time. As students, lined up outside of her classroom door, she made sure that they were demonstrating the correct behavior and were ready to enter the classroom. As students entered, Mrs. Oak welcomed them as technicians, engineers, scientists, and mathematicians. Students grabbed their journals as they came into the room and sat at their tables. Mrs. Oak announced that in one minute she would check their journals. She gave students one minute to write the essential question for the day in their journal. Mrs. Oak counted down the seconds and after the minute elapsed, she awarded each table a point for being on task and completing the task.

Before starting the first activity, Mrs. Oak played a song to warm the students up and introduce the topic for the day. Before starting the music, she explained to the class that during the song, they could write some of their ideas about what speed and motion are in their journals and share those ideas with the class after the song ended. At the same time, she lowered a projector screen and walked to the projector. Students sang along following the song lyrics on the projector screen. During the follow-up interview, she reflected on the use of the song at the beginning of her lesson. Mrs. Oak explained that she looked for songs and lyrics on the internet, especially YouTube. She explained that she selected songs that were upbeat and engaging to students, especially songs that had animations. As she explained during our initial interview, she believed students

learned and recalled information better when they listened and followed along to the songs. She added that she liked to leave the lyrics of the song on the screen to help students follow along. The comment illustrated Mrs. Oak's knowledge of technology, pedagogy, and content, which represents her *technological pedagogical content knowledge*. In the example, she demonstrated knowledge of the capabilities of songs to transform content and appeal for students and to improve content understanding. She also recognized that displaying the lyrics while students listened to the song appealed to multiple senses. In addition, choosing songs that are engaging to students, illustrated her *technological pedagogical knowledge*. Further, Mrs. Oak's ability to find and select songs on YouTube illustrated her use of *technological knowledge*.

After the song ended, Mrs. Oak gave some students rewards for appropriate behavior. To wrap up the activity, she asked students to raise their hands if they wanted to share something about speed or motion. Mrs. Oak called on students; and as students gave answers, she wrote their answers on the whiteboard. Below is an excerpt from the student-teacher dialogue of the speed and motion review:

> Mrs. Oak: Who would like to share? If you would like to share something that you know about speed or something that you know about motion, you may raise your hand.
>
> Student: The thing about speed is. . . say you have a tennis ball and you throw it hard. It might go farther. . . but if you throw it soft it may not go as far.
>
> Mrs. Oak: So you are telling me a little bit about distance now right?
>
> Student: Yeah.

Mrs. Oak: And what he was saying is if you throw a hard force or strong force, is it going to go faster or further?

Student: Further.

Student: Faster.

Mrs. Oak: Hard force is going to make something go further and faster. And, a, let me say larger force, and a smaller force is going to make it go a short distance and slower. That is a fantastic review item. Thank you orange table...

Student: Motion is how something moves.

Mrs. Oak: Yes, how something moves, that was mentioned in the song. I want to hear from someone at the blue table, Denise.

Student: Speed is something that helps you understand how fast something or someone goes.

Mrs. Oak: So a word that we are going to use to describe speed would be fast or how fast. I want to move on. Justin?

Student: Motion is like push and pull, because you are pulling back and forth.

Mrs. Oak: Push and pull cause motion, fantastic! What is the other part of this? When we wanted to know how fast the marble was moving, what did we do to measure? It had two measures.

Students: A yard stick

Mrs. Oak: What was the other tool we used to measure? Someone help her out? Raise your hand if you know it.

Student: Time

Mrs. Oak: Right, we used a cell phone to measure time. That was my other measuring tool, the timer on my cell phone. You know that speed is for fast or slow and we know that the way we measure it is the distance and the time and we are going to divide distance by time

As she finished the discussion, she lowered the projector screen and walked to the projector. Still talking, she projected a worksheet using the document camera and introduced what the class would be doing for the next activity. Mrs. Oak explained that because the class had just reviewed how to do speed problems, they would be trying some speed problems on their own. She indicated that the problems would require students to engage in more inferring and deeper thinking. As Mrs. Oak walked to the front of the class, she explained that she would model and show her thinking for the first problem, after which they would practice one together. Mrs. Oak read the problem aloud to the class. After reading the problem, she said she would show the class how to do the problem the hard way first and then the easy way. Again, demonstrating her classroom management skills, Mrs. Oak paused to direct students to pay attention and listen. After she had everyone's full attention, she worked through the problem on the whiteboard. As she wrote on the whiteboard, she asked students questions and explained her work. When Mrs. Oak finished solving the problem, she pointed out the right answer. Before moving on, she asked students if they understood. Figure 12 illustrates the speed problem-solving activity using a whiteboard.

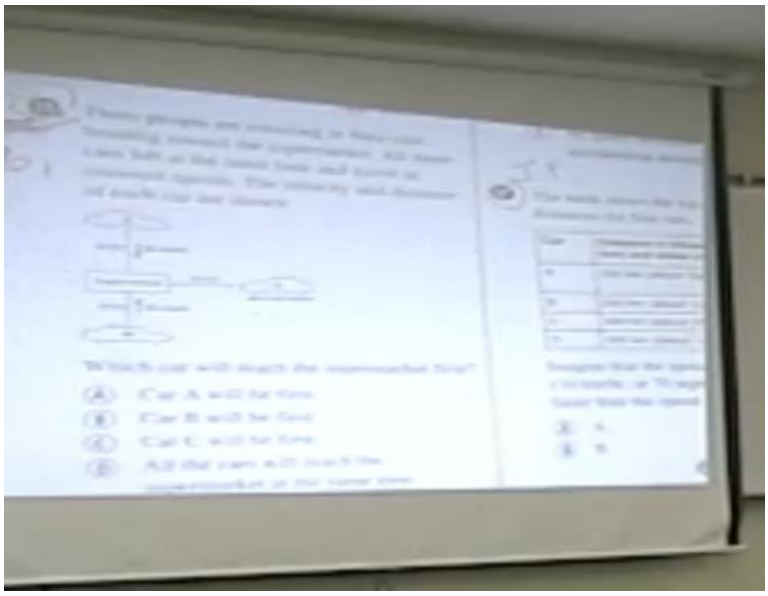


Figure 12. Oak Lesson 3: Mathematics Speed Problem

Reflecting on her use of the projector and document camera for the activity, Mrs. Oak explained that the technology assisted in the demonstration and modeling portion of the lesson. She indicated that projecting and using the document camera was helpful because students were able to follow along with her as opposed to having a piece of paper with the same thing on it. She explained, "They might not know exactly where I am if I'm just reading it and doing it on my own desk. Whereas, if they can see it on the screen, they can see what I'm doing and they can see me do the work on it and I just think it helps keep them focused a little better." The comment illustrated Mrs. Oak's knowledge of technology and pedagogy which represented her *technological pedagogical knowledge*. In the example, she understood how using the projector and document camera enhanced her pedagogical strategies.

Moving on to the next activity, and as she walked to the projector, Mrs. Oak explained to the class that they would do a problem together. Once at the projector, she moved the worksheet so that students could see the next problem. Soon after, she walked to the whiteboard and asked a student to read the problem aloud to the class. As the student read, one student commented that one of the words in the problem was from the song. After Mrs. Oak thanked the student for reading, the class worked through the problem together. Mrs. Oak called on different students to answer questions, and as they responded, she wrote their answers on the whiteboard. At the end of the activity, Mrs. Oak praised the class for getting the correct answer.

For the next activity, Mrs. Oak had the students solve a problem on their own for practice. She walked to the projector to display the next problem. Before students started working on their own, she gave them a hint to help them solve the problem. In addition, she crossed out unrequired information from the problem that she believed would be confusing. As students worked to complete the problem, Mrs. Oak walked around and assisted when needed. Students talked to their partners as they worked through the problem. After 10 minutes, Mrs. Oak gained the class's attention. At that point, she walked to the projector screen and worked through the problem on the whiteboard with the students. At the conclusion of the activity, students celebrated for having the correct answer.

Closing out the lesson, Mrs. Oak explained that the class would do a little more review about motion and then complete a quiz. She reviewed the concept of motion, units to measure distance, kinds of forces, and the concept of position. She then

explained the directions for the quiz and passed out a worksheet. Students worked independently on the quiz for the remainder of the class.

During the follow-up interview, Mrs. Oak said she believed the lesson went well. She reported there were few modifications she would make to the technology, instructional strategies or the content. She indicated that though the lesson was not technology heavy, it served its purpose by connecting what students learned from prior hands-on investigations. Mrs. Oak explained that students needed the hands-on investigations to understand the concept of speed. The technology allowed her to show students how to use what they learned from the hands-on investigations to find the answer when they were taking a test. In addition, she believed the song was effective at helping students review and define concepts. The comment illustrated Mrs. Oak's knowledge of technology, pedagogy, and content that represented her *technological pedagogical content knowledge.* In the example, she used the technology to model concepts so students would be able to associate with their prior knowledge more effectively.

Lesson 4. The fourth observation was of a second grade class. The goal for the day was for students to describe different types of plants. Mrs. Oak greeted students as they entered the class. The researcher observed that students came in talking loudly. In addition, the researcher observed one of the students slap another student and reported it to the teacher. While she was taking care of the situation, Mrs. Oak warned the rest of the class not to get involved. After Mrs. Oak wrote up the student, she praised some students for having good self-control and taking personal responsibility for themselves.

At that moment, she walked to the projector and set-up the ClassDojo, giving points to students who were following directions. She continued to work on the ClassDojo, checking around the room to see who was present or absent. Figure 13 provides a screen shot projection of the ClassDojo.

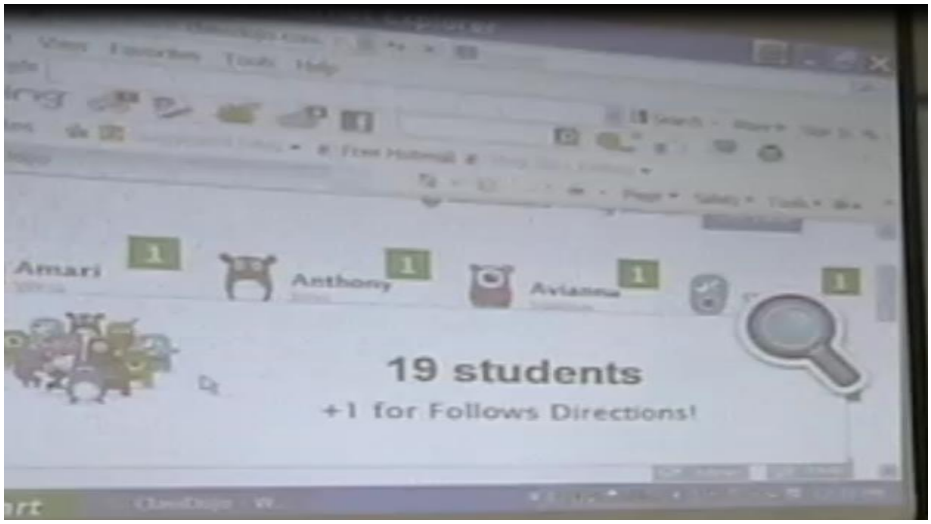


Figure 13. Oak Lesson 4: Screen Shot of ClassDojo

As mentioned in previous lessons, Mrs. Oak's use of technology and pedagogy to facilitate classroom management represented her use of *technological pedagogical knowledge*. In the example, she used the ClassDojo to assist in managing and tracking student behavior.

After managing classroom behavior, Mrs. Oak moved on with the lesson for the day. She informed the class that she had a new song. However, before Mrs. Oak could begin explaining, a few students interrupted her. She let those students know they would receive a point for classroom disruption. Continuing, Mrs. Oak displayed the words to

the song on the projector and walked over to the music player to start the song. Before she began playing the song, Mrs. Oak told the class her expectations for participation. She explained, "We have a new song but the first time I do not want you to sing it, the first time I want you to listen and read. If you participate appropriately by listening and reading you are earning your participation mark." Reflecting during the follow-up interview, Mrs. Oak explained that she wanted to put spaces between the verses and make the font bigger so students could follow along with the song. The comment presented her, once again, illustrated how Mrs. Oak used knowledge of technology, pedagogy, and content and represented her use of *technological pedagogical content knowledge*. In the example, she demonstrated knowledge of capabilities of songs to transform content and appeal and to improve content understanding.

After the song ended, Mrs. Oak started a discussion about the song. She called on several students to discuss what they heard in the song. Several students responded. Following is a brief excerpt from the five-minute student-teacher discussion:

Mrs. Oak: Christopher what was that song all about?

Tim: Plants.

Mrs. Oak: Just plants?

Tim: Plants and vegetables.

Mrs. Oak: Plants and vegetables? Thank you for sharing, I appreciate that and I will give a point to the green table. Would you like to add into that Tina?

Tina: Yes.

Mrs. Oak: What about plants?

Before the student could respond, Mrs. Oak had to stop again to reprimand another student. She then reminded the rest of the students that they needed to listen and pay attention. She continued with the discussion while standing at the whiteboard. Below is a continuation of the student-teacher discussion:

Mrs. Oak: I want to hear what Tina has to add on. Tim said the song was about plants and vegetables. Tina what would you like to add on?

Tina: I want to add it is about plants, and I think we need plants to survive.

Mrs. Oak: Why, why do we need this need to survive?

Tina: Because some parts have fruits.

Mrs. Oak: Okay, some have fruits. Thanks for participation. Why do we need plants to survive Isaac?

Isaac: We need plants to survive because they keep us healthy and strong and they can also and foods can help our digestion.

Mrs. Oak: Oh, they do help our digestion; you are right. They keep us healthy and strong. Why do we need plants to help us survive? Johnny?

Johnny: Also some vegetables have calcium that makes your teeth strong.

Mrs. Oak: Some vegetables have calcium, smart. Johnny, I love the way you knew you didn't need to call out the answer. You took your answer, you agreed, so smart.

Mrs. Oak continued the discussion by calling on different students from each table. As students responded, she awarded them points for their table. Throughout the

discussion, Mrs. Oak had to use her classroom management skills to manage classroom behavior.

Moving ahead, Mrs. Oak began a new discussion about plants and asked students their favorite plant to eat. Before she could begin, Mrs. Oak had to use her classroom management skills to manage student behavior. Then, she walked over to the computer and added more classroom disruption points to the ClassDojo. Afterwards, she walked back to the whiteboard to continue the discussion. Mrs. Oak called on students who were sitting quietly to tell her their favorite plant to eat. Several students raised their hands to respond to the question. As students answered, Mrs. Oak wrote their answers on the whiteboard, as shown in Figure 14.

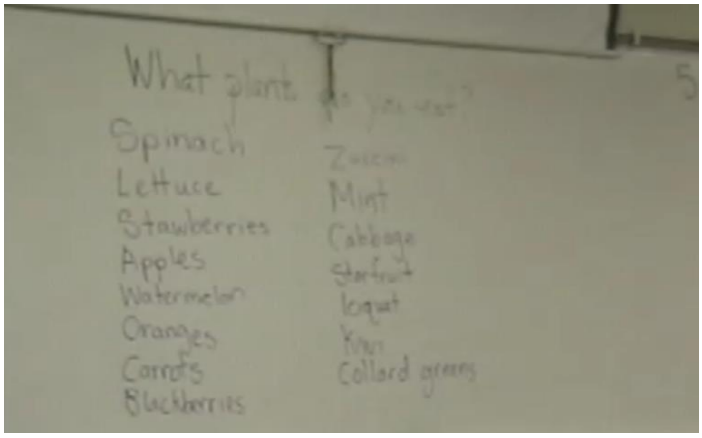


Figure 14. Oaks Lesson 4: Favorite Plant Responses Using Whiteboard

Following is an excerpt from the five-minute student-teacher discussion:

Ken: My favorite plant to eat is spinach.

Mrs. Oak: I love spinach.

Student: That is my favorite one too.

Mrs. Oak: What is your favorite plant to eat Jose?

Jose: My favorite plant to eat is lettuce and salads.

Mrs. Oak: Lettuce salads? We are going to move on. Anna what is your favorite plant to eat?

Anna: Strawberries.

Mrs. Oak: I am not going to call on anybody who is calling out. Thomas, what is your favorite plant to eat? I can't hear Thomas even though he addressed me inappropriately, and I called Thomas, that is a problem.

Thomas: My favorite plant to eat is an apple.

Mrs. Oak: Omar what is your favorite plant to eat?

Omar: Watermelon.

Mrs. Oak: I want to be able to let everyone share, I think green table is next, Jordon?

Jordan: It's like salad but it's a leaf that tastes like mint.

Mrs. Oak: Mint

Mrs. Oak: So, mint, you like mint flavor that comes from a plant. That's a good connection, that's good. If you eat mint, you don't like eat like a salad of mint because that would be weird. You use mint leaves to season and add flavor, but otherwise that is beautiful. Who else is listening appropriately? What is your favorite plant to eat Maya? What's your favorite plant to eat Johnny?

Johnny: Cabbage.

Mrs. Oak: I love cabbage. What's your favorite Adriana? Maybe you should pay attention to your classmates as they were sharing.

Adrianna: My favorite food is Star fruit, and I don't know the name, but it is really small, it is sweet and orange on the side and it really small, it's a Chinese plum

Mrs. Oak: Is it a cumquat? I'm going to look up.

At that moment, to help the student find the plant that she was trying to describe, Mrs. Oak walked over to the computer to search for a Chinese cumquat using Google search. After several results were shown on Google image, she asked the students to tell her if either one of the images displayed on the projector screen was the fruit. While searching, Mrs. Oak had to use her classroom management skills to manage student behavior. She stopped and added more classroom disruption points to the ClassDojo and asked students how their parents would feel if they saw four or five classroom distractions coming from them. Continuing, Mrs. Oak walked back to the whiteboard to write the result, which she called a loquat and explained that it is in the same family as a cumquat. In the activity, Mrs. Oak's knowledge of technology and pedagogy denoted her *technological pedagogy knowledge*. In the example, she used the technology to display information. Mrs. Oak used the projector to display the image from her Google search onto the projector screen so the class could see what the fruit looked like.

She continued the discussion, asked the rest of the class about their favorite plants, and wrote it on the board. At the same time, Mrs. Oak had to manage several disruptions.

After the discussion, Mrs. Oak moved on to the next activity. She asked two students to help her pass out a worksheet. At the same time, she told students that they would be in charge of reading and following directions since they were getting ready to go to the third grade. Subsequently, students worked independently to complete the worksheet. As students worked on their own, Mrs. Oak and Mrs. Day walked around the classroom to provide guidance if needed and check for progress. Mrs. Oak continued to use her classroom management skills and the ClassDojo as she tracked and monitored students' behavior during the activity. After five minutes, she asked students to come to the front of the room and submit their worksheets. Some students were disruptive, and Mrs. Oak used the computer to add disruption points on the ClassDojo.

Starting the next activity, Mrs. Oak asked students to sit in the front of the class. At the same time that she told the class, "I have a plant for you to eat," she passed a bag of carrots around the group. While they ate their carrots, Mrs. Oak monitored students for good self-control. After all of the students had a carrot, she seated herself in front of the class and began a discussion, asking students to identify different parts of a plant. As student guessed at the different parts of the carrot, Mrs. Oak wrote their answers on the board. After identifying and pointing to all of the different parts of a plant, she asked students to identify what part of the plant is a carrot, as follows:

Mrs. Oak: We all ate carrots. What part to you think they are, Alex?

Alex: Stem.

Mrs. Oak: Stem, how many people agreed with Alex and think it's a stem? Many people think it's a stem. Does anybody think it could be something else? Do you think, Jason?

Jason: A fruit.

Mrs. Oak: A fruit. Hands up if you agree with Jason that the plant is a fruit? Tammy, you don't think it is a fruit. What do you think it is?

Tammy: A seed.

Mrs. Oak: Seed. How many people agree with Tammy that it is a seed? So far I have a couple of people for seed, a couple for fruit, and a couple of people for stem. Nobody thinks it was the leaves?

Students: No, No.

Orlando: I think its roots.

Mrs. Oak: Orlando thinks it's the roots. Thumbs up if you agree with Orlando. Is there anyone who thinks it is a flower? So I am going to go one by one; you are going to tell me why you think that it is. Orlando, why do you think it is a root?

Orlando: Because I saw in some pictures because it grows in the ground. It goes in the ground. I would agree with Tammy, but I am not sure if it is the seed or if it is the root.

Mrs. Oak: So it being in the ground makes you know it is going to be either the seed or the root right?

Orlando: So I agree with Tammy.

Mrs. Oak: Tammy said seed. So what makes you think seed, Tammy?

Tammy: Because um, if you throw it out it could grow into a new carrot.

Mrs. Oak: Oh so if you throw out a carrot in your garden, it could grow into a new carrot. Interesting. Alex, you said stem. What makes you think stem?

Alex: I think it is a stem, because carrots, they grow leaves and on the top it has leaves.

Mrs. Oak: Oh, so you have seen in the grocery store the leaves on the carrot, so if the stem is below the leaves then you have a stem right?

Students: No, no, the leaves are on top.

Mrs. Oak: The leaves are on top.

Moving on, Mrs. Oak walked to the computer and projector and told the class she was going to put up a picture of what the students discussed. She searched for and then showed a picture of a carrot with leaves on top. While at the projector, Mrs. Oak added more disruption points to the ClassDojo for students who were off task and touching other students. After displaying the picture, Mrs. Oak walked back to the front of the room and pointed to the picture on the projector screen. Getting back to the discussion, she asked a student to come forward and point to where she thought the leaves and the stem were on the carrot. Then, Mrs. Oak pointed out the stem and the leaves on the carrot. Next, she pointed to the root and asked the class what part they thought it was. While students continued to guess, Mrs. Oak walked to the projector and computer to find another picture of a carrot. The researcher observed that students were excited and called out different answers.

Continuing on, Mrs. Oak walked to the projector screen and pointed to the picture she had just pulled up and asked, “So if it grows under the ground and it grows these root hairs off of the bottom and off of the edges. What part of the plant do you think it is?” One student answered “seeds.” Another student answered “fruit.” Mrs. Oak asked two more students the same question and produced a new picture. Students began yelling their answers. Due to the disruption, Mrs. Oak had to spend several minutes discussing classroom behavior. Continuing the discussion, after not receiving the response she was looking for, Mrs. Oak walked to the computer to find a picture of a carrot seed. Soon after seeing the picture of carrot seeds, the class concluded that the correct answer was “root.” Figure 15 provides an illustration of the carrot seed picture shown in the classroom.

Figure 15. Oak Lesson 4: Illustration of Plant Parts

In the activity, Mrs. Oak’s used her knowledge of technology, pedagogy, and content, which denoted her use of *technological pedagogy content knowledge*. In the

example, Mrs. Oak used the projector to display the image from her Google search onto the projector screen to improve students' understanding of the content. In addition, students were able to see a visual representation of carrots seeds.

Moving on, Mrs. Oak explained to the class they did not have time to finish the next activity, so she was not going to have them get their notebooks. At that time, students were not paying attention, and Mrs. Day had asked students to control themselves. Instead of having students do the activity in their notebooks, Mrs. Oak started a discussion about types of roots. Beginning the discussion, she walked to the computer and asked students if they knew of any other type of root that people eat. She called on several students and searched for an image as they gave an answer. Below is an excerpt from the student-teacher dialogue:

Mrs. Oak: Does anybody else know a root that we eat?

Isaac: This root is called Ginger.

Mrs. Oak: Oh, I love ginger.

Isaac: Ginger, you could make tea with ginger; you could make ginger tea. I just had ginger tea yesterday.

Mrs. Oak: This is a root we eat called ginger.

Mrs. Oak: I'll give a participation point for Isaac. If you know how to raise your hand appropriately to share a root we eat, you can earn your participation point. Joshua, what root do you eat?

Joshua: I eat celery

Mrs. Oak: It is close, but it is actually a different part of the plant, it is the stem. Johnny? Timothy?

Timothy: Spinach.

Mrs. Oak: Spinach is the leaf. Johnny?

Jonny: Carrots, no, not carrots what is it called again?

Mrs. Oak: You think as I pick someone else, Omar?

Omar: Turnips

Mrs. Oak: I love turnips. They are delicious. Do you have another one? Did you think of it Jonny? What is it?

Jonny: Onion.

Mrs. Oak: Good, onion. Kayla is having good self-control. Kayla what roots do you like to eat?

Kayla: Tomato.

Mrs. Oak: Oh, tomato. Tomato is a fruit. But, there is something that rhymes with tomato that is a root.

Students: Potatoes.

Mrs. Oak: This is a good illustration of the potatoes in the ground.

Figure 16 provides an illustration of the topic of the discussion, a root.

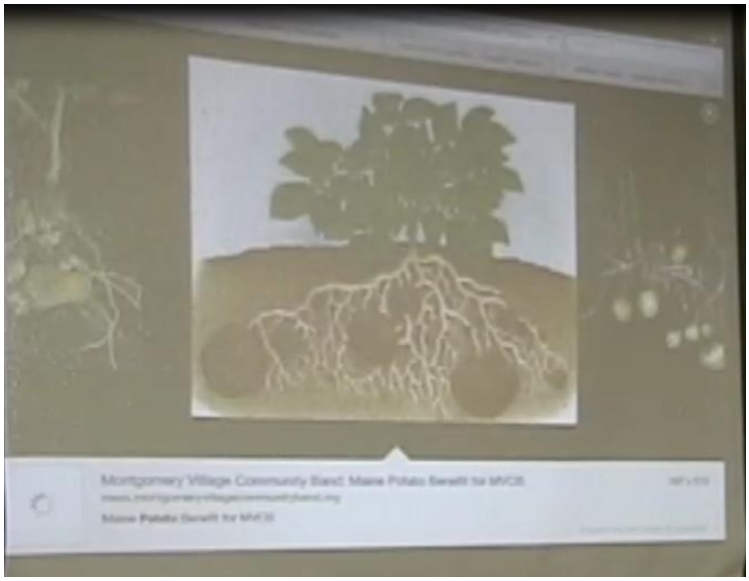


Figure 16. Oak Lesson 4: Root Illustration

Mrs. Oak displayed the last picture and thanked students for participating. At that point, she dismissed the class. Reflecting on the lesson, Mrs. Oak explained that she really relied on the projector and iPad, especially to look up information on Google. Mrs. Oak explained,

> Before I had the projector, we would have to listen to the song and remember the words and being able to project the words out there is really helpful. If we were talking about asparagus, and they don't know what asparagus is, I can look up a picture of asparagus and have it for them.

In the activity, Mrs. Oak used her knowledge of technology, pedagogy, and content which denoted her use of *technological pedagogy content knowledge*. In the example, Mrs. Oak used the projector to display the image from her Google search onto

the projector screen so students could see a visual representation of different types of roots and improve their content understanding.

As she had previously mentioned, and though it was manageable, walking back and forth to the projector was challenging. Mrs. Oak suggested that having the projector mounted overhead along with an interactive whiteboard in her classroom would help with classroom management. She explained that with the technology in the front of the room she would be able to control it from the front. Doing so would improve her ability to teach as she would not need to move from one location to the other or take her eyes off the class. In addition, she explained that students could present in the front of the class or interact with the technology. Overall, she believed it would make the flow of instruction better and enrich the content. The comment illustrated Mrs. Oak's knowledge of technology and pedagogy which represents her *technological pedagogical knowledge*. In the example, she described how technology could increase her productivity, effectiveness, classroom management practices, and the presentation of information.

The current lesson concluded the researchers' case report of Mrs. Oak. The researcher observed that Mrs. Oak was very comfortable and familiar with the content, technology, and instructional strategies throughout the lesson. Overall, the findings of the within-case analysis demonstrated how Mrs. Oak used her technology integration knowledge (TK, TPK, TCK, and TPACK) in the classroom. The researcher found several examples of how Mrs. Oak used each of the components of knowledge as she implemented both of the lessons, with the exception of TCK. The results of Mrs. Oak's within-case analysis supported the findings from the survey. However, although Mrs.

Oaks' self-reported score for TPACK was the lowest mean score of all of the technology-related components, hers was the most observed use of technology integration knowledge. The combinations of technology, pedagogy, and content that Mrs. Oak described in the initial interview and had put forth in her lesson plans were evident during the observed lessons. An analysis of interviews, documents, and observations showed that Mrs. Oak demonstrated all components of TPACK except TCK.

She used her technology integration knowledge in many of the activities during the lessons. Her most frequent uses of TK for teaching were to operate and select software and hardware such as the projector, iPad, document camera, and netbooks. She also instructed students in the operation of hardware and software to learn new skills using technology. Mrs. Oak's primary instructional strategies using technology included facilitating, classroom management, student motivation, and displaying information, all of which represented her use of TPK. The focus of Mrs. Oak's use of TPACK was primarily to improve student content understanding. Mrs. Oak perceived use of TCK was below the mean for the group, and the researcher did not observe any instance of TCK.

Barriers influenced Mrs. Oak's overall use of the technology integration knowledge components of the TPACK framework. The researcher found that the most significant barriers, other than student behavior, were resource related. Appendix A shows the codes placed in the different categories in the lessons from Mrs. Oak's classroom. The coded lessons highlight the range of different activities, pedagogical strategies, and technologies that she used when implementing the lessons.

Administrators' Views

In addition to interviewing teachers, the researcher interviewed administrators from the school to obtain supporting information, if any, regarding contextual factors influencing teachers. Interviewees included the school principal and the director of curriculum, instruction & assessment. The researcher asked administrators to share their expectations regarding technology use and describe supports and hindrances of technology integration knowledge at the school.

Administrators' Expectations

Both administrators explained that they expected teachers to include their plans for integrating technology in their lesson plans. Mrs. Wilson, the director of curriculum, instruction, and assessment, explained,

> We don't have the state of the art sort of technology that we would love to have in the classroom. But, we totally expect them to use what they have, whether it is from the very basic. . . like using the document camera. The integration of their computers and center time is a huge thing and it is how most of them want to incorporate their technology by using available resources of websites. As well as you know any program that they have downloaded to their computers are for the appropriate grade level. A lot of them will incorporate for their centers for math and reading. As well as a lot of them have it transferred their writing on their computers and sort of beginning their basic computer skills. So there is that

expectations to get kids really accustomed to using computers especially because there are going to be testing on the computers.

The excerpt revealed that Mrs. Wilson's expectations were for teachers to use *technology knowledge* to operate the equipment available to them at the school and find applications to download. In addition, the focus of her expectations were not just on technology knowledge but were primarily related to the use of technology to support teacher's pedagogical strategies. Mrs. Wilson described using technology to support strategies such as development appropriateness, students working in centers, and students learning technology skills. Accordingly, the comment illustrated Ms. Wilson's expectations for teachers' use of *technology pedagogical knowledge*. In addition, the principal, Dr. Jones, commented that she expected teachers to plan their lessons and select technology based on learning goals and assessment of student learning. Similar to Mrs. Wilson, Dr. Jones expected teachers to use technology as part of student centers as well as a part of individual learning programs to help students build on skills in areas of low performance. While both administrators focused on teachers' use of technology to support pedagogical strategies, Mrs. Wilson's comment regarding selecting technology based on learning goals reflected her specific expectation for teacher's use of *technological content knowledge*.

Contextual Factors

Dr. Jones explained that making technology available was the biggest motivator and support for teachers to use technology. She explained,

> You know I really don't think there are a lot of things that would hinder them from using it besides them not being available. Our team is open to the use of technology, honestly the more technology you give them they more they will use it. When we have given them the opportunities to have the things…they have incorporated them right away, and if one teacher has it and the other doesn't then the other is asking for it because they want to use it.

Dr. Jones noted that after the teachers received iPads, she saw an increase in technology use. She explained that teachers downloaded apps that had instructional applications and made the iPads available for students to use in centers. She believed that beyond talking about technology, having the resources available was the biggest motivator for teachers to use it. In addition, she expressed that a barrier to the teachers' use of technology was not having direct access to the technology in their classrooms. For example, she explained that going to the computer laboratory made it harder for teachers to access and use the Promethean Board. She expressed, "Teachers like things in their classroom, they like it to be, accessible. . . and that piece would be the hindrance." She explained that having the technology saved them time and helped them better prepare. Related to technology resources, Mrs. Wilson explained that she believed the biggest hindrance to technology use at the school was technology not working properly. She explained that the school was in serious need of upgrades.

Both administers admitted that technology-related professional development was lacking. Although the school had supported teachers' participation in professional development in previous years, the focus of professional development school-wide was

on using Conscious Discipline techniques for classroom management. However, teachers were encouraged to participate in sessions or classes provided at conventions or through the school district. Mrs. Wilson explained that teachers have individualized professional development plans and could choose learning activities they preferred.

Phase II: Cross-case Analysis

The following section discusses the themes that emerged from a cross-case analysis of the individual cases. The researcher considered all of the data, comparing survey results, documents, interviews, and observations. The within-case analysis provided insight into two teacher participants' use of technology integration knowledge. The themes are discussed as they appeared within each of the four technology integration knowledge components (TK, TPK, TCK, and TPACK) and contextual factors.

Technological Knowledge

According to Mishra and Koehler (2006), technological knowledge is knowledge about different technologies and the skills needed to operate technologies, e.g. knowing how to create documents. In a later publication, Koehler and Mishra (2008) described technology knowledge in a similar manner as the fluency of information (FITness) proposed by the Committee of Information Technology Literacy of the National Research Council (NRC, 1999). FITness, includes knowledge about how to use technology, in general, but also deals with knowledge of how information technology can assist or impede the achievement of a variety of goals or tasks. In addition, FITness, requires

individuals to continuously adjust to changes in information and technology. In the FITness definition, technologies include general technologies, e.g., books and chalkboards, and advanced technologies such as digital videos. Cox and Graham (2009) distinguished between digital and non-digital technologies to strengthen the definition of technological knowledge. In their elaborated TPACK framework, the definition of technological knowledge focused on teachers' knowledge of how to use emerging technologies. Emerging technologies were described by Cox and Graham as those "technologies that are not yet transparent in the context under consideration" (p. 63) versus older technologies such as books. The distinction between dated technologies and emerging technologies helps provide a clearer distinction between TPACK and PCK.

The researcher attempted to discover similarities and differences in how the two participants used their technological knowledge (TK) in the classroom. The evidence of TK was derived from the research of Cox and Graham, Graham et al. (2010), and Mouza (2011) as previously reviewed in Chapter 3.

Table 8 displays the technological knowledge (TK) employed by Mrs. Brownstone and Mrs. Oak. As shown, both teachers demonstrated their ability to operate technology effectively. The researcher identified several commonalities between the two cases in their use of TK in practice.

Table 8

Technological Knowledge (TK) Indicators

Indicator	Evidence	Brownstone	Oak
Teacher operated technology effectively.	Operating computer hardware	✓	✓
	Using standard software tools (MS Word, PowerPoint, Internet browsers, e-mail)	✓	✓
	Installing and removing peripheral devices (USB drives, microphones) and software	✓	✓
	Troubleshooting equipment	✓	✓
	Using appropriate vocabulary (technology terms)	✓	✓

Note. ✓ = evidence observed; X = no evidence observed.

First, survey data indicated that both teachers perceived themselves has having a high-degree of TK as compared to the group. During observations, the researcher recognized that both teachers were comfortable operating the technologies they used in their classrooms and in the computer laboratory for teaching and learning which was a reflection of their TK. As they implemented their lessons, both Mrs. Brownstone and Mrs. Oak used their TK to operate various types of technology. Either the teachers or students used technology in each lesson observed by the researcher. The teachers operated newer and older technologies throughout the observations; however, they both primarily relied on technologies that had become commonplace within their school

community. Examples of technologies that they used in the classroom included the interactive whiteboard, projectors, iPads, document cameras, and netbooks. Mrs. Brownstone and Mrs. Oak regularly operated the projector, document camera, and whiteboard in most of the activities they planned and implemented. During some lesson activities, the teachers used their TK to allow students an opportunity to operate the technology, such as PowerPoint and the document camera.

Mrs. Brownstone and Mrs. Oak showed commonalities in how they used TK in their ability to select and determine how to use technologies in lesson activities. They used their TK to select resources available from websites, such as Google and YouTube. Both teachers selected videos from YouTube which they played during class activities. In addition to selecting technologies they had at their school, both teachers spoke about technologies that they would use if available. Mrs. Brownstone reported that she would like to incorporate technologies like the iPad for every student during activities. Both teachers discussed wanting to use the interactive whiteboard more often, particularly if it was in their classrooms. Additionally, Mrs. Brownstone indicated wanting to know more about the capabilities of the interactive whiteboard.

Lastly, both teachers used their TK during lesson activities to troubleshoot technical problems during teaching and learning. Both were able to find solutions quickly to limit interruptions or disturbances during lesson activities. Even though, neither teacher had technological background or a technology specialist available to assist, they were able to resolve issues with technology. As shown in the within-case analyses, both teachers were able to troubleshoot technology issues during lesson

activities. For example, Mrs. Oak was able to help students with any questions they had and troubleshoot some of their technical issues while facilitating students' use of the computers.

Despite the similarities among the teachers, the researcher identified several differences in how they used their knowledge of technology in practice. Because both teachers considered the subject matter and the context of their classrooms, e.g., students' preferences, the technologies that they selected were different. Mrs. Brownstone used the computer laboratory and attempted to use her TK to operate the Promethean Board. She specifically mentioned wanting to operate different components on the Promethean Board but was not able to because of technical difficulties. In addition, Mrs. Brownstone regularly searched for and used videos which she found on YouTube. She often used her TK to create PowerPoint slides and operate the software in the classroom. In several lessons, Mrs. Oak used the internet to search for images. In addition, Mrs. Oak used her TK to instruct students in the operation of hardware and software to learn new skills using technology.

Technological Pedagogical Knowledge (TPK)

The combined knowledge of technology and pedagogy delineates technological pedagogical knowledge. TPK refers the knowledge of how technology is used to support instructional strategies and goals. Koehler and Mishra (2009) explained,

> TPK is an understanding of how teaching and learning can change when particular technologies are used in particular ways. This includes knowing the

> pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies. (p. 65)

TPK is not particular to the teaching of a specific content or subject (Mishra & Koehler, 2006). For example, though not tied to any particular content area, knowing how and using technology for activities such as tracking student attendance, managing behavior, and/or grading, or the use of tools like discussion boards or chat rooms would constitute the use of TPK (Mishra & Koehler, 2006). In addition, TPK encompasses an understanding of how to repurpose a range of technologies and software for instructional purposes whose target audiences fit other areas, e.g., business.

Survey data indicated that the TPK of the two teacher participants in the study was below the mean for the group. During interviews and observations, the researcher attempted to discover how the two participants used TPK in the classroom. As Mrs. Brownstone and Mrs. Oak implemented their lessons, the researcher discovered both teachers used technology to support their instructional strategies. Interestingly, in both classrooms, the teachers primarily relied on technology as a teaching tool in support of their instructional activities and goals rather than as a learning tool.

The researcher attempted to discover similarities and differences in how the two participants used their TPK in the classroom. The evidence of technology pedagogical knowledge were derived from research (Cox & Graham, 2010, Graham et al., 2010; Mouza, 2011) as discussed in Chapter 3. Table 9 presents the TPK employed by Mrs. Brownstone and Mrs. Oak.

Table 9

Technology Pedagogical Knowledge (TPK) Indicators

Description	Evidence	Brownstone	Oak
Teacher used digital/emerging technology to support general pedagogical (instructional) strategies that are not specific to a content domain.	Classroom management Collaboration Assessment Active learning Project-based learning Practice/feedback Authentic real-world experiences Student presentation Student research Interaction Discussion Drill and Practice	✓	✓
	Productivity/effectiveness Improve teaching materials and content Presentation/display of information Developing strategies for assessing student work with technology	✓	✓
	Knowing about the time required to teach with particular technologies Ability to envision potential student problems with particular technologies and plan relevant activities to support those students Generating alternatives in the event of technological failures Holding students accountable for equipment used	✓	✓
	Knowing about the existence of a variety of tools for particular tasks	✓	✓
	Ability to explain a computer procedure to students (e.g., through modeling)		✓
Used technology to address general learner characteristics	Using technology to address: Learning style/preference Developmental/age appropriateness Learner motivation	✓	✓

Note. ✓ = evidence observed; X = no evidence observed.

As shown in Table 9, both teachers used TPK. Mrs. Oak and Mrs. Brownstone both expressed their TPK to support general pedagogical (instructional) strategies. Under the TPK description, the teachers demonstrated TPK in the following ways: improving teaching material, presenting and displaying information, explaining computer procedures to students, providing feedback to students, and classroom management. In addition, both teachers used their TPK to support learner characteristics by addressing student motivation. As shown in the within-case analysis, both teachers used the document camera to display and present information. In some cases, the teachers allowed their students to use technology to share with their classmates. For example, in both classrooms, the teachers gave students an opportunity to operate the technology to present information. In Mrs. Oak's class, students conducted research using the internet, search engines, and reported their findings using PowerPoint software. Students in Mrs. Brownstone's class had an opportunity to use the document camera several times to demonstrate their problem solving strategies and share their answers to mathematical problems. However, the use of the document camera was not much different from using a projector or having students solve the problem on the whiteboard. Nevertheless, because the document camera allows one to project in three dimensions, it did allow students to display the work they created while working in cooperative groups. Another example of TPK used by the teachers was the use of technology to provide feedback to students. In Mrs. Oak's class, she used technology to provide students with feedback on their behavior as a part of her classroom management strategy. Mrs. Brownstone used the document camera to provide feedback on solving mathematical problems.

In regard to classroom management strategies, both teachers were able to plan for technology use by either creating alternative strategies in the case of technology failures, envisioning potential student problems with particular technologies and creating relevant activities to support students, and holding students accountable while using technology. Lastly, in both classrooms, the teachers used TPK to make learning activities more engaging in order to address student motivation. Both teachers reported using videos and music frequently in their classroom, regardless of the subject matter, to motivate and engage their students. However, in some activities the teachers used videos as visuals to represent content and present information, which was representative of the teachers' use of technological pedagogical content knowledge.

The researcher identified few differences in how Mrs. Oak and Mrs. Brownstone used their technological pedagogical knowledge. Even though they taught different subjects, the instructional strategies supported by technologies were similar. One noticeable difference was Mrs. Oak's use of technology to support her classroom management strategies. In addition to managing classroom behavior while students worked on technology, she was able to incorporate a technology that provided feedback to students on their behavior. In addition, Mrs. Oak's knowledge of developmental appropriateness for different technologies demonstrated her TPK. She used her TPK by modeling and demonstrating to students how to complete tasks using MS Word.

Technological Content Knowledge (TCK)

According to Koehler & Mishra (2009), technological content knowledge (TCK) "is an understanding of the manner in which technology and content influence and constrain one another (p. 65)." Teachers, who demonstrate TCK, understand how technology can change the representation of content. For example, technology can create new and improved representations of content. In contrast, technology can also constrain the arrangement of different kinds of representations. Accordingly, when teachers use TCK, they are making decisions about the best representation of content using technology. TCK includes selecting suitable technologies for the content. For example, using Geometer's Sketchpad for teaching and learning geometry (Mishra & Koehler, 2006), constitutes the use of TCK. Using Geometer's Sketchpad, students can arrange different shapes to create different geometrical configurations. According to Koehler and Mishra (2008), TCK is the most ignored component in the TPACK framework (p. 16).

Survey data indicated that Mrs. Brownstone's TCK score was above the mean, but Mrs. Oak's TCK was below the mean for the group. During interviews and observations, the researcher made attempts to discover how the two participants used TCK in the classroom. However, TCK was the least observed component. The researcher also attempted to discover similarities and differences in how the two participants used their TCK in the classroom. Table 10 shows the TCK employed by Mrs. Brownstone and Mrs. Oak. The evidence of technology content knowledge were derived from the research of Cox and Graham (2010), Graham et al. (2010), and Mouza (2011), as previously discussed in Chapter 3.

Table 10

Technology Content Knowledge (TCK) Indicators

Description	Evidence	Brownstone	Oak
Teacher used digital/emerging technology to investigate, represent, or transform topics or subjects specific to the content area independent of pedagogical strategies	Using video, audio, a website, Web 2.0, blog internet to represent, transform, or investigate a topic or subject specific to a content area, e.g., math, history, science	X	X
Selection of technology based on the nature of the content or content-specific goals or learning outcomes	Using technology to construct graphs or diagrams, the writing of number sentences, or the presentation of a written or oral explanation.	✓	X

Note. ✓ = evidence observed; X = no evidence observed.

As shown in Table 10, neither Mrs. Oak's nor Mrs. Brownstone used digital/emerging technology to investigate, represent, or transform topics or subjects specific to the content area independent of pedagogical strategies. Mrs. Brownstone was the only teacher who expressed selecting technology based on the nature of the content or content-specific goals or learning outcomes, which is representative of TCK. She expressed that the content was the driving factor that determined her selection of technology.

Although both teachers found websites, used videos, and music that transformed or represented the content, the teacher's primary purpose for using the technology during

activities was to transform the content and the instructional strategy that was representative of their technology pedagogical content knowledge (TPCK). In several instances, the teachers used technology to provide a visual representation of the content/topic they were teaching. For instance, Mrs. Brownstone used a video from YouTube to provide information to students that would help expand their knowledge of division. In the activity, she needed to find a way to represent the content. However, the content-related need was connected to a pedagogical need of how to best present the information to her students. Mrs. Brownstone also discussed wanting to use the manipulatives tools available through the interactive whiteboard to represent content for students as part of an activity. However, given her concern for content representation, using the tools was, again, linked to a pedagogical need for student motivation

Technological Content Pedagogical Knowledge (TCPK)

Technological pedagogical content knowledge (TCPK) represents the interaction between technology, content, and pedagogy knowledge. Foremost, the TPCK component of the knowledge represents a teacher's ability to blend technology, content, and pedagogy together to effectively teach with technology. Koehler and Mishra (2009) described TPACK as

> the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of

> the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (p. 66).

Illustrative of TPCK would be a social studies teacher facilitating students' use of technology to create storyboards which would allow for a visual representation of the sequencing of historical events. Survey data indicated that Mrs. Brownstone's TPCK score was above the mean for the group. However, Mrs. Oak's self-reported TPCK score was below the mean for the group. During interviews and observations, the researcher made attempts to discover how the two participants used technological content knowledge (TCK) in the classroom. However, TCK was the weakest component. The researcher attempted to discover similarities and differences in how the two participants used their technological pedagogical content knowledge (TPCK) in the classroom. Table 11presents the TPCK employed by Mrs. Brownstone and Mrs. Oak. The evidence of TPCK were derived from research (Cox & Graham, 2010, Graham et al., 2010; Mouza, 2011) as previously described in Chapter 3.

Table 11

Technology Pedagogical Content Knowledge (TPCK) Indicators

Description	Evidence	Brownstone	Oak
Used technology to facilitate subject-specific pedagogical method.	Teachers uses technology to facilitate subject-specific strategies: Science, e.g., inquiry, experiments Language arts, e.g., balanced literacy Math, e.g., inquiry, graph analysis Social studies, e.g., primary source Improved/new pedagogy	X	X
Used technology to transform a content representation to facilitate learning	Visual representation Multimodal representation Dynamic representation Accurate representation Professional representation	✓	✓
Used technology to address learner content knowledge	Prior content knowledge Correction of misconception Improvement in content understanding Prior knowledge/skill with technology	✓	✓

Note. ✓ = evidence observed; X = no evidence observed.

Both teachers used TPCK. It was, in fact, the most frequently used of the technology integration knowledge components. As shown in the table, Mrs. Oak and Mrs. Brownstone both expressed their TPCK to transform a content representation to facilitate learning. The researcher did not observe either teacher use technology to facilitate a subject-specific pedagogical method. The ways in which both of the teachers used technology were related to general pedagogical strategies. Under the description of TPACK, the teachers used their TPACK to provide visual and multimodal representations. The within-case analysis provided several examples of how both of the

teachers used their TPACK in practice to transform a content representation to facilitate learning. In several activities, Mrs. Brownstone created a PowerPoint and used videos to provide visual representations of how to perform mathematical problems. For example, she used a video of provide a visual of how to distribute in division. Her purpose for using the video was to help students visually understand how to distribute. Although a video could be used to help support any subject area, in the example, she was more concerned with how technology could provide a visual representation in support of students' understanding of the specific topic. In Mrs. Oak's class, while students were learning about different plants, she used her TPACK to search for and display images of plants. During the lesson, students were having a hard time recalling the parts of a plant. Like Mrs. Brownstone, Mrs. Oak wanted to find visual representations to improve content understanding and clear up misconceptions about a specific topic.

Second, Mrs. Brownstone and Mrs. Oak used their TPACK to address learner content knowledge in the following ways: using technology to improve content understanding and using technology to correct misconceptions. In addition to the examples, the within-case analysis provided several examples of how both of the teachers used their TPACK in practice to improve content understanding. In one activity, Mrs. Brownstone used the document camera to demonstrate and model division problems to enhance students' content understanding and to correct misconceptions. In the activity, Mrs. Brownstone directed her attention to students learning topic-specific skills while using technology to support their learning. Although the document camera could be used to support other content areas, Mrs. Brownstone's primary concern with using the

document camera was to provide support for students to clear up misconceptions in a specific subject using modeling which was representative of TPACK. In a few situations, Mrs. Oak created an environment where students were able to explore the content using technology while she took on the role of facilitator by assisting students with their learning needs.

Table 12 provides a summary of the observed technology integration knowledge components (TK, TPK, TCK, and TPACK) from each participant.

Table 12

Participants' Observed Technology Integration Components (TK, TPK, TCK, and TPACK)

Observed Technology Integration Components	
Mrs. Brownstone	Mrs. Oak
Technological Knowledge (TK)	
Technical skills and confidence to operate different types of use technology	Technical skills and confidence to operate different types of use technology
Operating, e.g., PowerPoint, Promethean Board, iPad, document camera	Operating hardware and software, e.g., netbooks, iPad, document camera
Locating and selecting videos and songs using internet and search engines	Locating and selecting videos and songs using the internet and search engines
Troubleshooting/solving technology issues and planning	Troubleshooting technology issues
	Managing websites
Technological Pedagogical Knowledge (TPK)	
Knowledge of different types of technologies/capabilities to support instructional strategies	Knowledge of different types of technologies and capabilities to support instructional strategies
Using technology to address student motivation, to spark student interest and engage students	Using technology to address student motivation
Using technology to improve teaching material and content	Using technology to improve teaching material and content
Using technology to present and display information for teacher and students	Using technology to present and display information for teacher and students
Able to explain computer procedure to students	Ability to explain a computer procedure to students, e.g., modeling use of MS Word
Using technology to provide feedback to students	Using technology to provide feedback to students, e.g., behavior
Using the Promethean Board	Organizing, managing, and maintaining classroom management
Able to plan for potential student problems	Holding students accountable for the technology
Able to create alternatives in the event of technological problems	Providing explanation to student on how to use the software
	Knowledge of the developmental appropriateness of the hardware
	Student presentation
	Student research

Observed Technology Integration Components	
Mrs. Brownstone	Mrs. Oak
Technological Content Knowledge (TCK)	
Selecting technology to support learning goals	
Technological Pedagogical Content Knowledge (TPACK)	
Using technology to reinforce content understanding	Facilitating students' use of an educational game to develop typing skills
Using technology to provide a visual representation of the content/how to distribute	Facilitating students' use of technology to practice and develop a skill
Using technology to support improving content understanding and correct misconceptions	Facilitating students' use of technology to present a topic-specific activity
Using technology to support modeling and providing a visual representation of the topic-specific process	Explaining and modeling the procedure to demonstrate how to use MS Word
Modeling how to solve a division problem	Facilitation of a topic-specific activity
Reinforcing concepts and enhancing comprehension, provide a visual representation of how to distribute	Enhance content understanding and technology skills
Support content understanding and correct misconceptions	Transform the content and improve content understanding
Facilitating student use of technology to present content representations	Improve student content understanding
Facilitating the representation of subtracting using a place value chart	
Facilitating students' use of technology to share their work on the topic	
Providing a multimodal representation	

Contextual Factors

Both teachers expressed, and the researcher observed, various contextual factors that influenced their use of technology integration knowledge. Both teachers and school administrators primarily identified resource-related factors such as access and functionality of the equipment as the primary factor for all components, with the exception of TCK, which was limited.

Although Mrs. Brownstone and Mrs. Oak perceived themselves as having a high-degree of technological knowledge, they noted contextual factors that limited how they used technology integration knowledge in practice, including limited technology and outdated equipment. For example, although Mrs. Brownstone knew how to operate the Promethean Board, she was limited in applying her knowledge because of problems with the equipment. When Mrs. Brownstone attempted to operate specific features on the Promethean Board, equipment issues hindered her. She clearly discussed in interviews that the equipment was outdated, and teachers had received limited training on how to operate it. In addition, the teachers and administrators expressed concerns with outdated equipment, especially the computers in the computer lab. In fact, Mrs. Wilson believed that technology not working properly was the biggest hindrance to technology integration at the school. Mrs. Brownstone explained that some of the computers would freeze, shut down, and/or did not have updated software. According to Mrs. Wilson, the school was in serious need of upgrades.

Another resource-related barrier was the location of equipment. Both teachers were concerned with not being able to use the Promethean Board because of its location. The teachers expressed that having access to technology in their classrooms would have allowed them to use it more often. For example, Mrs. Brownstone explained that it was time consuming and difficult to transition students from the classroom to the computer laboratory. The school administrators also echoed concern with the location of the equipment. Essentially, Mrs. Jones believed that the technology not being available in the teachers' classroom was the biggest hindrance. Similar to Mrs. Brownstone, Mrs. Jones felt that the availability of technology in the classroom would allow the teachers more preparation time. In addition, she expressed the belief that teachers needed access to newer technology in their classrooms. Mrs. Jones indicated that she observed that in the past when teachers had access to new technology they used it. She explained that because of receiving new Ipads, teachers selected and download applications. Mrs. Brownstone also alluded to the notion of access to technology as a barrier. She noted that student to computer ratio in her classroom limited the time student had to use the computers.

Resource-related barriers also influenced the teachers' ability to use instructional strategies. For example, Mrs. Brownstone indicated that she wanted to use the interactive whiteboard to engage and motivate her students. However, she was not able to do so because of the functionality of the equipment. As reflected in the within analysis, Mrs. Brownstone had planned an activity using the Promethean Board, however during the activity the interactive pen did not work. Without the pen, she was not able to use the

manipulative objects on the Promethean Board, which impeded the level of student interaction.

Despite the frustrations experienced, both teachers attempted to find ways to overcome resource related issues of availability and functionality of the equipment. For example, in regards to the student-computer ratio in her classroom, Mrs. Brownstone stated, "I try to rotate . . . a group each day but still it's only once a week they are getting to go on the computer. . . I have to really design my lesson keeping those limitations in mind." In addition, Mrs. Brownstone came in to work early when she planned to use the Promethean Board. She used the time to set up the technology. In general, Mrs. Oak explained that the inefficiency of a "technology supported classroom" was a challenge. However, in most cases she was able to implement the lessons with the technology available at the school such as the computer netbooks and projectors. In addition, she reported the school recently installed more bandwidth, which was helpful, especially when students did independent practice.

CHAPTER 5
SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Introduction

The qualitative multiple case study explored practicing elementary teachers' perceived and applied technological pedagogical content knowledge. Nine participants took part in the first phase of the study. To answer research question one, the researcher used survey data to gardener insight on elementary teachers' perceived technological pedagogical content knowledge in the urban, charter-school setting. A mean score for each participant on each of the variables was calculated. Data from the survey were also used to triangulate the data gathered for Phase II of the study and provided background information for each of the cases included the study.

Four participants, two teachers and two administrators volunteered to participate in the second phase of the study. During the second phase, the researcher used within-case analysis procedures, specifying each participant as an individual case. In addition, the researcher used data from administrators to provide insights into contextual factors at the school. Lastly, the researcher conducted a cross-case analysis using the individual cases developed from the within-case analysis to construct one final narrative.

Chapter 5 is organized around the three research questions which guided the study. The chapter begins with a summary and discussion of the findings as they relate to each research question in light of prior research. Next, implications and recommendations of the research are provided for schools, teachers, and the research

community. Lastly, the study limitations are identified and suggestions are offered for future research.

Summary and Discussion of Findings

Research Question 1

What are practicing elementary teachers in an urban charter school setting perceptions of each technological pedagogical content knowledge domain (TK, PK, CK, PCK, TCK, TPK, and TPACK)?

The Teachers' Knowledge of Teaching and Technology Survey was used to determine the extent to which participants agreed or disagreed with statements in relation to their knowledge of each of the seven subscales of TPACK. The findings indicated that the mean scores for CK, PK, and PCK represented the highest mean scores. While, the mean scores for technology-related components fell in the middle of the scale. This finding suggests that practicing teachers are not comfortable with their technology integration knowledge. The present finding is consistent with other research which found teachers had minimal knowledge of how to integrate technology knowledge with content and pedagogical knowledge (Mouza, 2011; Doering & Koseolgu; 2009). Doering and Koseolgu's (2009) research study revealed that prior to participating in professional development using the TPACK framework; teacher's scores for technology-related components were lower. They noted that after participation in professional development using the TPACK framework, teacher's perceptions of each TPACK component

increased. The finding may suggest that rather than technology resources, teachers may need professional development, leadership and/or peer support to influence their perceptions of technology integration knowledge. However, with a small sample size, caution must be applied, as the findings might not be transferable to other practicing teachers. In addition, more research on practicing teachers' TPACK needs to be undertaken to clearly understand the association between technology integration knowledge and types of support.

Further, with regard to teachers at urban charter schools, Mouza (2011) revealed similar results. Prior to professional development, there was little evidence of TPACK. After implementing professional development using case development, she noted that the teachers' written reflections on the implementation of their technology-integrated plan showed that they had developed an understanding of the complex relationship between technology, content, and pedagogy. However, Mouza (2011) noted that were differences in how teachers applied their knowledge in the classroom. She concluded that the teachers in the study were at different stage of development, consistent with the work of Niess et al. (2008). The findings observed in the current study reflect those of the aforementioned discussion regarding how teachers develop TPACK. According to Niess et al. (2008), teachers develop TPACK in five distinct stages (recognizing, accepting, adapting, exploring, and advancing). Based on the findings from the survey the teachers in the current study were neutral as it related to the technology-related components in the survey. A possible explanation for these results may be that some of the teachers in the study were at the recognizing level of the model. At recognizing level teachers have not

integrated technology, but are familiar with how technology aligns with teaching and learning in their content and at their grade level. Future studies could be conducted to determine their perceived levels of knowledge development in TPACK. In addition, the finding has implications as it relates to professional development. In particular, one consideration is the design of professional development opportunities that targets certain areas of TPACK to instruct teachers on ways in which they can use their technology integration knowledge in practice.

In addition, the current study found that there was a slight difference in the components for technology integration knowledge (TK, TCK, TPK, and TPACK), 3.67, 3.67, 3.74, and 3.61 respectively. The difference in TPK and TCK was consistent with previous research that has suggested that TCK may not exist or is hard to differentiate between other components in the framework. As noted by Hofer and Harris (2012) in their review, studies on technological pedagogical content knowledge have reported evidence of TPK more often than TCK. There are several possible explanations for this result. The finding in the current study corroborates the idea noted by Hofer and Harris (2012) who suggested that TCK might be limited because teachers may not have access to a variety of tools or are unaware of content specific technologies. Since the majority of the teachers reported the level of technology support at the school was strong, a possible explanation for the results might relate to teachers being unaware of content specific technologies. An implication of this is the possibility that teacher's need time to search for content specific technologies. Another issue that emerges from these findings is the availability of content specific technologies that support the elementary curriculum.

An unexpected finding was that the score for technology (TK) was also lower than technological pedagogical knowledge (TPK). In addition, the findings indicate that technological pedagogical content knowledge (TPACK) was the lowest score overall. It can thus be suggested that the teachers know how to teach with appropriate technologies, but need further knowledge on selecting and operating technology. These results provide further support for the suggestion that teachers develop TPACK in different stages.

Research Question 2

How do practicing elementary teachers in an urban charter school setting apply their technology integration knowledge (i.e. TK, TCK, TPK, TPACK) in their instructional practices?

The data analysis and interpretation revealed several themes in how teachers used their technology integration knowledge in practice. Four themes emerged as important in describing the use of teachers' technology integration knowledge: (a) operating technology (b) limited technological content knowledge (TCK), (c) support for general pedagogical goals, and (d) addressing students learning needs.

Theme 1: Operating Technology (TK)

There was a clear and observable use of technology knowledge in the teachers' instructional practices. Teacher participants used technology knowledge across the two phases of the research study. Using observations, documents, and interviews, findings of the within and cross-case analysis showed that the teachers were aware of the various

benefits of using the technology resources available to them at their school for teaching and learning. As shown in the cross-case analysis both of the teachers assertively located and selected technology to use in their classes. The finding reported here was also consistent with the results of the survey. Thus, teachers' perceptions of their technology knowledge aligned with the researcher's observations as they implemented their lesson plans. Considering all of the data, the researcher determined that the teachers had developed a solid foundation of technology knowledge, which they used to operate hardware and software and resolve technology issues in the classroom. The conclusion was not surprising. A possible explanation for this finding may be that when teachers learn to use technology, the time is often dedicated to learning about the technology with little, if any, time devoted to learning about content and pedagogy. As noted by Moesha and Koehler (2005),

> technology is viewed as constituting a separate set of knowledge and skills that has to be learned, and the relationship between these skills and the tried and true basis of teaching (content and pedagogy) is nonexistent or considered to be relatively trivial to acquire and implement. (pp. 1,024-1,025)

Such views have led to "technocentric" professional development opportunities that focus only on teachers learning skills to use software and hardware. Both of the teacher participants in the qualitative portion of the study had participated in some form of technology-related professional development in the past. However, Mrs. Brownstone explained that her training of the Promethean Board primarily focused on how to use the equipment. What was of concern in the findings of the study was that support for

technology-related professional development at the school was missing. Although both administrators saw the importance of technology use, the focus of professional development at the school was on learning a new pedagogical strategy unconnected to technology. The school principal noted that it was up to teachers to decide whether they wanted to pursue learning about technology in their individualized professional learning plans. While teachers at the school are able to create their own individualized learning plans, if the plans are not within the overall vision of the school it may not help with the integration of technology. A shared vision and technology plan are major attributes to successful technology integration (Hew & Brush, 2007; ISTE, 2012; Lim & Khine, 2006). In fact, one of the essential conditions for technology integration provided in the updated NETS-A framework for school administrators suggest that leaders develop a shared vision with the entire school community. Staples (2005), suggest that principals and others who decide how money is spent on technology resources need to understand that planning, purchasing, and learning about technology must take place at the same time, all in service of the curriculum. This finding has important implications for developing a shared vision and school technology plans. In general, it seems that an important aim for the school in the current study would be to create a vision for technology integration beyond requiring technology use as a component in lesson plans, but explicitly connecting the TPACK components. Further research could be done to investigate school technology plans that are TPACK focused and whether or not these plans have an influence on teacher's use of TPACK in planning and implementing lessons.

Theme 2: Limited Technological Content Knowledge (TCK)

Using observations, documents, and interviews, findings of the within and cross-case analysis the researcher found little use of technology content knowledge in the teacher's instructional practices. This finding was not surprising considering the finding from the survey as well as reviews of the literature. Limited use of TCK was consistent with that of prior researchers. Richardson (2009) reported in her dissertation study that of the seven TPACK components, TCK was "the weakest area of knowledge reported" (p. 133). She noted that although the teachers were aware of resources that would address learning objectives, their focus was on pedagogical concerns. The same result was reflected in the current study. As highlighted in Phase II, findings from observations, documents, and interviews, showed that the purpose of teachers using technology in the current study was to support issues with content understanding or to correct misconceptions. One explanation for the finding may support the notion put forth by Hofer and Harris (2012) that teachers may attend more to pedagogy than to content. As discussed in the within and cross-case analysis, both teachers found tools that helped represent the content but their goals for using the technology were connected to their instructional strategies and student learning which was representative of their technology pedagogical content knowledge (TPCK).

Another important finding was that the teacher's selection of technologies that aligned with the content was limited. The selection of technology that aligns with content was only reflected in lesson plans and discussed during an interview with one teacher. While planning activities, Mrs. Brownstone indicated that her primary concern

was to select technology resources to use in learning activities based on the content. The findings of the current study are consistent with those of Harris and Hofer (2011). In a study of the planning of experienced secondary social study teachers, Harris and Hofer discussed the nature and development of teacher's TPACK as the teachers planned for content-focused activity types (Harris & Hofer, 2011). In the study, the teachers experienced growth in TPK with little reported use of TCK. Further, this study has been unable to demonstrate teacher's use of TCK as it relates to uses of technology to investigate, represent, or transform topics or subjects specific to the content area without the use of a pedagogical strategy. These results match those observed in a study by Swan and Hofer (2011) who found that the teachers in their study showed no signs of using podcasts to transform economic concepts or skills. This is especially important because, according to Swan and Hofer (2011), "Specialized tools and resources (e.g., data modeling and online simulations in economics) offer opportunities to engage students in discipline based thinking" (p. 90). One explanation for the teachers in the current study was that teachers may attend more to pedagogy than to content. Although the teachers found tools such as videos and music, which transformed the representation of the content, their reasons for using the tools were once again connected to their instructional strategies. In addition, this finding might be related to limited knowledge of specialized tools, ability to find and select tools, and/or the availability of tools that fit with the elementary curriculum. Unfortunately, the combination of findings in the current study provided little support for the conceptual premise of the TCK component. This,

suggested the need for more empirical research to determine how the TCK component is demonstrated in practice.

Theme 3: Support for General Pedagogical Goals (TPK)

The researcher observed that the teachers used technology to support multiple instructional strategies within the context of their classrooms. The researcher identified two important findings regarding teachers' use of TPK: The use of technology to support student engagement and enhance classroom management strategies. Both of the research participants discussed the value of using technology to motivate their students to participate in learning activities. This, too, was on par with prior research, which suggested the same. In a study examining the impact of professional development, Doering and Koseolgu (2009) discussed the impact the program had on teachers' technological, pedagogical, and content knowledge (TPACK). Pre- and post-survey responses showed that teachers perceived student engagement and motivation as one of the most important benefits of using technology. In addition, teachers noted that technology raised student's interest level and provided a "hook." The benefits of supporting student engagement and motivation using technology cannot be understated. The aforementioned advantages of using technology were not lost on the teachers in the current study. Mrs. Brownstone noted that she believed students seemed more engaged when she used technology, and Mrs. Oak noted that praising students as they played games was motiving to the students in her class. In addition, throughout the observed

lessons, the researcher documented that when the teachers used music and videos, their students were engaged and participating in the activities.

Another important finding from observations, documents, and interviews, was the teachers' use of technological pedagogical knowledge using technology to manage classroom behavior. Technology integration is influenced by the teacher's classroom management knowledge and skills (Hew & Brush, 2007). These findings of the current study further support the idea of technology-related-classroom management knowledge (Lim et al., 2003). This knowledge goes beyond traditional classroom management strategies by providing additional guidelines for student behavior and procedures for using technology. Research on technology integration has shown that teachers can maintain a positive classroom environment using technological pedagogical knowledge. Wetzel and Marshall (2012) provided a research-based example of how a sixth-grade middle school teacher successfully applied her TPK to her classroom management in practice. The researchers observed that the teacher established rules and routines and communicated them to students, and this helped to manage the class and kept students on task. Wetzel and Marshall's (2012) findings were similar to the experience of the teachers in the current study. The findings presented here suggest that the teachers in the current study were able to manage their classroom and redirect behavior while students worked with technology. In addition, the study provides evidence of how technology can be used in support of traditional classroom management strategies. An implication of this is the possibility that support and professional development should be provided to assist teacher with carrying out these practices within their classrooms (Hew & Brush, 2007).

Theme 4: Addressing Student Learning Needs

The teachers in this current study did not use technology for the sake of using technology. Through observations, interviews, and documents used in the within and cross-case analysis, the researcher found that the teacher's used technology for the specific purpose of addressing the needs of their students. Although the researcher observed and teachers discussed varied reasons that supported how they used technology integration knowledge having their students develop understanding was the most significant influence in their choices. Specifically, Mrs. Brownstone and Mrs. Oak identified and used a variety of technologies with content and pedagogy to help students develop a better understanding of the content, enhance prior knowledge, and clear up misconceptions. The aforementioned findings were especially notable because they demonstrated teachers' understanding of their students and their ability to use technology, content, and pedagogy together to effectively teach with technology, the cornerstone of TPACK. What is surprising about this finding is that the survey results indicated that Mrs. Brownstone's TPACK score was above the mean for the group, while Mrs. Oak's self-reported TPACK score was below the mean for the group. Contrary to expectations, the survey results did not reflect the outcome of the observations and interviews with Mrs. Oak. The within and cross-case analysis provided several examples of her use of TPACK in practice.

In addition, the teacher's substantial uses of TPACK may be explained by their use of familiar pedagogical practices in the activities that used technology. In a study of 10 classroom teachers Zhao et. al (2002), found that pedagogical compatibility or how

well the technology fits in with teachers' existing pedagogical beliefs was a major determinant of the success of the implementation. The findings of the current study showed that the activities that the teachers used were compatible with their prior practices and experiences. Although teachers used technology to address the needs of their students, their instruction with the technology did not enhance their pedagogical approaches. In many instances, the teachers' technology use mirrored their pervasive strategies that did not require technology. For example, although Mrs. Brownstone used the interactive whiteboard to display and present information during a lesson on multi-digit subtraction, she noted that she could have as easily displayed and presented the information using the projector in her classroom. Although her intent was to use the interactive features of the whiteboard, the activity was limited to presenting and displaying information which she could have done using the computer and projector. This, too, was comparable to the findings of Richardson (2009) who reported that teachers used technology to support activities they had done in the past without the use of technology. Polly (2011) discussed the nature of two teacher's mathematical uses of TPACK after learner-centered technology-related professional development. In the study, both of the teachers used the interactive whiteboard in the same fashion, as they would have shown a transparency using an overhead projector. In the current case, although the teacher was aware of the capabilities and features of the interactive whiteboard, the teacher noted that she could have just as easily done the lesson in her classroom using PPT. This finding is hard to explain because the teacher was aware of how to use the interactive features of the interactive whiteboard to engage students and

help them understand the content. The poor functionality of the whiteboard may be one possible explanation for the lack of interaction. The teacher may have chosen not to attempt to use the features given the possibility the technology would not work. Another possible explanation as noted previously, the use of the interactive features may have been too distant from her existing pedagogical strategies.

Research Question 3

What contextual factors do practicing elementary teachers identify as influencing their ability to apply their technology integration knowledge (TK, TCK, TPK, TPACK) in the context of an urban charter school?

Findings from the qualitative data in the second phase of the study revealed that resource-related issues and limited knowledge influenced teachers' use of technology integration knowledge. During interviews, both of the teachers, along with school administrators, described concerns associated with resources including access to and functionality of the hardware. This, too, was similar to the findings of prior researchers. In relation to teachers at charter schools, Mouza (2011) found that limited resources influenced how teachers integrated technology in their classrooms. The teachers and administrators in the current study reported that the equipment at the school computer lab was outdated. In addition, both teachers discussed issues with scheduling the computer lab. Further, although the teacher's had access to a laptop carts, one teacher suggested that the screens were small and difficult for the younger students to use. Consequently, the teacher's use of technology integration knowledge was impacted. A possible reason

for the outdated equipment may be related to the amount of funding charter schools receive. Mouza (2011) explained, "Although access to technology resources is still a major issue in urban schools across the board, it is sometimes an even bigger problem in charter schools, which typically do not receive start-up funds for facilities" (p. 21). The findings from the current study appear to corroborate the need to invest in technological resources in urban charter schools.

Another important finding was the lack of continuous professional support for technology integration at the school. This also accords with our earlier observations, which showed the need for continuous support to help teachers continuously develop their knowledge. After participation in a professional learning experience, Guzey and Roehrig's (2009) research study revealed that availability of technology tools constrained teachers' development of TPACK. The researchers discussed the impact the professional development program had on teachers after returning to their classrooms. They noted that one of the teachers, Cassie who taught at an urban charter school, expressed the need for additional training, but teachers who had access to resources and encouragement from the school community were able to continuously development their practices. The impact from the school community on teacher practice was noteworthy. The school culture and school community is a factor that supports technology use in schools (Herandez-Ramos, 2005; Tondeur et al., 2009). Both teachers in the present study believed that the school supported their use of technology. This was also evident during the interviews with administration. However, an explanation for the lack of professional development at the school maybe the time devoted to other areas. Although the school

community was involved in professional learning, there was a lack continuous support in the professional learning community related to technology use. This finding has important implications for developing professional development. One recommendation is the development of an online community of practice. Researchers have suggested that technology used to help support teacher communities of practice can help with sharing, collaborating, and fostering relationships in face-to-face communities or online communities (Sheely, 2008; Vavasseur & MacGregor, 2008). In addition to designing professional development, it is recommended that future studies examine the use of an online community of practice and practicing teacher's development of TPACK.

Implications and Recommendations

The current research study has potential implications for schools and teachers and the research community. First, schools and teachers could utilize the findings to plan for professional development. In particular, one consideration is the design of professional development opportunities that target certain areas of TPACK to instruct teachers on ways in which they can use their technology integration knowledge in practice. In the current study, the teachers' self-reported data for each of the components of TPACK were at different levels. In addition, through observations and interviews, the researcher found that the two participating teachers' use of the components varied in actual practice. Professional development could provide a deeper understanding of different components based on identified needs. For example, the teachers in the study demonstrated little use of TCK. Consequently, based on the results of the study, the design of professional

development that targets specific TCK indicators may be beneficial for the two teachers and in this study. In addition, discussions with both teachers and the school administrators in the study supported the need for continuous and sustained professional development that provides the skills for technology integration knowledge in practice. School administrators should encourage teachers to seek out professional development opportunities that support their technology integration knowledge as well as provide support through their professional learning communities. As has been suggested, one recommendation to address this is the development of an online learning community.

An understanding of the contextual factors that hinder the use of technology integration knowledge in practice is necessary to provide appropriate mediations for teachers. The study has provided insight into the barriers that teachers experience as they attempt to use their technology integration knowledge in practice. Both the teachers and school administrators commented on the need for resources that are readably accessible in their classrooms. Thus, implications emerge for increased and direct access to resources. Teachers may benefit by having more opportunities to select a wider range of options to use technology in a manner that supports their use of technology integration knowledge. In addition, ease of access to technology and having individual technology for each student may support more student use of technology as opposed to technology used only as a tool for teachers.

In addition to the implications for schools and teachers, the research study has potential implications for the research community. All of the instruments used in the study, i.e., the survey by Schmidt et al. (2009), structured interview prompts developed

by Harris et al. (2012), and the Technology Integration Observation Instrument (TIOI) developed by Hofer et al. (2011), provided insight on how the teachers in the study perceived and used their technology integration knowledge in practice. In addition, using the instruments together, the researcher was able to disclose how teachers' self-reported knowledge related with how they demonstrated their perceived knowledge in their instructional practices. Consequently, the findings provide researchers with an example of how the measures can be used to document the ways in which teachers apply each of the subdomains related to technology (TK, TPK, TCK, and TPCK) in practice. In addition, the present study confirmed previous findings that reported little to no evidence of technological content knowledge. Therefore, there still exists a need to confirm through self-reported data, observations, and document reviews, how TCK is planned for and implemented.

Recommendations for Future Research

Though the current study was focused on how teachers at an elementary urban charter school used their knowledge of technology integration as they implemented their lesson plans, the need remains for research in middle and high school settings. There is room to explore the experiences of teachers in middle and high school settings regarding technology integration knowledge perspectives and uses. In addition, the teachers' experiences validated the use of TPACK as a framework for educational research. Future studies could be structured to pursue this line of research and to provide further examples of how each of the components is used with specific technologies or within specific

content areas. Future research emerging as an extension of the present study could include a replication study at other Charter Schools. Such a study could be conducted over a longer period of time and include additional observations.

APPENDIX A
SUMMARY OF ACTIVITIES

Mrs. Brownstone Lessons

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component (s)	Contextual Factor Observed
STEP Up to 3rd grade division Math Lesson	Review of multiplication	Direction instruction -Questioning Motivation	Multiplication rap song iPad	TPACK- Reinforce content TPK-Engage students TK- operate technology , find music on the internet	
I can do basic division without help	Explained that division means to share up in equal groups Explained how to share up 12 apples using manipulative and students Modeled how to do basic division on the board by paying attention to the details on how to share up 12 apples amongst 3 students evenly.	Direct instruction-Lecturing Modeling Presentation of information	Whiteboard Manipulatives	-	Availability of technology-TK, TPCK, TPK
With help I can division using models	Showed how to share up apples Showed how to do equal groups Division	Modeling	PowerPoint/iPad/projector	TPCK- Provide a visual representation of how to distribute Correct misconceptions and improve content understanding TK-ability to use PPT	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component (s)	Contextual Factor Observed
Independently I can do division with models	Modeled how to share 14 cookies on 2 plates	Guided practice Modeling	Document camera Worksheet Manipulatives Dry eraser	TK-operate the technology TPCK-represent the process and model, visual representation of the process	
I can teach a friend how to do division using models	Students build division models	Facilitation Think/Pair/Share	Dry marker Dry erase board /desk	-	
	Student demonstrates how they solved the problem Student works with shoulder partner to complete a worksheet	Facilitation	Document camera	TPCK- model how to solve the division problem.	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component (s)	Contextual Factor Observed
I can do basic division without help	Teachers started lesson with video to review Monday's lesson. Students watched video animation to open lesson http://www.youtube.com/watch?v=TScopM-a0b0 division	Whole classroom instruction Discussion Presentation of information Demonstration	Elmo and Video iPad	TCK-used to support learning goals/select technology based on learning goals TPCK- reinforce concepts and enhance comprehension, provide a visual representation of how to distribute	

	Explained the meaning of division by using a video Teacher will used jesters for division system.			TPK-spark student interest	
	Explained how to share up 15 apples using manipulative and students	Demonstration Modeling Thinking aloud	Document camera Worksheet	TPCK- content understanding and correct misconceptions	
With help I can division using models	Modeled how to use models to solve division problems	Whole class instruction-Interactive lecturing Modeling Thinking aloud	Projector/Worksheet/Document Cam(Elmo) Manipulatives	TPCK-demonstrate a process/skill	
Independently I can do division with models	Students will build division models using paper Students will work with shoulder partner to complete similar division problems by creating equal groups	Think/Pair/Share	Construction paper Glue		TPCK-Additional resources-iPads Time
I can teach a friend how to do division using models	Presenting to the class the steps they took to do the equation	Facilitation	Document camera Manipulatives (i.e. blocks)	TPCK-Facilitate student use of technology to present content representations Improve understanding of the content	

	Complete assessment		Worksheet		TPACK-time

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component (s)	Contextual Factor Observed
I can do subtraction without help	Review two-digit subtraction Modeled how to subtract 2 digit numbers	Direct instruction- Lecturing Modeling Presentation of information	Interactive whiteboard Powerpoint Desktop	TPK-to fix and use an alternative to work with technology TK-operate the technology and troubleshoot and plan ahead TPCK- Improve understanding of the content	Equipment not working Student disruptions
With help I can subtract 3-4 digit numbers	Introduced place value chart Modeled how to use place value charts to subtract word problems	Direct instruction- Lecturing Modeling Presentation of information	Interactive whiteboard Powerpoint Desktop	TPACK- improve students' content understanding. TPACK- facilitate the representation of subtracting using a place value chart	Updated equipment Equipment to working properly
Independently I can subtract 3-4 digit numbers	Student works with shoulder partner to solved the problem	Facilitation Think/Pair/Share	Laminated place value chart Dry erase marker	TPACK-to facilitate students use of technology to share their work on the topic	
I can teach a friend how to do division using models	Student demonstrates how they solved the problem	Facilitation	Promethean Board	TPACK	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component (s)	Contextual Factor Observed
I can do subtraction without help	Brain energizer Explained the importance of the order for subtraction and demonstrated how to solve a couple of problems.	Direct instruction- Lecturing Modeling Presentation of information Demonstration Modeling Thinking aloud	Whiteboard Hip Hop Video/Song Document camera iPad Projector	*TPK*-video to engage students *TK-selection of songs* *TPACK-multimodal representation*	Equipment not working
With help I can subtract 3-4 digit numbers	Modeled how to do a subtraction problem Modeled how to use a place value chart to subtract 3-4 digit numbers	Direct instruction- Lecturing Modeling Presentation of information Demonstration Modeling Thinking aloud	Whiteboard	-	-
Independently I can subtract 3-4 digit numbers	Student works with shoulder partner to solved the problem	Facilitation Think/Pair/Share	Whiteboard Dry erase boards Dry erase makers Worksheet	-	-
			Video	TK-locate and select videos TPACK-address content understanding TPK-engage students	

Mrs. Oak's Lessons

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
Students will practice typing and navigate to websites independently	Practicing typing using an internet game	Independent practice Drill & Practice Facilitating/Coaching Classroom management	Websites	TPK-holding students accountable for the technology TK-troubleshoot technology issues TPACK-practice and develop a skill TPACK- facilitated student's use of an educational game to assist in developing their typing skills	Student behavior Lack of resources
Students will write teacher appreciation letters using Microsoft office word.	Review of spacebar between words, shift to capitalize, enter to skip to the next line.	Modeling	Projector Microsoft word	TK- to operate the software TPK- to explain how to use the software, developmental appropriateness of the hardware, TPACK-facilitate students presentation of a topic-specific activity	TPK-Not enough time to provide one-on-one assistance TPK-limited resources limited the instructional strategy TPK-availability of computer lab
	Students write letter	Independent practice Facilitating/Coaching Classroom management	Projector Microsoft word	TPK- holding students accountable for using the technology TK- to operate the software	Student behavior Lack of resources

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
				TPCK- to explain and model the procedure to demonstrate how to use MS Word.	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
Students will practice typing	Practicing typing using an internet game	Independent practice Drill & Practice Facilitating/Coaching Classroom management	Websites iPad Projector	TPK- classroom behavior TPK- holding students accountable TPK-motivation TK-ability to understand, manage, and operate the website	
Students will share conservation Powerpoint presentations.	Students share animal PowerPoint presentations.	Presenting information	Netbook Powerpoint Projector	TPACK- facilitation of a topic-specific activity TPACK-enhance content understanding and technology skills	Availability of technology

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
Student will describe what motion is.	Students sing forces and motion song	Direction instruction -Questioning Motivation	iPad Projector You Tube song	TPACK- transform the content and improve content understanding	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
Identify the two factors that speed depends on. *f*				TPK-student motivation TK-selection of songs	
	Explained and discussed what is speed (distance divided by time) and motion.	Direct instruction- Lecturing Presentation of information	Whiteboard	-	
Students can calculate the distance, time, and speed of an object using the speed equation.	Model – Fusion speed equation question	Direct instruction- Lecturing Modeling Presentation of information	Document camera Worksheet Whiteboard Projector	TPK-used technology to enhance instructional strategy and display information	
	Guided students in Fusion speed equation question	Direct instruction- Lecturing Modeling Presentation of information	Document camera Worksheet Whiteboard Projector	TPK-used technology to enhance instructional strategy and display information	
	Student practiced speed equation question	Independent practice Facilitation	Document camera Worksheet Whiteboard Projector	-	
	Reviewed motion is a change of position, and the forces that act on	Direct instruction- Lecturing Modeling	-	-	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
	moving objects.	Presentation of information			
	Student took Motion and Speed quiz	Independent practice Facilitation	-	-	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
SC.3.L.14.1 Describe structures in plants and their roles in food production, support, water, and nutrient transport, and reproduction.	Students singing plant song	Direction instruction -Questioning Motivation Classroom management	Cassette player?	TPK-classroom management TPACK- transform the content and improve content understanding TPK-student motivation TK-selection of songs	
	Students identify the type of plants they eat	Direct instruction-Lecturing Presentation of information Interactive discussion	Projector iPad Google Search Whiteboard	TPK-classroom management TPK-display information TPACK-improve student content understanding	
	Students complete worksheet	Independent practice			
	Distribute baby carrots. HOT question – What part of the plant is a carrot?	Direct instruction-Lecturing Presentation of information Interactive	Projector iPad Google Search Whiteboard	TPK-classroom management TPK-display information	

Curriculum Topic/Content	Learning activities	Key Instructional Strategies	Digital & Non-Digital Technologies	Technology Integration Knowledge Component	Contextual Factor Observed
		discussion		TPACK-improve student content understanding	
	Identify other types of roots we eat.	Direct instruction-Lecturing Presentation of information Interactive discussion	Projector iPad Google Search Whiteboard	TPK-classroom management TPK-display information TPACK-improve student content understanding	

APPENDIX B
SURVEY

Demographic Data:

1. Please list your current school email address
2. What is your gender? (male or female)
3. What is your race (Caucasian/White, African-American/Black, Hispanic/Latino, Native American, Asian, Pacific Islander, Arab or Other (participant will enter answer if select other)?
4. How many years of teaching experience do you have? (participant will enter #)
5. Are you a National Professional Board Certified teacher? (yes or no)
6. What is your highest level of education? (undergraduate, masters, doctorate)
7. If you have a master's degree or higher, please describe the type of degree you hold (i.e., Instructional Technology, Leadership/Policy, Content Area Specific)? (participant will enter answer)
8. Do you have a Technology Facilitator available at your school? (yes or no)
9. How would you describe your school setting? (rural or urban)
10. Approximately how many professional development sessions targeting technology use in the classroom have you attended? (participant will enter #)
11. What best describes the majority of the professional development sessions targeting technology use in the classroom have you attended (presentation of a technology/tool only or presentation of a technology/tool in connection to a specific content area)
12. What best describes the type of leadership support for technology use at your school? (strong, moderate, low)
13. What best describes the level of technology support for technology use at your school? (strong, moderate, low)
14. What best describes the level of peer support for technology use at your school? (strong, moderate, low)

Survey of Teachers' Knowledge of Teaching and Technology

Technology is a broad concept that can mean many different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"

	Statement	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	I know how to solve my own technical problems.					
2	I can learn technology easily.					
3	I keep up with important new technologies.					
4	I frequently play around with the technology.					
5	I know about a lot of different technologies.					
6	I have the technical skills I need to use technology.					
7	I have had sufficient opportunities to work with different technologies					
8	I have sufficient knowledge about mathematics.					
9	I can use a mathematical way of thinking.					
10	I have various ways and strategies of developing my understanding of mathematics.					
11	I have sufficient knowledge about social studies.					
12	I can use a historical way of thinking.					
13	I have various ways and strategies of developing my understanding of social studies.					

	Statement	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
14	I have sufficient knowledge about science.					
15	I can use a scientific way of thinking.					
16	I have various ways and strategies of developing my understanding of science.					
17	I have sufficient knowledge about literacy.					
18	I can use a literary way of thinking.					
19	I have various ways and strategies of developing my understanding of literacy.					
20	I know how to assess student performance in a classroom.					
21	I can adapt my teaching based upon what students currently understand or do not understand.					
22	I can adapt my teaching style to different learners.					
23	I can assess student learning in multiple ways.					
24	I can use a wide range of teaching approaches in a classroom setting.					
25	I am familiar with common student understandings and misconceptions.					
26	I know how to organize and maintain classroom management.					

	Statement	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
27	I can select effective teaching approaches to guide student thinking and learning in mathematics					
28	I can select effective teaching approaches to guide student thinking and learning in literacy.					
29	I can select effective teaching approaches to guide student thinking and learning in science.					
30	I can select effective teaching approaches to guide student thinking and learning in social studies.					
31	I know about technologies that I can use for understanding and doing mathematics..					
32	I know about technologies that I can use for understanding and doing literacy.					
33	I know about technologies that I can use for understanding and doing science.					
34	I know about technologies that I can use for understanding and doing social studies.					
35	I can choose technologies that enhance the teaching approaches for a lesson.					
36	I can choose technologies that enhance students' learning for a lesson.					

	Statement	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
37	My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
38	I am thinking critically about how to use technology in my classroom.					
39	I can adapt the use of the technologies that I am learning about to different teaching activities					
40	I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
41	I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
42	I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district					
43	I can choose technologies that enhance the content for a lesson.					
44	I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.					

	Statement	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
45	I can teach lessons that appropriately combine literacy, technologies and teaching approaches.					
46	I can teach lessons that appropriately combine science, technologies and teaching approaches.					
47	I can teach lessons that appropriately combine social studies, technologies and teaching approaches.					

APPENDIX C
PRE-OBSERVATION INTERVIEW PROTOCOL

TPACK Interview Protocol*

LESSON DESCRIPTION:

1. Describe the content and/or process topic(s) for the lesson.
2. Describe the student learning goals/objectives addressed in the lesson. (These will not necessarily be state or national standards. Participants should describe these in their own words.)
3. Describe your students (e.g. grade level, and specific learning needs/preferences).
4. Walk me through the lesson/project as it unfolded in the classroom.
5. What educational technologies (digital and non-digital) did you use and how did you and/or your students use them?
6. Describe any contextual information (e.g. access to a computer lab, materials and resources available; particular departmental/school-wide initiatives) that influenced the design or implementation of the lesson/project.

TPACK-SPECIFIC QUESTIONS:

7. How and why do the particular technologies used in this lesson/project "fit" the content/process goals? (TCK)
8. How and why do the particular technologies used in this lesson/project "fit" the instructional strategies you used? (TPK)
9. How and why do the learning goals, instructional strategies, and technologies used all fit together in this lesson/project? (TPACK)

*Harris, J., Grandgenett, N., & Hofer, M. (2012). Testing an instrument using structured interviews to assess experienced teachers' TPACK. In C. D. Maddux, D. Gibson, & R. Rose (Eds.), Research highlights in technology and teacher education 2012 (pp. in press). Chesapeake, VA: Society for Information Technology & Teacher Education (SITE).

APPENDIX D
TEACHER INTERVIEW PROTOCOL

Informal Teacher Interviews

An Analysis of Technological Pedagogical Content Knowledge
by Practicing Elementary Teachers in an Urban Charter School.

Interviewee: _____

Today I observed _____, can you tell what went well?

What modifications would you make if any?

How well did your selection of technologies support/hinder the lesson plan?

How did the particular technologies used in support/hinder content/process goals?

How did the technology support/hinder students in their learning and exploration of a topic/skill?

How well did the particular technologies used in this lesson support/hinder the instructional strategies you used?

Describe any contextual information (e.g. access to a computer lab, materials and resources available; particular departmental/school-wide initiatives) that <u>hindered</u> the implementation of the lesson/project.

Describe any contextual information (e.g. access to a computer lab, materials and resources available; particular departmental/school-wide initiatives) that <u>supported</u> the implementation of the lesson/project.

APPENDIX E
TECHNOLOGY INTEGRATION OBSERVATION INSTRUMENT

User Guide: Technology Integration Observation Instrument

Purpose and Use of the Instrument

The Technology Integration Observation Instrument was designed to assess the quality of technology integration in an observed lesson. The components of this instrument are grounded in different aspects of teachers' knowledge for technology integration, also known as "technological pedagogical content knowledge," or TPACK. Please note, however, that the instrument is *not designed to assess this knowledge directly*. It is designed to focus upon the *use* of technology integration knowledge in observable teaching.

No particular pedagogical philosophy or approach to teaching (e.g. problem-based learning; direct instruction; inquiry learning) is assumed or preferred in the design of this instrument. Rather, the rubric is designed to assess the quality of technology integration with any teaching approach that the observed instructor has chosen to use.

The instrument may be used by teachers, teacher educators, administrators and educational researchers as a way to assess how well technology use is integrated with the curricular focus and teaching strategies employed in the observed lesson. It can be used with both live and videorecorded instruction. It is not meant to provide a comprehensive assessment of teaching that is evident in a particular observational episode. Instead, we strongly suggest that it be used *in conjunction with* other observational measures of teaching effectiveness, since this instrument focuses solely on curriculum-based technology integration.

Definition of Technology Integration

Technology integration is defined in many ways. Many educational technology specialists advocate for student-centered, project-based and/or collaborative uses of educational technologies. This view of technology integration unnecessarily constricts the many possible ways that technology can support, enhance, and extend a wide variety of instructional approaches. This instrument is built upon a definition of technology integration as *the curriculum-based use of tools and resources to support learning and teaching*. We consider "technologies" to consist of both digital (e.g. computers, Web sites, digital cameras) as well as non-digital (e.g. whiteboards, Cuisenaire rods, paper maps) tools and resources. When using this rubric, we encourage scorers to consider the full range of digital and non-digital technologies in their assessments.

Scoring Guidelines:

- As you watch the lesson, be sure to take detailed notes on the curriculum topic(s) addressed, key instructional strategies and learning activities incorporated, and *all* of the digital and non-digital technologies used. These notes will help you to more easily score the lesson using the rubric after you have finished watching it.

- As you write your notes, be sure to record any contextual factors that you notice at play in the classroom (e.g., language differences, physical space constraints, presence

Technology Integration Observation Instrument

Observer_____ Teacher _____Date_____

Grade Level(s)_____Subject Areas(s) _____

Primary Learning Goals_____

Directions: We have tried to key the components of this instrument to different aspects of teacher knowledge for technology integration. Please note, however, that the instrument is not designed to assess this knowledge directly. It is designed to focus upon the use of technology integration knowledge in observable teaching. Please record the key curriculum topics addressed, instructional strategies/learning activities observed, and digital and non-digital technologies used by the teacher and/or student in the lesson.

Curriculum Topic	Key Instructional Strategies/Learning activities	Digital & Non-Digital Technologies

What, if anything, do you know about influences upon what you have observed in this lesson? Examples might include students' learning needs, preferences, and challenges; access to technologies; cultural, language and/or socioeconomic factors.

APPENDIX F
ADMINISTRATOR INTERVIEW PROTOCOL

What are your expectations for teachers?

What type of support do you provide to teachers to help them develop their knowledge of technology, pedagogy, and content?

What type of support is available to teachers to use their knowledge technology, pedagogy, and content in the classroom?

How do you encourage teachers to develop their knowledge of technology, pedagogy, and content?

How do you encourage teachers to use their technology knowledge in the classroom?

Can you describe in general the types of instructional activities you have seen teachers use that involve technology? What content areas were teachers teaching? What technologies were they using? What instructional strategies?

Based on your observing teachers use technology as an instructional tool, what do you perceive as the most significant factor that promotes or hinder the use of technology?

APPENDIX G
INSTITUTIONAL REVIEW BOARD APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Kendra L. Minor**

Date: **May 10, 2013**

Dear Researcher:

On 5/10/2013, the IRB approved the following activity as human participant research that is exempt from regulation:

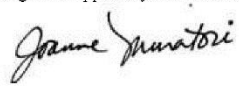
Type of Review:	Exempt Determination
Project Title:	An analysis of technological pedagogical content knowledge by practicing elementary teachers in an urban charter school
Investigator:	Kendra L Minor
IRB Number:	SBE-13-09393
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 05/10/2013 02:55:25 PM EDT



IRB Coordinator

APPENDIX H
SCHOOL COMMUNICATIONS

Letter to School Administration

DATE

Dear FIELD(2),

Let me begin by expressing my thanks for your assistance in offering this proposal regarding my dissertation research project. Your willingness to speak with me has been most helpful, and I am very grateful.

As I indicated, I am nearing the completion of my doctoral study in education-instructional technology track at University of Central Florida.

I have defended my dissertation proposal and I hope to begin data collection in late April. The purpose of the study is to explore elementary teacher's perceived technological pedagogical content knowledge who practice in an urban charter school setting and how teachers demonstrate this knowledge in their instructional practices and plans. The researcher will also seek to understand what factors influence their technology integration knowledge

Accordingly, I am writing formally to request that I be given permission to develop a case study regarding your school.

I should indicate the school will remain anonymous and a pseudonym will be used to present the case and report the results. In addition, no individual associated with the school will be identified anywhere in the study.

My intention is to approach the research in three stages.

- Survey- to all of the teachers at the school
- Interviews, Observation, & Document Analysis with a select group of teachers (based on certain criteria and recommendations)
- Interviews with the school administration

First, I would like to send a survey to every teacher. The survey will ask them to reflect on their teaching practices and perspectives on the use of technology and perceived influences to how technology is used.

Participation will of course be voluntary, and a written consent will be obtained from each participant.

Second, I would like to interview a selected group of teachers based on survey responses and recommendations. I am particularly interested in teachers who have been at the school over three years, are comfortable using technology, and who have participated in professional development to gain insight into the dynamics of the decision-making process.

Third, I would like to observe teachers in their classroom using technology. The focus of the observation will be essentially the same as the interviews, and a written consent will used.

By combining these data collection strategies, I hope to develop a detailed description of each case. I will gladly provide a copy of the study for your review and record keeping and would ask for any factual corrections to be made prior to my presentation of the report.

Thank you again for your kind help.

Sincerely,
Kendra L. Minor

An analysis of technology integration knowledge by practicing elementary teachers in an urban charter school.

Informed Consent

Project: Dissertation Research

Principal Investigator: Kendra L. Minor, Doctoral Candidate, University of Central Florida

Faculty Sponsor: Atsusi (2c) Hirumi, Ph.D

Investigational Site: XXXX Community Charter School

The XXXX Community Charter School grants its permission for Kendra L. Minor to engage in dissertation research that will use XXXX Community Charter School and teachers as a subject in the research. The research will include the analysis of school documents, a survey of teachers, semi-structured interviews and observations with teachers, and in-depth interviews with the school administration.

All information will be treated anonymously, and the identities of all participants as well as the identity of the institution will not be revealed in the writing of the dissertation or any other subsequent publication of the research. A pseudonym for the school will be used, and any obvious characteristics will be masked.

Signed _____ Date _____
(Institutional Representative)

APPENDIX I
PARTICIPANT COMMUNICATIONS AND CONSENT

EXPLANATION OF RESEARCH

Title of Project: An analysis of technology integration knowledge by practicing elementary teachers in an urban charter school.

Project: Dissertation Research

Principal Investigator: Kendra L. Minor, Doctoral Candidate, University of Central Florida

Faculty Supervisor: Atsusi (2c) Hirumi, Ph.D

Investigational Site: XXXX Community Charter School

Dear Participant:

You are being invited to take part in a research study. Whether you take part is up to you.

- The purpose of the study is to explore elementary teacher's perceived technological pedagogical content knowledge who practice in an urban charter school setting and how teachers demonstrate this knowledge in their instructional practices and plans. The researcher will also seek to understand what teacher-related and school-related factors influence their technology integration knowledge.

- You being asked to participate in a survey, interviews, and classroom observations. You will be asked to participate in a survey to provide demographic information and information regarding your experience with technology. Following the survey, you may be asked to provide the researcher with copies of your lesson plans and participate in a 30 minute interview. Initial interviews will be no longer than 30 minutes. In addition to interviews, you may be asked to be observed in your classroom. I would like to observe a 20-30 minute lesson in which you use technology for instructional purposes and then interview you for 15-20 minutes to discuss your perception of how well the lesson went.

- I expect that you will be in this research study for no longer than 30 days. The researcher will come to the school 2-3 times to conduct interviews and observations during a prearranged class time.

You must be 18 years of age or older to be included in the research study.

Study contact for questions about the study or to report a problem: If you have any questions about this research project, please contact my faculty supervisor, Atsusi (2c) Hirumi, Ph.D. at: Atsusi.Hirumi@ucf.edu or you may contact me directly at (269) 598-1132 or Kendra.minor@knights.ucf.edu. Information regarding your rights as a research volunteer may be obtained from:

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

Email I to Participants

Dear:

Within the next few days, you will receive a request to fill out a brief questionnaire. The questionnaire is a part of the research being conducted for my dissertation research project.

The survey is designed to gain a better understanding of your technological pedagogical content knowledge.

I am writing to you in advance because we have found that many people like to be informed prior to being contacted. The study is important in that it will help determine what support is needed by teachers.

Thank you for your time and consideration. It is only with the generous help of people like you that my research can be successful.

Sincerely,

Kendra
Kendra L. Minor
Doctoral Student

Email II to Participants

Greetings!!

I am contacting all of the teachers at the school to ask demographic information and perceived technological pedagogical content knowledge.

Please use the following link to access the survey:

https://ucfced.qualtrics.com/SE/?SID=SV_a2I414QSCxq5STj

Results from the survey will be used to help in the completion of my dissertation; in addition the information provided from the study may help determine what support teachers need.

This survey is voluntary. However, you can help us very much by taking a few minutes to share your experience and opinions about your perceptions and experiences with technology.

If you have any questions or comments about this study, I would be happy to talk with you.

My number is 269-598-1132, or you can email me at: Kendra.minor@knights.ucf.edu

Thank you very much for helping with this important study.

Sincerely,
Kendra
Kendra L. Minor
Doctoral Student

Email III to Participants

Greetings,

Let me begin by expressing my thanks for agreeing to participate in my dissertation research project. As I indicated, I am nearing the completion of my doctoral study in education- instructional technology track at University of Central Florida.

The purpose of the study is to explore elementary teacher's perceived technological pedagogical content knowledge who practice in an urban charter school setting and how teachers demonstrate this knowledge in their instructional practices and plans. The researcher will also seek to understand what contextual factors influence their technology integration knowledge.

I am looking forward to interviewing and observing your classroom. During my first visit, I will be interviewing you for no longer than 30 minutes.

During subsequent visits, I will observe a 20-30 minute lesson in which you use technology for instructional purposes and then interview you for 15-20 minutes to discuss your perception of how well the lesson went.

I would like you to select any day and time, Monday to Friday, between April 29th to May 4th that would work best for you to be interviewed. Please provide more than one day you would be willing and available.

During the interview, I will set up a days and times with you to observe your classroom.

I am also requesting that prior to the observations; you send a copy of the lesson that I will be observing when I visit your classroom.

Prior to the observation, I will send an email confirming my visit.

Kind regard,

Kendra

Follow Up Email to Participants

Greetings,

Thanks again for agreeing to participate in my dissertation research project. I am sending this email as a reminder of my visit to your classroom on:

If you have not done so already, please send a copy of the lesson I will be observing.

I will be arriving 30 minutes before the scheduled time to set-up the video camera.

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