Examining Technology Integration Practices and Beliefs of Grades 1-3 Teachers: A Case Study

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It has been said that PhDs are earned, not given. My journey to this point has shown me the truth of that quip, and without the support of many people, I would never have arrived here. Some of you aren't named here, but know that is only an issue of space.

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Dedication

This is dedicated to my family and friends. Without your support, guidance, and appreciation for education, the person I am and this dissertation would not be possible.

Abstract

This study examined how technology integration beliefs and practices of first and second grade teachers impacted their respective teaching practices. Technology is becoming more deeply integrated into US public school curricula, and it is therefore helpful to understand how teacher beliefs might affect how technology gets used within teaching practices, especially in the early primary grades. While belief systems are of critical importance to a teacher's technology integration efforts and can pose a barrier to technology integration (Ertmer, Ottenbreit-Lefwich, Sadik, Sendurer, & Sendurer 2012; Funkhouser & Mouza, 2013; Lin, 2012; Liu, 2012), the impact of those belief systems is not well understood. Furthermore, P-12 educational research literature may be underrepresenting grades 1-3, and so this research strives to also be pragmatically useful for teachers and district administrators. An exploratory case study (Stake, 1995; Merriam, 1998) was conducted with three current teachers in grades 1-3 to obtain new insights on how these beliefs manifest in current classrooms to address three research questions: (1) What are the experiences of grades 1-3 teachers trying to integrate technology? (2) What beliefs do grades 1-3 teachers have, connected to technology integration? (3) What other factors affect how a grades 1-3 teacher integrates technology?

With a case being defined as each individual teacher, this qualitative case study collected data through initial interviews, naturalistic observations, and follow up interviews. Analysis consisted of values coding and theming the data (Saldana,

2016) to identify six themes: (1) Pedagogy and focus on students wherein teachers' consistent primary focus was on meeting students' needs and engaging them in learning experiences, both with and without technology; (2) Technology knowledge that facilitated the use or avoidance of technology; (3) Technology as a barrier when design failures created problems for students; (4) School as ecosystem, as students have needs seemingly disconnected from formal classroom learning but that impact their learning experiences; (5) Teachers' needs that, when left unmet created barriers to technology integration; and (6) Change management, especially in regards to stakeholders' apprenticeship of observation (Lortie, 1975), made innovative uses of technology and pedagogy more difficult to implement. Insights gained from this research were used to make recommendations for addressing issues in each of the six themes to be used by teachers, district administrations, and education research as foundations in their own contexts. Future directions for this research include laying the foundations for a new model of technology integration for teachers.

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Chapter 1

Introduction

Using technology to improve or enhance a K-12 student's formal educational experience has been an elusive goal across many districts in the United States. Through systematic and structural involvement in school teaching, technology can assist in the analysis of problems, curriculum design, development of the learning topic and implementation and evaluation of school teaching (Lin, 2012). In spite of that promising statement, research into classroom technology integration has identified many problems with implementation.

One such concern is that it appears much of the published literature focuses on work done with students outside of grades K-2. Without a focus on younger children we could be missing large benefits for this age group, such as gains in digital literacy and other important 21st-century skills (NAEYC, 2012). As such, the educational enterprise could be improved with additional research in the kindergarten to second grade (K-2, hereafter) space. It is worth noting here that research cited in this document often refers to grades K-2, but the research completed through this dissertation focuses on grades 1-3. Additionally, because of the large developmental differences between kindergarteners and first through third graders, this research intentionally focused on grade 1-3. Transferring the results of this research to other grades and contexts should be done only with caution.

Another identified concern with technology integration is that a universal

model doesn't exist because of the breadth of pedagogical stances of teachers (Doering & Roblyer, 2006). For example, it's been seen that teachers who use mobile-learning technologies such as iPads and tablet device have their students more active and working on projects in and out of the classroom, whereas teachers whose pedagogies focus on using technology in class prefer laptops (Shamir-Inbal & Blau, 2016). Related to individual pedagogies, it has been observed that the beliefs a teacher holds about technology are highly influential in how that individual might integrate technology (Ertmer, Ottenbreit-Lefwich, Sadik, Sendurer, & Sendurer, 2012). In addition to developing solutions to these complex, deep-seated issues, it's critical that teachers have the resources necessary to support their integration efforts.

K-12 public education in the United States as a whole has been undergoing resource constraints for a long time and due to these constraints, teachers have encountered severe difficulties in finding the resources to grow as professionals, integrate technology, and use research in their classroom practice. This dissertation examines these issues through an exploratory case study of teachers' beliefs and experiences related to technology integration.

Statement of the Problem

Within the United States, significant resources have been devoted to getting technology into public K-12 classrooms (NCES, 2016). However, we seem to be missing much of the transformative potential of technology within instructional designs and the learning experiences of children (Stallard & Cocker, 2001). While a

lack of resources still exists in some schools and classrooms, the fact that these problems persist suggests that doing more of what we have already been doing in unlikely to overcome the issues. Furthermore, simply allocating more resources for an ill-defined problem would seem to be unlikely to prompt a move towards transformative practices. Therefore, a better understanding of the experiences and beliefs of primary grade teachers regarding technology integration enables more voices to be heard regarding the challenges of modern classroom practice (Shamir-Inbal & Blau, 2016) thereby creating more opportunities to better understand how technology might be better utilized within and for different modes of teaching, contexts, and particular educational purposes (Mama & Hennessey, 2013). This research examines the beliefs and experiences of teachers who are integrating technology so as to better define the issues facing these teachers.

Background of the Problem

Within K-12 public education there are competing views surrounding the purpose of education, how best to inform the profession, and how best to utilize resources (Apple, 1988). One significant area of formal K-12 education being examined is that of technology integration. Competing views and requirements sometimes conflict, creating confusion as to what exactly constitutes effective technology integration, which in turn leads to difficulties and a lack of guidance for teachers.

Pedagogical and learning philosophies. While effective technology integration must be aligned with learning objectives, instructional strategies, pedagogical

stances, and learning theory (Doering & Roblyer, 2006), the breadth of these terms can create problems. There are many different pedagogical stances that teachers might take, and these pedagogies are embedded in learning theories that take very different views of how learning even occurs (Doering & Roblyer, 2006), let alone what technologies might best support a given pedagogy. Even defining effective technology integration is difficult, since a teacher utilizing a direct instruction or objectivist pedagogy would use technology in different ways than a constructivist practitioner would. For example, a teacher using objectivist direct instruction in a behaviorist model might use technology in order to provide consistent stimuli to produce a specific response, fitting this teacher's view of what learning should be (Doering & Roblyer, 2006). In contrast, a constructivist teacher using social cognitive theory might use technology to connect students in a social manner, believing that technology is best used to provide social spaces since learning occurs when social interaction occurs (Doering & Roblyer, 2006). While both strategies have merit based on a learner's needs in a given context, the very different views of technology use make creating a universal definition of technology integration extremely difficult.

The variation in what constitutes the definition of effective technology use can add difficulty for veteran in-service teachers to implement technology integration strategies beyond their own context. For pre-service teachers, figuring out technology integration can be even more daunting (Ring, 2014). Despite little pragmatic experience in the classroom as a teacher and lacking experience in

applying a learning theory to instruction, figuring out what makes a given technology effective is often left out of their training. Further complicating matters, pre-service teachers are often left to determine what technology integration means to them personally, without an experience base to help them determine what does and does not work or a framework to help them even begin this process (Ring, 2014).

Underrepresented grade levels in research. One concern regarding a trend in technology integration research is the potential for a disproportionate focus on grades 3-12 or on early childhood education, leaving grades K-2 potentially underrepresented. I conducted a systematic review of peer-reviewed journal articles accessed through the University of Minnesota library system using the search term "K-12 classroom technology integration" and filtered out articles published prior to 2010. Of the 40 articles reviewed, I found only two articles explicitly focused on grades K-2. If one assumes that all grades get researched equally, and with fourteen grades in total between preschool and 12th grade, then each grade should have been represented by approximately 2.86 articles. Therefore, I should have found between six and nine articles if grades K-2 were represented equally and explicitly.

When an article stated which grades were being examined, grades K-2 were well represented. One such example was when Ottenbreit-Lefwich, Glazewski, Newby and Ertmer (2010) specifically mention that of their 12 participants, three of

them worked in grades K-2. Of concern, however, is that only seven of the articles sampled stated which grade level they focused on.

Within the sample of 40 articles, 33 never explicitly stated what grade level or levels the research was being conducted within. When specific grade levels were called out, they were often lumped crudely into groups such as *elementary* or *middle*. Slightly more specific language was used by Ritzhaupt, Dawson, and Cavanaugh (2012) in a survey sent to over 300 K-12 teachers. Here, grade level was described as having as a mean of 7.09, with a standard deviation of 3.002 grades (Ritahaupt et al., 2012). While it is possible that grades K-2 were represented within these studies, the lack of fidelity and explicit language makes it impossible to determine what grade levels are being targeted. In turn, given the developmental differences present in early grades, this lack of fidelity also makes it harder for research results to be utilized for classroom purposes for risk of trying to apply research that simply cannot work for students of a certain age or developmental ability. The research proposed in this dissertation mitigates these concerns by explicitly focusing on grades 1-3.

Teacher beliefs. The ways and depths to which a teacher integrates technology into his or her teaching practice is deeply impacted through his or her system of values and beliefs about technology (Ertmer et al., 2012; Funkhouser & Mouza, 2013; Liu, 2012). In other words, if a teacher believes that integrating technology is merely an additional, non-crucial task to complete, especially when facing dwindling money, time, and resources, then technology integration is unlikely

to play a significant role in his or her teaching. One complication in the technology integration process could be that the aforementioned potential disproportionate focus of research on grades outside of K-2 is making it more difficult for teachers in these grades to use research as a guide for their professional development and curricular reform efforts. It is possible that more research, specifically aimed at underrepresented grades, may help build a framework against which teachers may evaluate their beliefs, providing a possible impetus for change.

Research Purpose

The purpose of this research is to explore the experiences and underlying beliefs of first through third grade teachers when they work to integrate technology. The study used an exploratory case study methodology with multiple cases (Merriam, 1998), with values coding and data theming (Saldana, 2016). A thick narrative description (Merriam, 1998; Stake, 1995) used as a reporting mechanism helps convey the beliefs, experiences, and contexts of the teachers to help increase resonance of the results. The explicit focus of the research on first through third grade teachers and classrooms is intended to help teachers examine their own beliefs about technology, help school administrations better understand teacher-level factors in technology-integration projects, fill an identified gap in the literature bases, and hopefully lay the groundwork for a model that teachers could use to align pedagogies, beliefs about technology, and technologies that support both.

Research Questions

The questions explored within this research are listed below. The three questions are:

- What are the experiences of grades 1-3 teachers trying to integrate technology?
- What beliefs do grades 1-3 teachers have, connected to technology integration?
- What other factors affect how a teacher in grade 1-3 integrates technology?

Significance of the Study

This study examines grades 1-3 teacher technology integration experiences and beliefs. Beliefs form an important basis for technology integration both directly and through pedagogical practices (Ertmer et al., 2012; Funkhouser & Mouza, 2013; Lin, 2012; Liu, 2012), but are not yet well understood. Given that grades 1-3 remain important in the development of student attitudes towards, and engagement in, formal academic work (NAEYC, 2012) research on these grades may help support future student academic success. Therefore, the significance of this research stems from the further exploration of beliefs connected to technology integration that may help district administrators and practicing teachers evaluate the impact that belief systems have on teaching practices and technology integration. Secondly, the explicit focus on grades 1-3 helps address a gap in educational literature and theory. Finally, this study is intended to help lay the foundation for future research into

development of a new model for technology integration that includes teacher beliefs, practices, and pedagogies.

Assumptions and Limitations

There are multiple limitations under consideration at the beginning of this research design. This research project has a target *n* of 3-4 participants, as a way to craft a representative sample of participants and to ensure that increased numbers of teacher voices are heard (Dede, 2008), but balanced with the available resources available for data analysis. Combining the sample size with multiple interactions of initial interviews, observations, and follow up interviews increases triangulation of the results. Engaging this many participants may be difficult given resource constraints, especially in regards to time. Although relationship formation can occur in parallel with multiple teachers in order to more efficiently use the available time, significant amounts of time needed to be spent fostering relationships with each participating teacher. Even with this streamlining, the research involving participants still required between two and three months to conduct. While the researcher within a studied environment is never a pure observer (Merriam, 1998), there is always a time commitment involved in allowing a researcher into the classroom. Teachers may not have sufficient time to devote to the interactive elements of this research, creating a constraint. In the beginning stages of research, attempts were made to engage more than four participants since it was possible some participants would drop out during the course of the project. While this study is designed to be transparent, attempts at transferring or generalizing these results

to other populations should be done only with caution, given the small sample size and limited contexts the research was conducted in.

Intersections of research and researcher

As of this writing, I have 22 years of experience connected to the education field. In formal classrooms, I've taught students ranging from Kindergarten to 12th grade and currently teach undergraduate classes that focus on pre-service teachers working on how they might use technology in their teaching practice. Informally, I've worked with inner city youth in an afterschool center teaching about digital citizenship and helped high school kids enter into STEM careers as a way to improve their own lives. I've held leadership and advising positions pertaining to technology-related issues in education. I've worked in a company that helped school districts understand the potential their brand new 2005-vintage wireless networks had when it came to innovating new practices for classrooms. I still self-identify as a teacher. As I transition toward researching a field I have been deeply involved for my entire professional career, I carry these prior experiences with me along with the belief that technology has unique, profound potential to fundamentally transform how we teach (Stallard & Cocker, 2001) when used effectively.

The consideration of whether or not a teacher's integration of technology is effective should be grounded in the context in which they're teaching. Teachers have a great deal of knowledge about phenomena within their unique classrooms (Stake, 1995). These contexts include individual factors such as a teacher's beliefs about what technology can do and how it should be used (Ertmer et al., 2012, Funkhouser

& Mouza, 2013; Lin, 2012; Liu, 2012), the pedagogical strategies a teacher has or is willing to try, their own understandings of the content they are teaching, prior experiences a teacher had with technology, and how they view their relationship with students. A teacher's context involves other people, including students, families, other teachers, administration in the school and district, and other stakeholders in the community. Given the highly contextual nature of a teacher's technology integration efforts, attempts to generalize or transfer the results of an individual's integration efforts should only be done with caution (Stake, 1995).

Technology changes quickly, therefore studying the process of technology integration is of longer-term relevance both in research and in the application of research to the education field. An exploratory case study method can be used to examine a process, so long as the process includes a description of the context and population of the study (Merriam, 1998). Additionally, exploratory case study is a tool that can be used to examine beliefs connected to technology integration (Merriam, 1998) and can do so through a thick narrative description of the participants situated within naturalistic settings (Stake, 1995). It is my hope that this study helps teachers to critically examine their own beliefs about technology integration, help district administrators see another side of what's involved in technology integration, and to lay the groundwork for building a model that could be used in schools as a way to align a teacher's pedagogy and beliefs systems to technologies that would support them.

Summary

This chapter introduced background information and issues involved with teacher technology integration. The purpose of the research was outlined, the research questions were posed, and assumptions were revealed. The next chapter examines what is known about technology integration within the literature base.

Chapter 2

Review of the Literature

When considering new educational research, it is important to review what is already known about what teachers are doing. This chapter reviews some of what has been written about teachers in the contexts in which they teach, as well as relationships between technology integration and pedagogical approaches. Next, this chapter reviews four identified barriers to technology integration, as well as research-based models of technology integration. This chapter concludes with the requirements of this research design that include the conceptual framework and research method to be used, as well as how those connect to the literature reviewed.

Classrooms are complex social environments, with many interacting and interrelated parts. Technology integration adds an additional variable to these classroom dynamics (Mama & Hennessey, 2013). Anyone examining classroom technology integration should deeply consider the context in which the study is occurring. This literature review serves as a way to provide context for both the reality of classroom practice and the research to study it, and therefore includes multiple factors affecting teacher integration of technology, such as teacher contexts, pedagogical stances, and barriers identified in the literature. From a research perspective, it is important to look at existing models that have been used to examine technology integration, such as TPACK (Mishra & Koehler, 2006), RAT (Hughes, 2013), or TIP (Doering & Roblyer, 2006). In order to understand how and why the research is being conducted, the literature review delves into the

conceptual frameworks underpinning the research, and details the case study methodology to be used. Figure 2.1 illustrates the three distinct tracks of this literature review along with the areas of overlap between them, and positions the research questions accordingly.

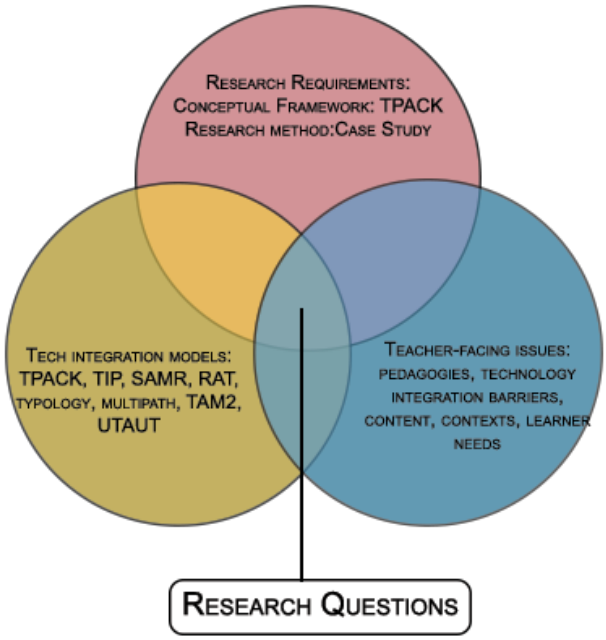

Figure 2.1. Literature review infographic. This figure shows the relationships between areas of the literature review, and how they relate to the research questions.

With classrooms being complex and often unique in their individual contexts, a focus on a technology integration experiences and beliefs that is grounded in actual classroom practice may help to build research that resonates more with grades 1-3 teachers and could potentially be used as a starting point for integrating technology into their own practice. Given the complexities surrounding technology integration, along with a goal of relevance in an age of rapid technology development and change, this literature review focused on recent publications as often as possible. Unless there are specific needs to draw from older sources, articles dated 2011 or more recently have been given primacy to help ensure that the rapid pace of technological change is less likely to have rendered the article's findings invalid or no longer applicable within the field. In order to provide confidence and credibility in the researcher's

methods, the majority of articles in this literature review are drawn from professional, peer-reviewed journals. This approach thereby also helps support those aspects within the research detailed in this dissertation.

Teachers and Classroom Contexts

Educators and other decision-makers in education need to understand the benefits within particular modes of teaching, for particular phases of education and student groups, within particular social, cultural and political contexts, and for particular educational purposes (Mama & Hennessey, 2013). A breadth of teaching methods are used in US K-12 public schools, such as behaviorist, cognitivist or constructivist methods (Dede, 2008) as well as the wide range of technologies that can be used to support those methods. One study found that as many as 94.7% of teachers agree that technology can be appropriate as a learning tool for young children (Yurt & Cevher-Kalburan, 2011). Computers have been shown to support the development of memory, communication, problem solving, literacy, and math for children (Yurt & Cevher-Kalburan, 2011) but have yet to be used widely to transform the educational experience beyond using technology to complete learning tasks in ways fundamentally similar to analog methods (Mama & Hennessey, 2013). For example, without other changes, there is little difference in student learning between using a computer for repetitive *drill-and-kill*-style practice versus completing a paper-based worksheet with a similar problem set. Aspects that could change the learning experience could include immediate feedback offered by the software, gamification of the activity, or alternate media that represent or display

student learning.

While technology-based tools have potential to help children, it is critical to remember that these tools are not ends in themselves (Keengwe & Onchwari, 2009). The available technology should not determine the curriculum; specific tools should be chosen to serve the teaching and learning needs (Ashbrook, 2011). The use of what McRaney (2012) called "Maslow's hammer" should be avoided when integrating technology. McRaney (2012) described Maslow's hammer as having only one tool (i.e., a metaphorical hammer) to treat every problem as though it were a nail. If a teacher were to have only one tool for technology integration, then it would be more difficult, or even more problematic, when trying to solve problems that go beyond the scope of that single tool. It has also been asserted that technology integration should follow a sort of pedagogical dogmatism, in which the integration efforts specifically follow educational theory (Lin, 2012). With all of this in mind, technology integration itself is a complex task, making it challenging to devise a model that teachers could follow.

Technology Connected to Pedagogical Approaches

Many learning theories that pedagogical strategies are based on treat technology for instruction as a simple activity that remains invariable across people, context areas and education objectives (Dede, 2008). Many instructional designers and scholars seek a single best medium for learning, suggesting that there is a single best *killer* app or one-size-fits-all device as part of universal design (Dede, 2008). Universal design and the idea of simplistic technology integration is problematic

because the very definition of technology integration can vary based on pedagogical and instructional philosophies (Doering & Roblyer, 2006). It has been noted that purposeful, meaningful learning with technology includes the following key issues:

1. Digital technologies and technology-supported activities align with open-ended, constructivist, learner centered pedagogies (Doering & Roblyer, 2006; Lin, 2012; Wang et al, 2008) that are also developmentally appropriate and seen as more child-centered (Lu, Ottenbreit-Lefwich, Ding, & Glazewski, 2017). These pedagogies include active inquiry and meaning-making activities for learners. Integrated technologies can encourage engagement, creativity and social interaction for young learners within those pedagogies.
2. The decision as to which technology should be used is best made when giving primacy to how well the tool serves classroom learning and teaching needs (Doering & Roblyer, 2006; Wang et al., 2008). In other words, the pedagogical strategies and intentional instructional planning are what drive purposeful learning, rather than the technology itself. Technology is not a means unto itself (Keengwe & Onchwari, 2009).
3. Opportunities for all learners to participate must be a consideration in a technology-rich environment (Ashbrook, 2011; Wang et al., 2008). This does not necessarily mean that technology needs to be the center of all activity or that all students must have their own device. Rather, technology should be a part of a holistic analog and digital learning environment that enables learners to investigate and learn together with technology, instead of having

technology be separate from daily classroom learning and teaching. In other words, technology that is effectively integrated into a learning experience has the potential to transform it (Mama & Hennessey, 2013).

Further complicating the task of building a model of technology integration is that pre-service teachers, who make up a growing constituency of the teaching profession as veteran teachers retire (NCES, 2016b), are largely left to define for themselves what technology integration means with little input from teacher educators (Ring, 2014). Once in the field there are further complications, such as the conundrum regarding assessment. Assessment of constructivist, technology-based activities, even when they are pedagogically sound, can be a difficult task since a comparative norm for assessment may break down in this sort of environment (Doering & Roblyer, 2006; Keengwe & Onchwari, 2009). Therefore, assessment in a constructivist environment must be both strategic and purposeful, with the results being used to determine adaptations needed for further integration and development (Keengwe & Onchwari, 2009). Solving even this particular pedagogical misalignment is difficult, as many schools don't have the capacity to enact the requisite level of change among their staff, given the required investments of resources, time, and money to achieve it.

Constructivism. Constructivism is founded on the creation of knowledge in learning environments and is supported by active, collaborative learning in contextualized, authentic tasks (Keengwe & Onchwari, 2009) that are developmentally appropriate and child-centered (Lu et al., 2017). Constructivist

environments provide multiple paths for students to demonstrate knowledge and explore, with teachers performing the role of guide, mentor or facilitator (Keengwe & Onchwari, 2009). In constructivist pedagogy, educators understand that technology can be useful in enabling children to solve problems and in building a cooperative learning environment where the students actively work together with the teacher on those solutions. Technology also helps educators to transform their role as a teacher, acting as a guide for children and turning them into active participants at their own level (Onkol, Zembat & Balat, 2011). What constitutes developmentally appropriate practice within technology integration is an identified key issue (Lu et al., 2017).

According to Doering and Roblyer (2006) a constructivist pedagogy combined with technology facilitates three valuable learning modalities. The first of which is learning through the creation of new material (as opposed to passively consuming material already extant). Next, the challenging of previously prior thoughts and feelings about a topic is a crucial aspect of constructivist practice. Finally, a technology-integrated constructivist practice enables collaboration, including student-to-student and student-to-teacher efforts. Teachers, under a constructivist pedagogy then must also design for technology to be used to enrich learning experiences that support teaching and learning (Keengwe & Onchwari, 2009) as well as the cognitive and social abilities of children (Yurt & Cevher-Kalburan, 2011) in order to support student meaning-making. When integrating technology with younger students, such as kindergarteners or even grades 1-3

students, it's also important to consider physical limitations, such as fine motor control (Yurt & Cevher-Kalburan, 2011). Examples of technology-integrated constructivist practice can include using iPads to complete interdisciplinary digital production projects, such as creating digital books that span science, literacy and social studies (Lu et al., 2017).

Teachers lack a model that they can use to guide them through the necessary changes needed to be successful when integrating technology in their classroom practice (Keengwe & Onchwari, 2009). Many teachers problematically view instruction and integration as two separate entities (Keengwe & Onchwari, 2009). One possible solution is to have teachers who are enthusiastic about using technology demonstrate their ability and willingness to go through integration efforts, and designate them as technology coaches (Keengwe & Onchwari, 2009). As a coach, constructivist pedagogy is modeled, reinforcing the use of constructivism at the site and potentially helping disseminate context-specific created knowledge. The teacher-as-coach model, however, is far from universal or even reasonable in many cases.

For example, a teacher who takes on the coaching role is then necessarily taking time away from his or her own work, often doing so without additional compensation (NCES, 2016). Additionally, the constructivist model mentioned above is not the only pedagogical stance that is in practice in education, nor is it always the right stance to use. If one is trying to build base-level skills as quickly as

possible, it may be that a direct instruction method is a more effective tool than open-ended constructivist methods would enable (Doering & Roblyer, 2006).

Direct instruction. Direct instruction, teacher-centered practices focus on skill development (Doering & Roblyer, 2006) on the premise that basic skills must be mastered before more advanced learning can occur (Lu et al., 2017). These types of instructional practices involve a teacher setting the schedule and fixing the purposes of activities that students work on (Lu et al., 2017). In contrast to constructivist practices, direct instruction practices typically put the student in a passive role where they follow along and listen, while the teacher delivers whole-group instruction (Doering & Roblyer, 2006; Lu et al., 2017). Direct instruction certainly has value; however, the prevalence of standardized assessment to focus on skills can set up misalignment between a teacher's pedagogy and what serves to engage learners. Examples of skill-oriented, direct instruction uses of technology include using iPads for drill-and-practice activities such as writing letters on the screen (Doering & Roblyer, 2006), establishing a learning station where students drag letters to the correct spot within an app or practice phonemic awareness, or using iPads as a classroom management technique (Lu et al., 2017). In first and second grades, interactive iPad apps can be very useful for learning and practicing basic skill areas within spelling and arithmetic. The instant feedback nature of apps can help reinforce appropriate learning concepts in an efficient, timely manner.

Consider that high-stakes testing, conducted in a decidedly direct instruction method, are a primary teacher evaluation tool. When evaluation is based on direct

instruction but student learning may be better served through constructivist pedagogies, there is a misalignment. This misalignment phenomenon both helps illustrate the complexities facing technology integration and demonstrates why many teachers feel compelled to do what it takes to ensure students do well on the test.

Barriers to Technology Integration

There are many identified barriers to integrating technology into a teacher's practice, such as the following:

- the unavailability, inappropriateness, or inaccessibility of technological equipment in schools, (Hechter & Vermette, 2013; Lin, 2012; Mama & Hennessey, 2013)
- lack of ongoing technical support (Mama & Hennessey, 2013)
- lack of time to integrate technology in the lesson (Mama & Hennessey, 2013)
- problematic communication of policy to school leaders and negative school culture surrounding innovation (Mama & Hennessey, 2013)
- lack of teacher technological knowledge and skills (Mama & Hennessey, 2013; Mishra & Koehler, 2006)
- lack of design thinking as a way to overcome classroom problems surrounding technology integration (Tsai & Chai, 2012)
- insufficient technology training programs (Mama & Hennessey, 2013), and,

- teachers' beliefs about technology, especially in terms of their compatibility with their teaching philosophy (Ertmer et al., 2012 Mama & Hennessey, 2013).

The literature categorizes these barriers first-, second-, third-, and fourth-order barriers and each presented as discussed in the literature, with further detail on each included below. While all of these barriers are important to consider when integrating technology, the primary focus of this dissertation research is on the fourth-order barrier, which looks at what beliefs teachers have about technology and the role those beliefs play in their practice. It is worthwhile to note that these barriers can be interconnected in any given teacher's practice (Mama & Hennessey, 2013) and that more than one might exist for any individual.

First-order barriers. First order barriers are external to the teachers' locus of control, such as access to technology, time, training, and support (Hechter & Vermette, 2013; Lin, 2012; Mama & Hennessey, 2013). Training has been found to be a common barrier in K-4 technology integration, with 57.8% of teachers (n=128) reporting it to be an issue (Hechter & Vermette, 2013). Additionally, while 59.4% of K-4 teachers from that same sample identified that they had access to technology (Hecter & Vermette, 2013), these numbers mean that even as recently as 2013, as many as 40% of teachers in grades K-4 encounter a lack of access to technology as a barrier. Sometimes, access to technology is part of a larger discussion about infrastructure, which can also include aspects of bandwidth targets and capital expenditures (MDE, 2016).

One way to help overcome this barrier includes being able to better make the case about why technology is needed to help students. This justification may open up additional funding or other needed resources (Tsai & Chai, 2012). An independent groups t-test was conducted to reveal whether teachers' computer use attitudes and beliefs, knowledge-skills, computer habits and teaching methods varied depending on if a computer was in the classroom (Onkol et al., 2011). This study showed that a statistically meaningful difference existed in their attitudes and beliefs ($t=2,561$; $p<0,05$) and knowledge-skills ($t=2,778$; $p<0,05$) (Onkol et al., 2011). While first-order barriers are an issue in technology integration, they are external to the teacher and the act of teaching, suggesting these barriers can be largely solved through external solutions. These external solutions are beyond the scope of this research in terms of being studied in terms of offering a solution, but they were considered in the context of data collection and analysis.

Second-order barriers. Second-order barriers are fundamental beliefs teachers have regarding interpersonal aspects of teaching such as beliefs about the roles and relationships between teachers and students, curricular freedoms, assessment practices and purposes, (Hechter & Vermette, 2013) and pedagogy (Keengwe & Onchwari, 2009). Second order barriers are also impacted by school cultures (Ashbrook, 2011). It is worth noting here that teachers' beliefs about technology are currently treated separately from second-order barriers although they often connect in teaching practice. Lu et al. (2017) found that teachers need support and concrete examples to show them how to integrate technology into their

teaching. In addition, to support learner development, effective technology integration efforts need to be in conjunction with learner-centered, constructivist pedagogies (Lu et al., 2017; Shamir-Inbal & Blau, 2016).

For example, a school's philosophy and curriculum should guide the choice of technology, such as if a curriculum emphasizing learner-centered exploration and active meaning-making is adopted (Ashbrook, 2011). Such a curriculum would likely be best supported by constructivist pedagogy (Keengwe & Onchwari, 2009) and integration of technology (Ashbrook, 2011). Assessment in this curriculum using a constructivist pedagogy should be strategic and purposeful and designed to enable meaning-making (Keengwe & Onchwari, 2009).

Second-order barriers are important to examine given how interwoven they are with the fourth-order barriers which are the core of what this research examines. For example, a teacher's pedagogical philosophy affects his or her technology integration practice (Mama & Hennessey, 2013). How that philosophy affects practice can be best seen when a teacher is exposed to a massive range of technological applications, activities, and approaches (Mama & Hennessey, 2013). A majority of teachers choose technologies to reinforce and accommodate their own perspectives on teaching and learning (Mama & Hennessey, 2013), but doing so puts designing technology-integrated learning experiences that enable more effective learning experience for their students at risk.

Third-order barriers. The third-order barrier to technology integration is a lack of design thinking by teachers (Tsai & Chai, 2012). Without solutions to third-

order barriers, even when teachers have overcome first- and second-order barriers, they may still not experience successful technology integration because of the dynamic nature of students and classrooms (Tsai & Chai, 2012). One example of a design failure is when pedagogically innovative teachers who have integrated technology in meaningful, transformative ways are isolated from the school and system of which they are a part (Kozma, 2003; Mama & Hennessey, 2013). Isolation in this context can mean being seen as *different* from other teachers, or not being empowered with opportunities to share what and how the technology integration worked. This isolation then leads to a widespread situation where technology often supports and enhances teaching practice, but without profound transformation of the learning experience (Mama & Hennessey, 2013; Munro, 2010). Understanding the process needed to integrate technology and transform student learning experiences, are foundational steps to using design thinking and overcoming the third-order barrier.

Steps to overcoming the first three orders of barriers should include strategies that provide a shared vision of a technology integration plan (Ottenbreit-Lefwich et al., 2010). The plan should target a specific purpose or learning goal that aligns with teachers' values and beliefs associated with teaching and learning (Ottenbreit-Lefwich et al., 2010), overcoming a scarcity of resources, changing attitudes and beliefs, conducting professional development, and reconsidering assessments (Hew & Brush, 2007). The habits of computer users must be examined because those habits can indicate the users' attitudes (Lin, 2012). Attitudes towards

computer use must be known because the negative attitudes of users, including teachers, students and administrators, are among the biggest barriers to adoption (Ertmer et al., 2012; Onkol et al., 2011). Even with the first three orders of barriers in mind, it is necessary to also address a fourth-order barrier to technology integration.

Fourth-order barrier. Teacher belief systems about technology, and their resulting habits, are also an identified barrier in technology integration (Ertmer et al., 2012; Funkhouser & Mouza, 2013; Lin, 2012; Liu, 2012). For the purposes of this research, a teacher's system of beliefs and values around technology are being considered a fourth-order barrier. For example, even models that examine teacher technology practices through the knowledge aspect, such as Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge model (TPACK), highlight that teachers' knowledge and understanding of technology integration are influenced by their pedagogical beliefs and personal appreciations and values (Koehler & Mishra, 2009; Mama & Hennessey, 2013).

It is still frequently the case that necessary curricular resources and professional development for teachers to integrate technology in meaningful ways are overlooked in favor of layering technology as an add-on to existing curricula and pedagogies (Bauer & Kenton, 2005; Dooley, Ellison, Welch, Allen, & Bauer, 2016). It's also important to understand that for teachers, merely believing the use of technology is worth the effort needed for integrating it isn't enough (Hechter & Vermette, 2013). There is often a lack of leadership, feedback, and follow-up on

stated integration requirements and efforts; this lack is identified as a hindrance to integration efforts (Keengwe & Onchwari, 2009). Rather, acquiring skills and abilities to act on their own beliefs is essential for teachers, and a lack of skill acquisition can become a substantial barrier unto itself (Ertmer et al., 2012). The most highly correlated factor in a teacher's integration of technology, however, is their system of values and beliefs about technology (Ertmer et al., 2012; Funkhouser & Mouza, 2013; Liu, 2012).

Teachers whose attitudes and beliefs support technology integration, along with having the requisite skills and knowledge to act on their beliefs, have been more likely to experience success in technology integration regardless of the barriers they faced (Ertmer et al., 2012). With the critical nature of teacher beliefs and attitudes, it is important to understand those beliefs and attitudes deeply in order to craft effective technology integration plans. Given the evidence of teachers' beliefs being strong predictors of classroom behavior (Mama & Hennessey, 2013), it is necessary to also examine where an individual's beliefs stem from.

Anderson and Groulx (2015) suggest that important foundations around teacher beliefs can be found in intrinsic factors surrounding teacher preparation and teacher education programs. There are five intrinsic factors identified by Anderson and Groulx (2015), listed here:

- beliefs about the value of technology, teaching, and education,
- beliefs about self-efficacy for themselves and students,
- the perceived ease of use of the technology,

- a subjective sense of normativity and,
- intention

Even when teachers hold positive perceptions of technology, their practice is often limited to small additions to conventional teaching practices rather than transforming the learning experience for students (Mama & Hennessey, 2013). In cases where teachers state that their philosophy fits with the employment of specific tools, inconsistencies have been found between reported and observed practices (Mama & Hennessey, 2013). Two areas that are directly and significantly impacted by fourth-order barriers are that of literacy instruction and mobile device integration.

***Literacy instruction*.** Technology has been used to help students work on higher-level literacy skills relative to their development. For example, multimedia technology can be used even with pre-K children in an environment that enables students to represent their ideas through audio-video recording and image-selection and drawing in ways that merely writing text cannot (Lu et al., 2017). Furthermore, the meaning-making for students derived from multimedia, interactive technology use goes deeper than what can be accomplished through writing alone (Lu et al., 2017).

***Mobile device integration*.** It is important to note here that exploring the use of mobile devices isn't necessarily about the devices themselves. Rather, this portion of the review is about what mobile devices enable. Indeed, a focus on the devices themselves risks a media comparison study (Doering & Roblyer, 2006) that would

dilute from the study of integration processes. This examination of mobile technology integration is conducted through the lens of analyzing the *process* of technology integration and looking at the gradual development of teacher knowledge (Shamir-Inbal & Blau, 2016).

Effective use of mobile technologies requires teachers to be willing to shift toward constructivist pedagogy and take on more of a role as learning facilitator who supports the active construction of knowledge by students. This shift requires that teachers give up the concept of learning as passive student assimilation of material that the teacher delivers (Shamir-Inbal & Blau, 2016). A learning facilitator perceives students as capable of generating unique explorations and understandings of the world and as owners of their own learning (Shamir-Inbal & Blau, 2016). One example of this shift could be that a teacher begins to learn *with* the students in the use of mobile technology, rather than prescribing its use *to* students (Shamir-Inbal & Blau, 2016).

Mobile devices have been part of many efforts that increased student self-efficacy and independent learning. To be most effective, there should also be movement towards increasing students' digital wisdom, which is characterized by learning-relevant technological competency (Shamir-Inbal & Blau, 2016). There are complexities involved specifically with mobile device integration, such as finding appropriate applications for the specific device to be used and the learning context the student and teacher are situated in (Shamir-Inbal & Blau, 2016). These complexities suggest that being able to use a model of technology integration could

help improve the efficacy of technology integration efforts. For example, TPACK is the synthesis of Technological, Pedagogical, and Content Knowledge within the TPACK framework (Mishra & Koehler, 2006). Within a TPACK model, the complexities of mobile device integration would be identified as a need to spend more time on increasing the technology knowledge, or TK, of teachers (Mishra & Koehler, 2006).

Models of Technology Integration

Technology integration, along with the pedagogical changes needed in order to take advantage of that technology from a learning perspective, has been the subject of considerable study across US public education. As a result of this time and effort, several models have emerged through qualitative and quantitative research tracks. Ritzhaupt et al. (2012) state that classroom technology integration is a moving target and cannot be considered finished, especially in light of how fast technology changes. Therefore, the following exemplar models represent many modern models identified in the literature, but one must be aware that new models appear continually. Indeed, even once one does select a model, modification might be needed to recognize the constant changes in the field (Ritzhaupt et al., 2012) or to adapt the model to contextual requirements.

Technology, pedagogy and content knowledge (TPACK). Shulman's (1987) conceptualization of knowledge that all teachers utilize and draw upon for successful teaching includes only pedagogical and content knowledge. TPACK, as illustrated in figure 2.2, builds on Shulman's (1987) model by introducing technology knowledge as an additional domain (Mishra & Koehler, 2006). Represented by the center of the TPACK diagram, Koehler and Mishra (2009) argue:

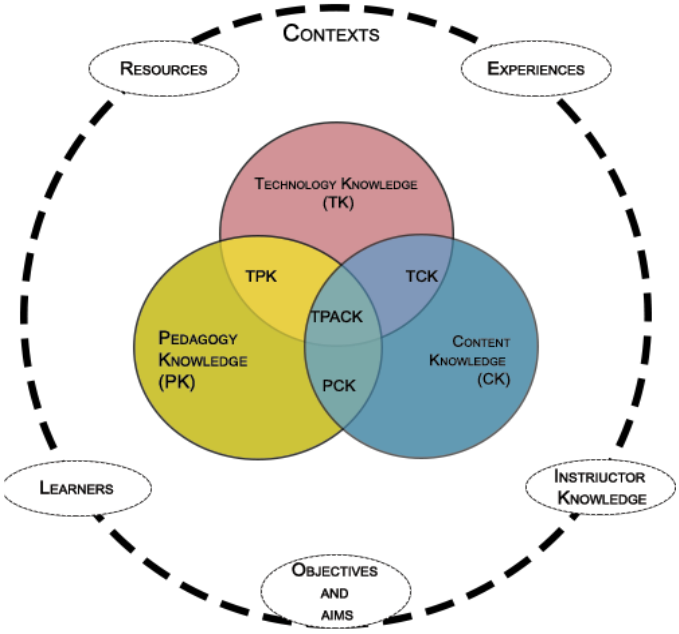

Figure 2.2. TPACK diagram (Mishra & Koehler, 2006).

> In order to be an effective teacher, one must have 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. (p. 66).

Given the complexities of classroom contexts, the differing needs of learners, and teacher beliefs and skills, the route by which one arrives in the center of TPACK is unique for each individual. This individuality can create a problem with transferability, given that the majority of TPACK-related research to date is most often uses quantitative, self-reported data that lacks the vibrant voices of the teachers themselves (Dede, 2008; Shamir-Inbal & Blau, 2016).

Technology integration planning (TIP). The Technology Integration Planning (TIP) model, as shown in figure 2.3, uses elements of the TPACK framework (Mishra & Koehler, 2006) in the Tech-Pack (Doering & Roblyer, 2006). TIP is designed to be useful for teachers when selecting different strategies, materials or digital tools when seeking to integrate technology further into their practice (Doering & Roblyer, 2006). Due to the emphasis on usefulness for teachers, TIP goes beyond TPACK (Mishra & Koehler, 2006) by addressing the need to examine both teaching *and* learning within the context of classroom technology

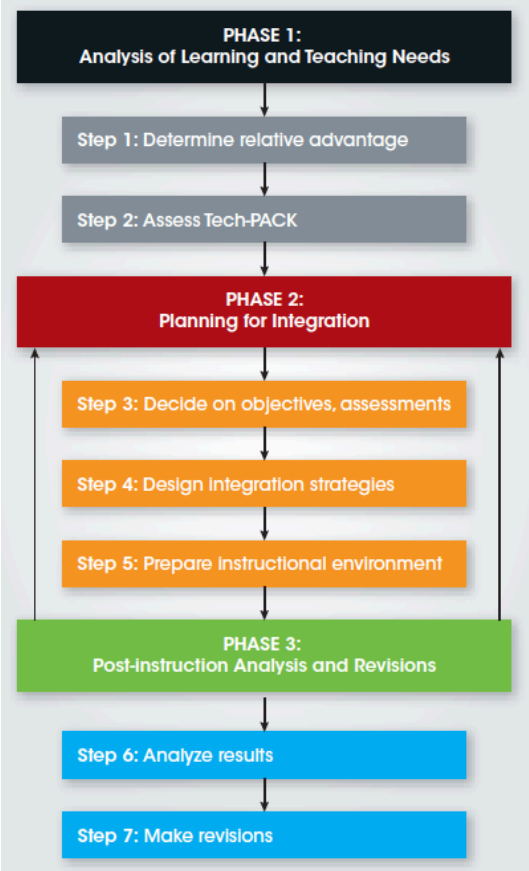

Figure 2.3. TIP model (Doering & Roblyer, 2006)

integration and introducing elements of design thinking (Doering & Roblyer, 2006). Lack of design thinking is an identified barrier to technology integration (Tsai & Chai, 2012), as discussed earlier in this chapter.

Substitution, augmentation, modification and redefinition (SAMR). Developed by Puentedura (2006), SAMR is a four-level, taxonomic approach for technology integration in K-12 settings and is aimed directly at use with practicing K-12 teachers, as shown in figure 2.4. Within the SAMR model, levels of technology integration increase as one progresses through the model, beginning with substitution. At the substitution phase, a teacher uses technology as a direct replacement for another medium, with no functional change (Puentedura, 2006).

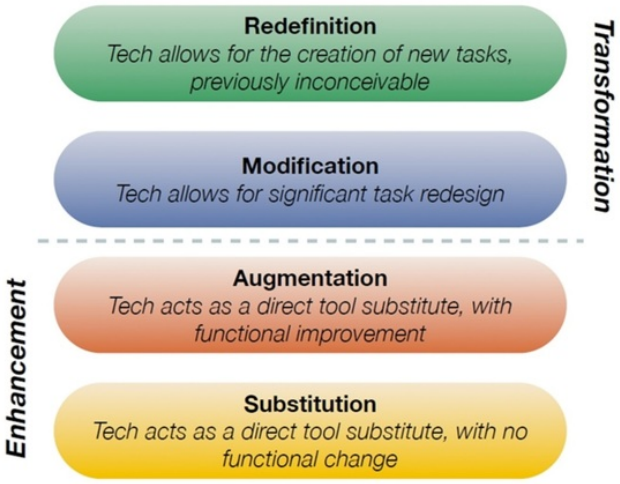

Figure 2.4. SAMR model (Puentedura, 2006).

Substitution could look like a posting a non-editable, plain text PDF rather than using a hardcopy printed version. One level up, augmentation, technology can act as a tool substitute that also conveys a functional improvement (Puentedura, 2006). At the augmentation level, a teacher might enable students to listen and read individual stories on a device like an iPad, rather than having a whole-class read-aloud session. In the next phase, modification, technology enables a learning task to be significantly redesigned (Puentedura, 2006). Redesign within the modification

level could include a teacher enabling multimedia responses to an assignment that was previously restricted only to plain-text responses, or using a learning management system (LMS) to post instructional and interactive learning resources for students with 24/7 access. At the final stage of redefinition, technology integration enables the creation of entirely new modes of instruction that were previously inconceivable (Puentedura, 2006). Redefinition examples include a flipped classroom pedagogy where students preview instructional materials before coming to class via technology to maximize the use of social interaction in class, or personalized lesson design where content is tailored to individual student needs or abilities using data gleaned from technology-based assessments combined with teacher knowledge of that student.

Replacement, amplification, transformation (RAT). Hughes (2013) identifies three ways that technology might be used in a classroom: as a replacement for existing materials, a way to amplify or improve student experiences and/or teaching, or as a way to transform teaching, learning, and the student experience. Figure 2.5 illustrates how Hughes (2013) views the

	Student Learning	Instruction	Curriculum
Replacement	With the addition of technology, aspects of SL, I, and C remained exactly the same		
Amplification	With the addition of technology, aspects of SL, I, and C became more efficient, obtainable, quicker, etc.		
Transformation	With the addition of technology, aspects of SL, I, and C were transformed in ways unattainable w/o the technology		

Figure 2.5. RAT model (Hughes, 2013).

concepts of replacement, amplification and transformation and their respective impact on student learning, instruction and curriculum. The TIP (Doering & Roblyer, 2006) and RAT models (Hughes, 2013) are similar in their explicit focus on both teaching *and* learning as well as providing a general framework from which a teacher might begin the process of technology integration into his or her practice. The dual focus on both teaching and learning makes TIP and RAT substantially different from TPACK (Mishra & Koehler, 2006). In contrast to TIP (Doering & Roblyer, 2006), RAT does not require a previous understanding of TPACK in order to be used effectively within a classroom (Hughes, 2013).

Typology of beliefs and practices. Because of the identified impact of teacher beliefs on technology integration (Ertmer et al., 2012; Funkhouser & Mouza, 2013; Liu, 2012), Mama & Hennessey (2013) designed a model that explicitly takes teacher beliefs into account. This typology model places teachers into four distinct categories based on belief statements: Integrationists, Apprentices, Optimists, and Laggards (Mama & Hennessey, 2013). Each of these categories have corresponding effects on classroom practice (Mama & Hennessey, 2013).

There are multiple differences between Mama & Hennessey's (2013) typology and the models discussed previously. The typology model doesn't require a preexisting understanding of TPACK (Mishra & Koehler, 2006). The typology model *describes* differences between teachers and their respective technology integration efforts (Mama & Hennessey, 2013) without the generation of a TIP (Doering & Roblyer, 2006) or RAT (Hughes, 2013) *prescriptive* model that teachers might use to

guide self-directed technology integration efforts. If a teacher were to use the typology model in their practice, it might be as a way to reflect on their beliefs surrounding technology integration (Schon, 1983), which could in turn inform their use of TIP (Doering & Roblyer, 2006) or RAT (Hughes, 2013). That said, the typology model developed by Mama & Hennessey (2013) looks to be useful from a researcher's perspective looking into classroom practice from the outside, and it forms the basis for the work being done in this research.

It is worth noting at this point that the technology integration models presented thus far have been exclusively grounded in qualitative research tradition. Being a summary of models currently in use, the intent is not to suggest that these models are somehow better or more valuable than quantitative models. To complement the qualitative models previously presented, the following models are all grounded in quantitative research tradition.

Multipath model. Liu, Ritzhaupt, Dawson, and Barron (2017) utilized a multipath model to examine multiple factors in how teachers integrate technology into their classrooms, producing the infographic seen in Figure 2.6. The results of the study conducted by Liu et al. (2017) found statistically significant correlation between many factors:

- Teacher confidence and comfort using technology was positively influenced by the number of years of teaching experience with technology and school technology support.
- Teacher confidence and comfort using technology was negatively influenced by the number of years of teaching experience in general.

- Teacher use of technology was positively influenced by teaching experience with technology, access to technology in classrooms and teacher confidence and comfort using technology.
- Teacher use of technology was negatively influenced by the years of teaching experience and grade level.
- Classroom technology integration was positively influenced by the years of teaching experience with technology, school technology support, access to technology in classrooms, teacher confidence and comfort using technology and teacher use of technology.
- Classroom technology integration was negatively influenced by years of teaching experience and gender.

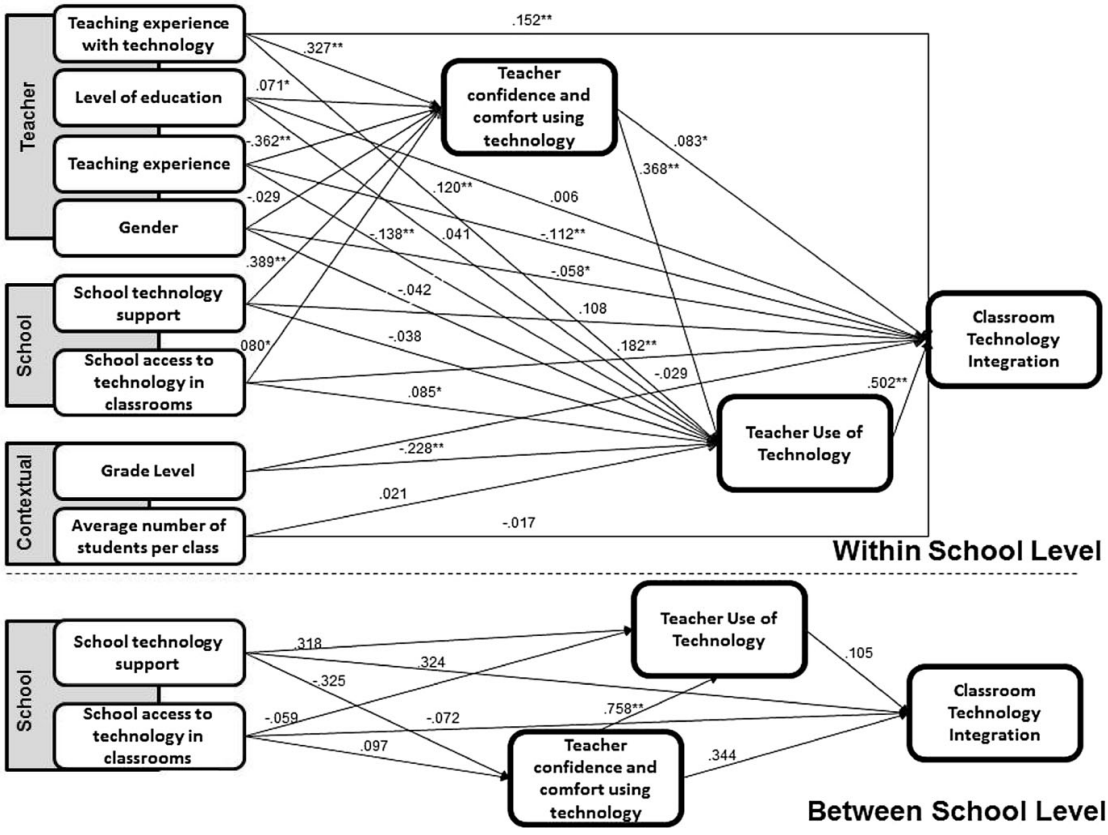

Figure 2.6. Multipath model (Liu, et al., 2017).

The correlations with the largest effects for teachers themselves were the positive correlations between teachers using technology, having access to technology in the classroom, and years of teaching experience with technology (Liu et al., 2017). There was also a confounding issue that years of teaching experience negatively impacted classroom technology integration (Liu et al., 2017).

Technology acceptance model, version 2 (TAM2). The technology acceptance model (TAM) (Davis, Bagozzi, & Warshaw, 1989) and the updated version, TAM2 (Venkatesh & Davis, 2000) were both developed based on psychological concepts of behavior and have been used to measure perceptions of technology acceptance (Justus, 2017). Most recently, TAM2 has been used to investigate technology acceptance when social media tools are incorporated within a learning experience (Justus, 2017; Ngai, Tao, & Moon, 2015) with a specific focus on moving from intent to action (Ngai et al., 2015). Both TAM models leverage belief structures of individuals through their use of perception (Justus, 2017). TAM's perceived ease of use also aligns with an element of design thinking, a lack of which is an identified barrier to technology integration (Tsai & Chai, 2012) discussed earlier in this chapter. Given the increasing usage of mobile devices within K-12 classrooms (Shamir-Inbal & Blau, 2016), a better understanding of how social media might be utilized by teachers could help inform their technology integration.

Unified theory of acceptance and use of technology (UTAUT). The unified theory of acceptance and use of technology model, or UTAUT, is a quantitative model based on eight previously existing models (Justus, 2017). UTAUT introduces

four new constructs: performance expectancy, effort expectancy, social factors and facilitating conditions, as well as variables such as age, gender, education, and whether or not use was voluntary (Justus, 2017). UTAUT has been used with both traditional students and adult learners, and is most commonly used to examine the impact of a single technology (Justus, 2017). UTAUT, as is implied by the *unified* portion of its name, seeks to build a one-size-fits-all model of technology integration; universal models risk limiting their usefulness across differing contexts (Dede, 2008).

Research Requirements

The following section outlines the requirements of academic education research for this study. To begin with, a review of the conceptual framework describes both the underpinnings of the research and the lens through which the research is being conducted. To conclude this section, a look at the methods to be used in the research illuminates how the research was conducted.

Conceptual Framework: TPACK

The TPACK framework (Mishra & Koehler, 2006), as seen in figure 2.2, offers a means to view teacher understanding and skill as an integrated blend of technology, pedagogy, and content knowledge (Doering, Koseoglu, Scharber, Henrickson, & Lanegran, 2014). Within the context of this study, TPACK is viewed as a conceptual framework through which the factors affecting a teacher's integration of technology can be explored as part of their individual context, and then examined for pattern or overlap. For example, two teachers even within the same building

may have similar resources available, but different objectives and experiences. Further, TPACK offers a descriptive lens through which to conceptualize teacher change over time, which is useful in the context of this dissertation research because case studies do not require a determination of causality (Stake, 1995). Finally, the TPACK diagram itself offers a visual metaphor to aid data triangulation and a means through which teachers can reflect on and improve their teaching and technology integration practices (Schon, 1983). As a conceptual framework, TPACK is appropriate for this study given its emphasis on the relationships between different aspects of teaching.

Research method: Case study. Case study is an appropriate methodology here because of my explicit focus on interpretive study of the phenomena surrounding technology integration, rather than testing a hypothesis (Merriam, 1998) or attempting to suggest causality (Stake, 1995). The starting point for this research was a semi-structured interview with participating teachers, followed by a period with multiple observations, and then a follow-up interview and member checking. The initial interview and observations enable teachers to alternately tell and show how they work to meaningfully integrate technology in their classrooms, while the member checking serves as a feedback mechanism for both participants and the researcher as part of ongoing conversations (Dooley et al., 2016). The interview, observation, follow-up cycle is important because a case study researcher must remain open to seeing new aspects previously not considered (Stake, 1995; Merriam, 1998). Analysis within this cycle, such as coding during the transition from

initial interview to observations or from an observation to a subsequent observation, created potential for new understandings and helped ensure that I remained reflexive to new information.

One application of this research is to contribute knowledge that helps teachers and administrators better understand issues surrounding technology integration, enabling them to perform better within their environment (Patton, 2002). Therefore, this research is being situated within real-world problems and naturalistic setting in order to connect the deep, contextual knowledge each teacher-participant has of their classrooms (Stake, 1995) with informing theory and literature (Patton, 2002) and be relevant for teachers and district administrators who might seek to expand technology integration efforts. Relevance for educators and administrators is important because they need to understand the benefits within particular modes of teaching; for particular phases of education and student groups; within particular social, cultural and political contexts; and for particular educational purposes (Mama & Hennessey, 2013).

One of the weaknesses associated with the case study method is that it lacks prescriptive techniques limiting the transferability of case study findings in many cases (Creswell, 2000). While case study findings can lead to developing theory, especially when multiple case studies are used (Patton, 2002; Stake, 2006), it is important to note that cases are bound by their unique context (Stake, 1995; Merriam, 1998). Therefore, attempts to generalize from this research or efforts to

transfer recommendations to other contexts should be made only with caution (Stake, 2006).

How research questions are asked and how they are worked into a problem statement reflect a theoretical orientation (Merriam, 1998). The first research question is "What are the experiences of grades 1-3 teachers trying to integrate technology?" Specifically, this first question seeks to build a theory that could be used to build a foundational, adaptable process of technology integration for grade 1-3 teachers. Classroom realities are complex, with differing pedagogies, resources, student backgrounds, community supports and learning goals (Doering & Roblyer, 2006). These complexities also apply to effective technology integration (Mama & Hennessey, 2013). Further, in order to help ensure transferability within education, this research focused on the process of technology integration, rather than specific technologies to integrate. A focus on specific technologies would be particularly problematic given the rate of change associated with technology.

The second question, "What beliefs do grades 1-3 teachers have, connected to technology integration?" explores the beliefs that teachers currently hold and uncovers the underlying reasons for those beliefs. Examining belief systems as part of educational technology integration research is critical, because of the importance those beliefs hold when teachers attempt to integrate technology into their own classrooms (Ertmer et al., 2012; Mama & Hennessey, 2013). This dissertation was also designed to help lay the foundations for creating a model for how one might

change teacher belief systems regarding technology integration, although such a model is beyond the scope of this research.

The third question, "What other factors affect how a grades 1-3 teacher integrates technology?" examines contextual variables that might impact technology integration efforts. While the four orders of barriers already discussed are well documented in the literature, there might always be new issues present in classrooms not presented in literature. The new issues could be due to political changes that are widespread, policy-level decisions at state or district levels, or even unique to individual classroom-teacher combinations. Regardless of the reasons, opening up the research to look for previously unknown factors pertaining to the question makes for research that is both timely and of value to teachers and district administrators.

Merriam (1998) asserts that within case study research, if the "phenomena [being studied] is not intrinsically bounded, it is not a case" (p. 27). As such, for this research, a case was defined as each individual teacher, being bounded by the physical place and unique culture in which they taught, making for finite potential for data collection (Stake, 1995). Additionally, each case was selected in order to help achieve as "full an understanding of [technology integrated beliefs and practices] as possible" (Merriam, 1998, p. 28).

Summary

This chapter began with an examination of research in order to establish what is already known about the ways in which teachers navigate their teaching

contexts related to technology integration, different pedagogical approaches and how those approaches are impacted by technology, identified barriers to technology integration, and research based models of technology integration. In a broad sense, the two major areas that impact technology integration are pedagogies and four orders of barriers to technology access and integration.

First-order barriers center on access to technology (Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010). Second-order barriers include beliefs of teachers about what relationships between teachers and students should be (Hechter & Vermette, 2013), the degree of freedom students and teachers have in a given curriculum (Hechter & Vermette, 2013), and the habits teachers have surrounding their use of technology (Lin, 2012). Third-order barriers, as identified by Tsai and Chai (2012) are specific to a lack of design thinking when undertaking a technology integration effort. Finally, beliefs and attitudes about technology (Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010) are identified as a fourth-order barrier. Although some overlap with multiple barriers is anticipated during data collection, this research examines issues stemming primarily from the fourth order barrier.

This chapter then discussed how TPACK (Mishra & Koehler, 2006) forms the conceptual framework through its emphasis on relationships between distinct aspects of teaching (Koehler & Mishra, 2009). These relationships form a foundation for the use of an exploratory case study, which itself serves as a way to help understand the process of technology integration (Merriam, 1998). Given the varied uses for, and relative openness of case study, a discussion of how the case

study is being defined per the literature as well as tying that information to the research questions was completed. This study defined each teacher as a case, bound by the grade levels and physical and cultural contexts in which they teach. In the next chapter, I discuss in more detail how the case study methodology was used to study teachers in their classrooms and research what their beliefs and practices around technology integration might be.

Chapter 3

Methodology

Qualitative research within an educational context is, at best, a simplified model of that complex reality (Maxwell, 2013). In the United States, there is a long history of qualitative educational research; new research should be positioned within that history in order to help frame it and lend contextual understanding (Maxwell, 2013). Stake (1995) asserts that practicing teachers, as members of a system, have a great deal of experience surrounding the unique phenomena in their classrooms. These phenomena include the students themselves, teaching requirements, and in the context of this research, technology integration. The research questions and the research design being explored here take the experience of teachers into account and are listed here:

- What are the experiences of grades 1-3 teachers trying to integrate technology?
- What beliefs do grades 1-3 teachers have, connected to technology integration?
- What other factors affect how grades 1-3 teachers integrate technology?

A qualitative, exploratory case study, such as that proposed here, seeks to utilize ordinary ways of making sense of the unique, complex contexts of technology integration in K-12 classrooms (Stake, 1995). Case study is a powerful tool in the study of K-12 classroom technology integration because of its focus on human experience over time, a desire to understand complex relationships among those

experiences and the collected data and without a need to establish cause and effect (Stake, 1995). In order to have the research findings be as widely transferable as possible, this project focused on the *process* of technology integration in research participants' classrooms (Merriam, 1998) as opposed to the integration of specific technologies.

While there is some contention as to the use of case study to examine processes (Stake, 1995; Yazan, 2015), Merriam asserts that so long as the process being studied is part of a bounded system, case study is still appropriate (1998). Case study methods can be used to examine a process, where the process includes the description of the context and population of the study (Merriam, 1998). Here, the study of technology integration as a process is situated in the formal classroom environment of a public K-12 school, and the population involved in the study is limited to currently practicing grades 1-3 teachers. Further, case study is still an appropriate tool because this research relies on thick, narrative description and naturalistic settings (Stake, 1995).

Research Design

This research relies on an exploratory case study methodology, as it seeks to describe and explore general theoretical statements about regularities in the process of technology integration in a grades 1-3 classroom (Merriam, 1998). The design is grounded in current literature and direct observation, two critical requirements of this style of case study (Merriam, 1998). The research examines present phenomena surrounding technology integration. Exploratory case study is a

tool to examine the importance of beliefs about the phenomena being studied (Merriam, 1998), which is important given that the beliefs a teacher holds about technology are such an important factor in the way that teachers use technology in their practice (Ertmer et al., 2012).

Exploratory case study is an appropriate method to use in this research because technology integration is a complex phenomenon, and understanding an individual's beliefs about and experiences connected to technology integration requires unpacking the many factors contributing to that phenomenon (Merriam, 1998; Olson in Hoaglin, et al., 1982). Illustrating these complexities requires the use of vivid materials such as quotes, interviews, multimedia, and narrative in order to convey a sense of experiencing the phenomena as the participants have, reinforcing the appropriateness of an exploratory case study (Merriam, 1998; Stake, 1995) as well as the use of thick narrative as a reporting mechanism (Stake, 1995). Case study itself is a useful tool since it can present information in a variety of ways including viewpoints from different groups (Merriam, 1998), such as when teachers are treated as individual cases.

This research design defines a case as each teacher, bounded by the physical and cultural contexts of the school in which they teach. Based on the case study criteria generator (Appendix A) each teacher was selected because they would be likely provide further insight into how beliefs and experiences connected to technology integration impact that teacher's practice (Merriam, 1998). This interpretive stance is also appropriate within case study to make the results more

useful to the intended audiences of teachers and district administrators (Merriam, 1998).

This exploratory case study was conducted in naturalistic settings and in real-life situations, in order to produce rich, holistic accounts of technology integration phenomena (Merriam, 1998) within the targeted sample group. The grounding within naturalistic settings was especially important since studying technology integration is a long-term, continually evolving process. As such, the insights and assertions of this case study can then be used to guide future research (Merriam, 1998). Figure 3.1 illustrates the flow of the data through the methodology being used in this research.

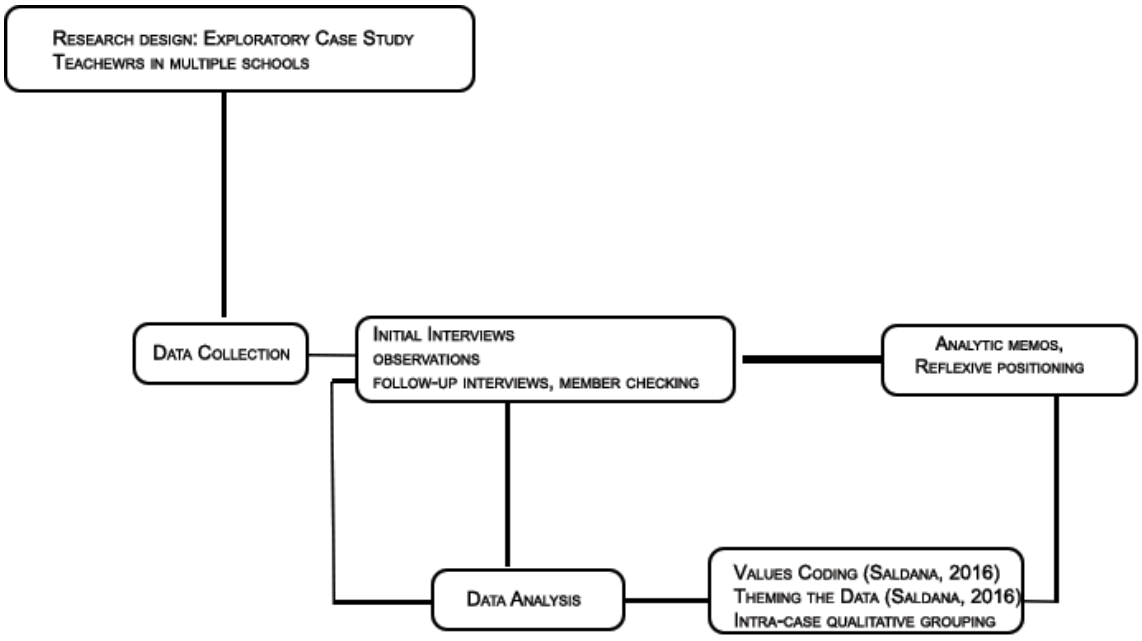

Figure 3.1. Research design based on typology model (Mama & Hennessey, 2013). This figure shows the process used in this research design.

Sampling. Given the large size and geographic distribution of the population of first and second grade teachers, it is necessary to use a sample. This particular

research used a purposeful sampling method, with some convenience sampling elements, to select information-rich cases for in-depth study and learn the most about the central issues facing classroom teachers integrating technology (Patton, 2002). The list of sampling criteria below includes justifications for their use in this research.

1. Practicing grades 1-3 teacher
    - Justification: a desire to connect and ground the research directly to the experiences of those in the field.
2. Diverse student population within the classroom
    - Justification: A model developed from this research should be resonant and transferable, and the vast majority of classrooms in K-12 in the United States are diverse environments. Diversity can be defined racially, socioeconomically, or on an achievement basis. Not all three factors need to be present for a classroom to be selected since a classroom could be included because it provides an increase in variability, leading to richer data and, ultimately, more valuable results (Glaser & Strauss, 1967; Patton, 2002).
3. Resource and time constraints require locations within 50 miles of Minneapolis-Saint Paul metropolitan area
    - Justification: Proximity enabled increased frequency of observations and contributed both more data and increased understanding of the challenges faced by participants. Additionally, more frequent visits to

classrooms helped my presence seem more natural for both the teacher and the students.

4. Participants must be willing and able to have me conduct observations in their classroom as a participant-observer.
    - Justification: In order to conduct observations, I had to be in the physical classroom. If this was not acceptable by the participant, the school, or the district in which they work, data could not be collected, which in turn would void the reason to conduct research there.

While purposeful sampling techniques add to the overall transferability of the research findings, convenience sampling also played a role in the selection of cases. After all, as a graduate student conducting a study on a very limited budget with constrained resources, there was an overall paucity of possible participants. Certainly, the geographical constraint mentioned above is part of the convenience sampling issue, as significant travel time would negatively impact my ability to collect data. There was also an issue of many school districts having policies in place that prevent graduate students from conducting research. For example, the three largest school districts in Minnesota have restrictive research policies in place, requiring inside connections and administrative approval as preliminary steps before research can even be started. Even when such connections are made, in order to obtain approval the research needed to be seen as both useful and beyond the scope of what the district's own internal research team could do in order to begin recruiting participants.

Research questions. The research questions for this project are intended to look into the holistic experiences and beliefs of practicing grades 1-3 teachers surrounding technology integration. The research questions are as follows:

- What are the experiences of grades 1-3 teachers trying to integrate technology?
- What beliefs do grades 1-3 teachers have connected to technology integration?
- What other factors affect how grades 1-3 teachers integrate technology?

While it is important to have research questions formulated before the research begins, it is also possible that these initial questions may be modified or even replaced mid-study (Stake, 1995). With the examination of every tally or happening, there remains the possibility that seeing things in a different way might change the tally (Stake, 1995). Mutable research questions are one facet of good case study research (Stake, 1995; Merriam, 1998) and this mutability requires evolution on the part of the researcher. In this context, one example of evolution is to make changes via progressive focusing if the questions are not working out or if new issues arise (Stake, 1995). In progressive focusing, the researcher hones the question(s) to deal with the unforeseen circumstances (Stake, 1995). Another example of evolution is when delving into the questions draws out understanding and it is appropriate to restate noted issues as assertions, so long as multiple observations are available to corroborate and triangulate these assertions (Stake,

1995). The process of transitioning from question to assertion may include rephrasing or needed clarification, and based on Stake (1995), might look something like this:

- Topical question: What beliefs does a grades 1-3 teacher have surrounding technology integration?
- Foreshadowed problem: The beliefs a teacher holds surrounding technology and technology integration greatly affects how that teacher uses technology.
- Evolved issue: What steps can a teacher take in order to better understand his or her own implicit biases surrounding technology integration?
- Assertion: Effective technology integration requires, in part, that teachers are reflective practitioners and have the time, support and resources to affect change within the constraints of their teaching practice.

Setting. This research is situated within the naturalistic setting of classrooms of practicing K-12 teachers in a radius of approximately 50 miles surrounding the Twin Cities metropolitan area of Minnesota. The geographic area is a necessary constraint of resource and time limitations but did not pose a significant deleterious effect on data given the diversity and sheer number of possible partners within this densely populated area. In fact, the aforementioned research policies of many school districts posed a much greater challenge. Initial interviews and observations conducted during the research were necessarily on-site and in-person. Although synchronous video communication, such as Google Hangouts, were an option to

conduct participant follow-up interviews if necessary, none of these participants required that accommodation.

The selected sites represented a diverse cross-section of student and teaching communities. Diversity for the purposes of this research includes racial, socioeconomic, and academic achievement factors. Especially in lieu of having *n*=3, the diversity within and between these sites added variability and richness to the data set, thereby making for stronger research findings.

Participants. A purposeful sampling technique was used in this research as the samples are taken in order to discover, understand and gain the most insight into the phenomena (Merriam, 1998) of technology integration. The initial goal in recruiting participants was to have an *n*=2-4. This sample size was adequate to reasonably cover the purpose of this research (Merriam, 1998; Patton, 2002) and to produce a manageable amount of data while also being rich enough to utilize a thick narrative. Participants were selected through a combination of the following criteria:

- Currently practicing grades 1-3 teacher in the seven-county metropolitan area surrounding Minneapolis and Saint Paul.
- Having a classroom with racial, socioeconomic, or academic achievement diversity. Diversity, in terms of socioeconomic status, racial constitution, and academic achievement is important to enrich the data and provides transferability of research findings.

- Being able and willing to have an observer in the classroom, since data collection required my direct physical presence.

It is worth noting here that my prior experience both as a kindergarten teacher and current experience as a teacher educator could increase the risk of my entrapment within the specific cases I am studying (Stake, 1995). As a researcher, it is my goal to remain noninterventionist, as the study may raise questions and options not previously considered or even contradictory to my own direct experience (Stake, 1995). These multiple realities within a case study are permissible as they may add to the overall richness of the study (Stake, 1995), so I used my experience as a teacher to *frame* what directions the research could go but *not constrain* the research directions to my own practice or experience as I collected and analyzed data.

Data Collection

All fieldwork was guided by the research questions (Stake, 1995). Data collection within a case study framework contains four critical elements: the definition of a case, the list of questions, the identification of participants, and the data sources (Stake, 1995). The case definition and identification of participants can be seen in full in appendix A. The list of questions participants were asked is shown in the interview protocol document, seen in appendix B. Finally, appendix C shows the base template observation protocol used during initial observation sessions. Additional questions and points gleaned from initial coding were added to subsequent observation protocols for each teacher.

Data sources consisted of three main elements: responses to the semi-structured initial interview protocol, field notes and recordings from observations, and the follow-up interviews with subsequent member checking. The initial interview provided insight into participant beliefs surrounding technology as well as providing a way to inductively generate initial codes. Observations, used in conjunction with the interviews, increased the amount of data and helped triangulate emerging findings (Merriam, 1998) as well as providing a mechanism to remain reflexive to new information through analytic memos (Saldana, 2016). Follow-up interviews with integral member checking served as the third step, affording me an opportunity to affirm initial findings and themes with each participant, as checking to see if there was inter-case transferability.

Interviews. Interviews have a long history of use within qualitative research, consisting of a range of question types (Merriam, 1998). The questions in the semi-structured interview protocol designed for this research can be seen in appendix B. Once participants are identified, the semi-structured interview was used to provide data on teachers' beliefs about the value and level of technology integration in the participants' practice. The interview also determined the barriers the participants confront in their practice with technology and their general teaching philosophy. Peripheral purposes of the interview were to obtain information about integrating technology from the teacher's perspective, establishing rapport with research co-participants, creating initial data analysis codes and determining when a teacher would be able and/or interested in being observed.

Observations. Four archetypical roles have been defined for the observer in case study research that are on a spectrum from complete participant through complete observer. The role of *complete participant* is when the observer goes native, and behaves and is treated as one of the group (Merriam, 1998). This role can be problematic given the potential for a loss of perspective and potential triangulation concerns, in addition to being labeled a spy when the research motive is revealed, and also presents questionable ethical issues (Merriam, 1998). The role of *participant as observer*, also known as an active membership role, is when the observer is subordinate to the role as a group participant (Merriam, 1998). At this point on the spectrum, the observer helps to further the goals of the group, but remain just outside of fully committing his or her self to the group members and values (Adler & Adler, 1994). The role of *observer as participant* is when the researcher's observation role takes precedence over the identity as a group member (Merriam, 1998) and has also been aptly termed a peripheral membership role for visualization of the observer's position within the group (Adler & Adler, 1994). Finally, the role of *complete observer*, is one in which the presence of the researcher is completely hidden from participants (Merriam, 1998).

Being a *complete observer* would not work for this study, since I was onsite conducting interviews with participants and observing their classrooms. Taking on the *complete participant* role would be unsuitable for this research, as positioning the research in a misleading way would damage my relationship with the teachers. Maintaining a *complete participant* role would be troublesome because of the

openness needed in good case study (Merriam, 1998; Stake, 1995), and prior experience as a kindergarten teacher could cloud what practicing teachers are experiencing. With these constraints in mind, my role oscillated between *participant as observer* and *observer as participant*.

The challenge is to balance the insider and outsider positions of observation research (Merriam, 1998). The goal of this balance was to become an insider enough for access and understanding, but still be able to describe the phenomena and processes to, and for, outsiders (Patton, 2002). My default role was *observer as participant*, primarily out of prior experience working with children as both a teacher and mentor. This role afforded me insider language and knowledge surrounding how a classroom functions, as well as a deep enough understanding to communicate what is observed and found. This inside knowledge was balanced by maintaining a sense that the participants' rooms are not *my* classroom, along with keeping a log of analytic memos to check on my own internal reflexivity (Saldana, 2016) and that my primary job is to record and report on what is observed.

Observer as participant was also appropriate because of youth forming attachments when working with them; many become very disappointed when interactions end. This disappointment can lead to behaviors that make the practicing teachers' roles more difficult and could affect the data in unforeseen ways. Therefore, maintaining the distance required within the *observer as participant* both served my purposes as a researcher and helped mitigate student behaviors attributable to my presence in the classroom.

Rapport, a necessary part of observation (Merriam, 1998) was established by fitting into participant routines, helping out before formal observations start, and attempting to give back to my participants in some way such as with formal continuing education credits. A sense of two-way sharing seemed to increase the engagement of participants, thereby also opening up additional access. Increased access may in turn helped me move past the novel aspects of unfamiliar settings, facilitating more direct data gathering, and more honesty between researcher and participants, thereby leading to increased authenticity of the data (Stake, 1995).

Observation has been criticized as a data collection tool because it is seen as selective and unreliable (Merriam, 1998). Observation also requires training as a descriptive writer, discipline when taking field notes, and knowledge of how to separate trivia from detail (Patton, 1990). However, observation can be a useful research tool when it serves a formulated research purpose, is deliberately planned, is recorded systematically, and is subject to checks and controls (Merriam, 1998). For its purpose within this research, observation was used to collect data in naturalistic, authentic settings. Deliberate planning occurred as participants scheduled observations with me as the researcher, and suggested reasons for why they chose those times, and the beginning planning stage occurred via the case study selection criteria document listed in appendix A. Per Taylor and Bogdan (1984) and Merriam (1998), systematic recording of field notes is aided by paying attention, shifting to a metaphorical telephoto lens, in order to attend to a specific person, interaction, or activity (while necessarily blocking out others), looking for

key words that stand out, concentrating on the first and last remarks in a conversation or interaction, and mentally playing back remarks and scenes.

All four observations were conducted within each teacher's classroom during regular school hours. Dates and times of each observation were scheduled with the teacher, and were left flexible to both accommodate the needs of each teacher and also to see different subjects being taught at different times of the day. Changing the times and days of data collection helped to increase the validity of the data being collected by mitigating issues related to common classroom issues such as teacher strengths in a certain subject, student interest in specific subjects being taught, student fatigue or hunger. Each observation was conducted with a blank, hardcopy observation protocol, with the template protocol seen in appendix C, and was filled out during each observation. Using hardcopy paper observations helped ensure that technology did not distract students or the teacher from the work in the classroom, and helped mitigate concerns of trying to fill out forms should the technology break down. With subsequent observation sessions, notes and emergent codes and themes were listed on each protocol. All observation-based data was captured within Atlas software for coding and further analysis.

Follow-up interviews and member-checking. Member-checking is the process whereby member participants provide critical observations and interpretations, sometimes even making suggestions to the sources of data (Stake, 1995). Member-checking served as a way to triangulate the researcher's observations and interpretations (Stake, 1995). Data-source triangulation examines if the phenomena

remain the same at other times, in other spaces, or as people interact differently (Stake, 1995), making the research results and recommendations more resonant with other teachers and district administrators, thereby increasing the pragmatic value of the research.

The purposes of post-observation follow-up interviews are to provide an opportunity for reflection by participants, ask clarifying questions based on observations, and to increase validation. The member-checking aspect of the follow-up interview also serves as a method to mitigate constraints or limitations that may have been present in the initial interview document, thereby triangulating the data. Follow-up interviews provide teachers an opportunity to reflect on their observed practices with technology and their explanations of, or justifications for, their choices (Mama & Hennessey, 2013; Schon, 1983). This reflection can then help to pinpoint any discrepancies between reported beliefs and observed practices. Second, the additional round of interviews provides an opportunity to clarify ambiguous statements or unclear points that emerge in the first round of interviews or in observations. Follow-up interviews serve as a validation tool for researcher objectivity (Mama & Hennessey, 2013).

Data Analysis

Data analysis in qualitative research is recognized as a highly interpretive activity (Merriam, 1998; Stake, 1995), and this dissertation research maintained that tradition. Within a case study context, the interpretation of events and phenomena is a high priority, while interpretation of measurement data is a lower

priority (Stake, 1995; Guba & Lincoln, 1994). Stake (1995) suggests that direct interpretation within a qualitative case study should align with the nature of the study, foci of research questions, and the curiosities of the researcher. Put another way, a qualitative researcher concentrates on a specific instance, trying to pull it apart and put it back together again more meaningfully as an example of analysis and synthesis in direct interpretation (Stake, 1995).

In the context of this research, the nature of the study requires interpretation because of the examination of direct experience that must be presented to readers. With the foci of the research questions on the experience of technology integration processes and the exploration of beliefs and practices of a teacher, interpretation is required to make sense of these elements within their natural contexts. Finally, given that the questions reflect the researcher's curiosities about technology integration, interpretation is again a useful and necessary tool for this research.

Key, experiential variables were embedded in the research questions (Stake, 1995). The first question explores teachers' experiences of technology integration processes in a holistic way, embedded within a teacher's classroom practice. For example, how does the support, lack of support, and sources of support that teachers experience when trying to integrate technology, affect their technology integration efforts? The second question, closely related, explores teachers' beliefs surrounding technology integration. For example, a teacher who believes that technology is best used as a behavioral or classroom management tool would use technology very differently than a teacher who believes that technology

fundamentally alters the role of a teacher. The third question seeks to determine if there are barriers to technology integration for grades 1-3 teachers not already identified within the literature. This question is included here because the rate of change connected to technology may open up new as yet unidentified barriers. This is especially important when comparing rates of change in society versus the timelines necessary within academic educational research. Finding something new during this research would accelerate the ability for new research to find solutions to those barriers.

Analysis methodology: Values coding. Analysis for this research uses the values coding methodology, which explicitly examines values, attitudes, and/or beliefs that represent a participant's experience and worldview (Saldana, 2016). Although the structures of values, attitudes, and beliefs are all different, they all fall under values coding, and there is no need to distinguish between the three constructs within qualitative research (Saldana, 2016). While Saldana (2016) suggests that values coding could be appropriate for any qualitative research, values coding is particularly useful in this case given the explicit focus on *beliefs* within this study's research questions and the complex interplay of those beliefs within teaching practice. After all, beliefs are part of a complex system of perception including morals, opinions, personal interpretations of the world around us (Saldana, 2016), and rules for action (Glaser & Strauss, 1967; Stern & Porr, 2011), which are all part of the teaching experience. Teaching experiences in turn affect teaching practices.

When considering values coding for this research, I saw ways that beliefs and practices were interrelating that were similar to the ways that the domains of TPACK interrelated (Mishra & Koehler, 2006; Koehler & Mishra, 2009). For example, beliefs and practices are intertwined in ways that changing a belief is likely to change a practice. Visually, these similarities are represented in figure 3.2. Further, because of the impact that beliefs about technology can exert on a teacher's use of technology (Ertmer et al., 2012; Funkhouser & Mouza, 2013; Lin, 2012; Liu, 2012) and thus also their teaching practice, those beliefs may also have a direct impact on a teacher's pedagogy and content knowledge domains. One such example could be a teacher's belief that online technologies should be used cautiously because of the risks involved in having students interacting via the open Internet, that teacher might then use technology knowledge and make pedagogical decisions to limit or even eliminate online activities or media that require social engagement. This belief-driven cautionary teaching practice might then also lead to a self-reinforcing

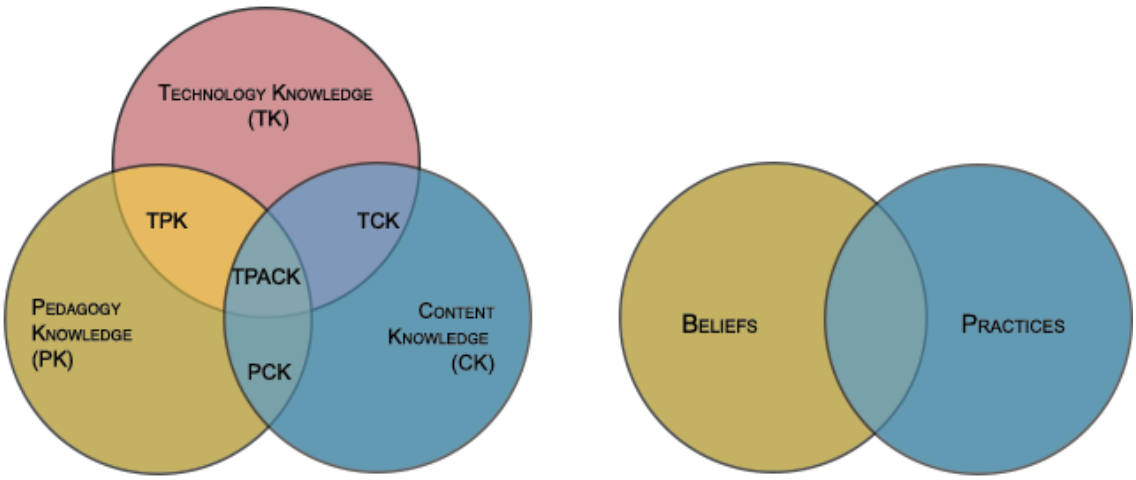

Figure 3.2. TPACK connections to beliefs and practices. This figure illustrates the connections between TPACK and beliefs and practices.

experience wherein the only good use of technology is when it can be contained.

With data collection consisting of transcribed interviews and observational field notes being taken in a naturalistic setting, values coding is appropriate (Saldana, 2016). LeCompte and Preissle (1993) suggest that using multiple sources, such as interviews and field notes, helps to corroborate codes and enhances trustworthiness of findings. Within this application of values coding, analysis for this research consists of open coding of all transcript and observation data for *beliefs* and *practices*, then categorizing those codes and reflecting on collective meaning, interaction and interplay between and among them (Saldana, 2016). Values coding is appropriate in a case study because the analysis style itself remains open to new information presented through the research, which in turn may help guide changes to research questions (Stake, 1995) or guide further analysis.

Analysis methodology: Theming the data. Given that a high number of codes would make finding deeper meanings impossible as well as reporting findings difficult, theming the data was used as an appropriate second round analysis method. A theme is an extended phrase that is used to help identify what a unit of data is or what it means and serves to further categorize a set of data into an implicit topic (Saldana, 2016). The overall goal of theming the data is to narrow the information presented in a final report. As such, after values coding, the data and the codes were themed to help derive meaning and make for a deeper understanding of connections between beliefs and experiences for these teachers.

Analysis tools: Atlas.ti software. Data was be analyzed using the Altas.ti (hereafter, "Atlas") software package. Atlas is a purpose-built qualitative data analysis tool, enabling document importing, coding, grouping, graphical exporting, and other tools that are pertinent to the scope of this research. Other qualitative analysis tools, such as Nvivo, Dedoose, and MAXQDA, were available on the market as of this writing. All four of these software packages were tested along with Atlas prior to the beginning of data analysis. Atlas had the most intuitive user interface and was priced according to graduate student budgetary constraints. The robust toolset of Atlas, combined with intuitive usability and a reasonable price made it a natural fit for use in this research.

Data reporting: Thick narrative description. In order to adequately convey participant experiences of trying to integrate technology into a preexisting teaching practice, an empathetic understanding for the reader must be constructed (Stake, 1995; Merriam, 1998). As such, this research utilized a thick, narrative description in an attempt to convey what the experience itself was like (Stake, 1995). Building a thick narrative required a significant amount of data and use of structured methods such as systematic field note work (Merriam, 1998). There was still a risk that important elements would get left out. To mitigate this risk, initial interviews and follow-up interviews were recorded to preserve nonverbal communication and directly assist in the crafting of the rich, thick narrative (Merriam, 1998). The recordings of initial and follow up interviews, and the use of thick narrative itself

helped to ensure that the perspectives of the teachers came through in the write up of the research (Shamir-Inbal & Blau, 2016).

Participant Compensation

Although every school and teacher selected for the study met the criteria, an element of convenience sampling also played a role as these three teachers were the only ones who agreed to participate within districts where other barriers could be overcome. In the case of Kathy's school district, prior research I had conducted there provided inside connections and made district and building administration more receptive to my research. In Terry's case, his district did not have a restrictive policy on graduate research studies, and the fact that Terry would receive information and feedback to support more technology integration into his teaching was adequate reason for the principal of his school to approve the research study. In Lori's case, I had a direct connection to her via a mutual friend. Given her status as a technology integration leader within her school, the principal approved her participation so long as I was willing and able to complete the Virtus training per archdiocese policy.

I offered each teacher three incentives as compensation for the time required to complete the initial and follow-up interviews and the potentially disruptive presence of a researcher in their classroom:

1. feedback from the interviews and observations as a reflective mechanism to improve their practice,
2. personalized technology integration ideas based on their interviews and observations combined with teaching and research experience, and

3. a University of Minnesota-backed certificate worth 5 CEU credit-hours to be used for professional development or other requirements.

All three teachers were particularly enthused about the technology integration ideas, especially Terry and Lori. Terry felt the idea could supplement the lack of guidance he was getting from his administration, and Lori found it helpful to get ideas from an outside perspective. Given that some school districts perceive graduate researchers as being there to only obtain data and then never be heard from again, offering something of value to the teachers in recognition of the value of their time and effort demonstrated a mutually beneficial mindset for both the researcher and participants and was very useful in getting my metaphorical foot in the door.

Summary

This chapter discussed the methodological foundations being used in this research. First, the discussion included the research design, with its attending sampling techniques, examination and unpacking of the research questions, and where the research was conducted and with whom. Second, data collection methods were stated, to include initial interviews, rounds of observations, and then member checking and follow-up interviews. Finally, the data analysis methods were examined. Values coding, given its explicit linkage with belief structures (Saldana, 2016) was the primary analysis method, followed by theming the data to clarify, examine repeated ideas, and look for deeper meanings (Saldana, 2016). A thick, narrative description was discussed as a reporting mechanism to help ensure that

the voices of individuals were adequately represented (Shamir-Inbal & Blau, 2016). In the next chapter, I discuss the research findings via profiles of each teacher, additional information about their unique contexts, and walk through analysis of the data.

Chapter 4

Research Findings

This chapter presents the findings from the research collected via initial interviews, observations, conversations and follow-up interviews. It begins with a profile of each participating teacher constructed from interviews and observations. Next, information is presented about each teacher from the perspective of other school personnel to help illustrate the unique contexts in which each participant worked and to further illuminate why each participant held certain beliefs and had certain teaching practices. The last section discusses the codes and themes that emerged from the analysis of the data.

This research was conducted with three practicing teachers across grades 1-3. These teachers, here identified with the pseudonyms Kathy, Terry, and Lori, each taught in different districts at different grade levels, and had unique teaching styles based on their different contexts, pedagogical beliefs, and experiences with technology. Data from each participant were collected through an initial interview, four weekly observation sessions, and a follow-up interview. Additional data were collected via single interviews with principals, a technology specialist, and a district director of curriculum and instruction to provide insight about technology integration from non-teacher perspectives.

Data collection spanned a total of 14 weeks between March and early June of 2018. Once participants had agreed to be part of the research project and any other barriers to participation had been overcome, each teacher was observed during a

six- to eight-week span. This duration helped mitigate the disruption of my presence in each classroom, afforded me enough time to gain sense of the culture and flow of the classroom, enabled data analysis between interactions, and honored outside time commitments of each participant.

Teacher Profiles

Profiles of each participant are included in this section to help provide context for why each teacher held certain beliefs or practices. This included the culture of each teacher's building, their students' needs and abilities, the values they inherited from and shared with the community, and the unique teaching experiences. As such, the context of the individual teachers influenced what beliefs they might hold and which practices they might exhibit regarding teaching in general and about technology integration specifically.

Profile 1: Kathy

Kathy Vignette 1

> *"Look at how excited they are to use the Osmo! These are kids who are smart, but their parents can't wrap their heads around the sorta flipped model I'm trying to do. So, it can be hard to personalize the lessons for those kids…but they really come alive when they get to use the Osmo and just explore things."*

The K-4 school where Kathy taught was once the poorest performing elementary school in the district, to the point that it had been in danger of being closed down. After a remarkable turnaround, the same school became a nationally recognized environmental STEM magnet school and was positioned as a leader for

technology integration efforts in the district at the elementary level. In fact, by the time of this study, this school had become the highest performing elementary school in the district. Many parents considered getting their children enrolled in this school to be a coveted placement, and many also volunteered their time and expertise. The school was located in a first-ring suburb south of Saint Paul, Minnesota, with a population of over 430 that reflected the racial and socioeconomic diversity of the surrounding community, which was majority Hispanic population, followed by whites, African Americans, and Asian Americans. Kathy's class of 24 students reflected this diversity. As evidence of the value the community placed in public education generally and in this school in particular, a tax levy had recently been passed by voters that directly aimed at district-wide school improvements, including increased technology integration efforts. This school was specified in district information on some of the ways revenue from the tax levy would be spent. The success of this tax levy was particularly notable because similar tax levies in nearby communities had often failed in recent years.

Kathy was a veteran teacher who had 10 years of experience and a BA in elementary education from an accredited local private university. Before the 2017-2018 academic year, Kathy had taught only second grade, but due to a bubble in student population, she was teaching third grade for the first time during the period this data was collected. She still self-identified as a second grade teacher, however, and "returned home to second grade" after the academic year this study took place.

Five years earlier, Kathy had joined a district-sponsored technology integration cohort and became a digital learning coach at her school, making her a building-level resource for teachers seeking to further integrate technology into their own practice. Kathy was also the only participant of the three who, during our initial interview, mentioned a formal technology integration model she was familiar with, SAMR (Puentedura, 2006). Kathy specifically stated that despite her familiarity with the SAMR model, neither it nor other formal academic technology integration models played a role in her pedagogy or technology integration efforts. Instead, she claimed, she relied on her experience, student needs, district constraints and resources, and a flexible mindset when integrating technology.

Kathy's room was set up in a flexible arrangement with stations, mobile seating, standing desks and a semi-private spot for students who needed a little bit of extra space during the day, as seen in figure 4.1. The room's physical arrangement helped meet students' needs by being developmentally appropriate and facilitating student work when classmates were pulled out for remedial work or specialist services. During each of my observations, up to 10 of Kathy's 24 students were

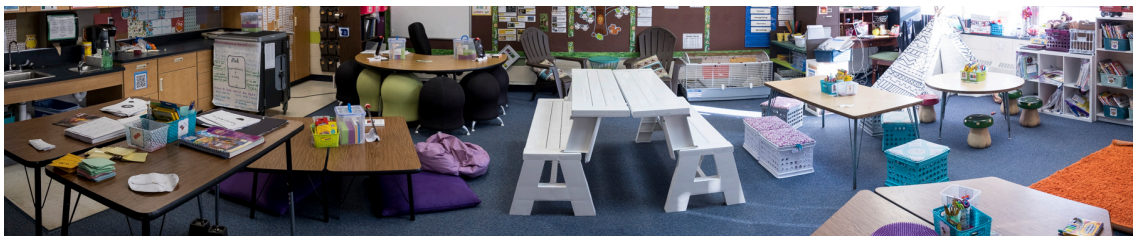

Figure 4.1. Kathy's classroom as seen from the front. This figure demonstrates the flexible spaces designed into Kathy's room, which are necessary given her pedagogical approaches.

pulled out of her classroom for other services. With so many students being pulled out, it was necessary to have flexible arrangements for the students remaining in Kathy's room to help facilitate their continued work and help them maintain focus.

Kathy Vignette 2

> *"Kids don't learn the way we did, the way their parents did. It's not wrong…just different. But, even though I know what works as a professional and have a good handle on best practices, I feel like maybe I'm pushing my beliefs on people. Maybe that's making it harder for parents, but at the same time, I went to school and worked really hard to be a teacher…and most parents didn't, you know?"*

Based on my observations, Kathy's room arrangement aligned with her pedagogical beliefs and practices, as she predominately used these stations primarily to group students. These groupings were based on pretests administered the night before instructional material was delivered in class, using a partially flipped classroom model for specific subjects such as math and helped facilitate Kathy's delivery of personalized materials. In her model, supported by 1:1 iPad deployments, the students she had identified as needing a little extra help worked with Kathy as she moved around the room. I observed Kathy using a variety of pedagogical models as she moved between groups. Sometimes, she used a direct instruction model, altering some of her vocabulary and working through some things verbally as pedagogical considerations, depending on the students needs. Other times, Kathy took a more constructivist stance, asking open-ended questions to help students keep moving in a productive direction. With students who had shown mastery in the pretest, Kathy empowered them to move forward

independently with some flexibility through a pedagogical approach where she acted as a learning coach. No matter their grouping, students received feedback both face-to-face from Kathy and via the pretest to help guide them as they developed deeper understandings of the material. During the initial and follow up interviews, Kathy noted that one barrier to student success in this model was that some families had trouble understanding the partially flipped model being used and the underlying importance of the students watching videos and completing preassessments each night. Although Kathy had discussed with her students' families why and how the flipped classroom model would benefit the students and received verbal acknowledgment from families about how important completion of these activities were, the pattern of student behavior and lack of family engagement did not seem to change.

Kathy Vignette 3

> "*I'm sad today, you guys, and we gotta talk. You know why? It's because of behavior issues yesterday, when I was gone. The substitute had to go talk with [the principal] because of the behavior issues. I know you can do better…You know you can do better. Still, these sorts of problems need to stop."*

Kathy strived to create a sense of community through her teaching practice. Examples of her efforts included the aforementioned face-to-face feedback, use of the word "we" when talking through expectations (e.g., "We need to respect each other"), and even posting printed messages and phrases around the room such as "It's only failure if we don't learn from mistakes" or "I am still learning, so it's ok if I make a mistake." As I observed Kathy interact with her students, she clearly

demonstrated her commitment to helping guide each of them through firm but compassionate interactions. My own experience of working with children suggests that over time these firm, compassionate interactions combined with a sense of stability are very important for long term student success, especially for those children who struggle with disruptions outside of school.

Profile 2: Terry

Terry Vignette 1

> "*OK guys, we just got back from Spanish. You can see your groups on the screen. If you're working with me to start, grab your books and come to the table please. Otherwise, you know what you need to do. Come see me or Mr. Dave [a classroom volunteer] if you need help."*

Terry was a third-year veteran teacher with a BA in elementary education from an accredited local private university who had always taught in this same P-5 school. His first two years were spent teaching kindergarten, and Terry had transitioned to a first grade position for the 2017-2018 academic year. The school where Terry taught was in a first-ring suburban district north of Minneapolis, Minnesota and its student population of 550 was representative of the surrounding community's demographics and socioeconomic trends. The school district was slowly working its way toward increased technology integration, but tax levy proposals to fund integration efforts had failed the last two times they had been put before voters. Therefore, the school's technology integration efforts were centered

on the tools that came with new curriculum materials while more innovative efforts within the district were few and isolated.

Terry's class consisted of 21 total students, who were representative of the demographics in the surrounding community. During my observations, that number constantly changed due to pullout and specialist services. For example, during one afternoon observation, there were 16 students in the room at 1:10, 19 at 1:30 and 21 at 1:35. This did not appear to cause disruption for the students however, suggesting that they were quite used to their classmates coming and going.

The room Terry taught in was referred to as a *learning studio* and consisted of two independent classes of first graders sharing a large, open space, as shown in

Figure 4.2. Terry's learning studio space with iPad cart in center of frame. This figures shows tables, a rug, and a table with desktop computers used as stations.

figure 4.2. This open arrangement provided a lot of flexibility for the two teachers sharing the space and served as a way to reduce technology costs for the district, since the two classes could share the cart of iPads for student learning activities positioned as shown in the center of figure 4.2. The open space also required that

students keep their voices and noise levels down, and the shared resources required the two teachers to schedule lessons as a team to ensure that devices would be available as needed. Overall, during my observations, the arrangement seemed to feel perfectly natural for the students in Terry's class, and the disruptions that did occur were not specifically a result of the nature of the studio space.

In his teaching, Terry used a mix of rotating stations so that he would have individual contact with each student multiple times each day. Terry grouped students by ability and had each group rotate through multiple stations in his room. This enabled Terry to deliver tailored material to students when they were with him. By the time I conducted observations, this routine had become established enough that students were seldom disruptive and often solved problems they encountered independently. All four of these observations took place at the end of the day during 90-minute spans of dedicated literacy time. As part of his developmentally appropriate practice, Terry empowered his students to move as they needed during this time including sitting or lying on the floor, sitting at their assigned tables (seen in the foreground of figure 4.2), or pairing up with other students in an ad hoc fashion if needed. Terry explicitly encouraged independence as part of his pedagogy, and his students responded positively to this model.

Terry Vignette 2

"So many of my kids just want or need human contact. But you never know how someone might interpret what's said by a kid, so anytime I touch them, it's about a fist bump or a high five…If they come up to me and want a hug, I have to be sure it's visible by others and only ever done with an open hand."

Terry is a relative rarity among primary teachers in that he is both African American and male. Terry used these elements of his identity to his advantage during teaching by injecting an almost paternal, but not paternalistic, energy into the classroom. His students and their families knew that he cares deeply about his students, and many of them come up to him during the day seeking a hug or other appropriate physical contact. As a male working with young children, Terry stated that while "[he] wants to provide the physical contact his students seek out, [he] must also be cautious to keep all contact in plain view of other adults" and that he must be "mindful about avoiding all possible perception of wrongdoing." My own personal experiences of working with young children, and those of a male parent volunteer named Dave, echoed Terry's sentiments and concerns. Prior communication and relationship building with students' family members and the transparency of classroom activities that Terry integrated into his interactions with families all contributed greatly to the level of trust placed in him. There was no doubt among his students or their families that Terry was committed to everyone in his classroom and that he taught in ways he would want his own children taught.

From my observations and our interviews, it was apparent that Terry actively sought out ways to integrate technology into his teaching practice, although his efforts were treated with benign indifference by his principal, Jim. The district had largely abandoned wider technology integration efforts for the time being due to funding concerns. This meant that while Terry had a large degree of autonomy to explore devices, apps, and other possible technology integration solutions for his

classroom, he received neither guidance nor hindrance on those efforts from his principal or other administrative staff. In short, Terry engaged in technology integration in independent but isolated ways. Terry knew he could call on district tech support staff, but they operated within a largely break/fix mentality because their job was defined as keeping existing technology running and secure rather than serving as a resource to help teachers learn how technology might be differently utilized. One such example of where this limited form of support caused a problem was when Terry planned to use a centrally located iPod to enable multiple students to listen to the same audiobook simultaneously using Bluetooth devices but the devices he selected didn't support this functionality, however. Although tech support staff came to look at the configuration to attempt to troubleshoot the problem, they essentially told Terry that this idea would not really work as he envisioned and left without offering any alternate implementation or way of achieving his goal. Although the experience had disheartened Terry earlier in the school year, by the time of this research, he had moved on to other ideas and reported he was again looking for new ways to use technology with his students that would engage them and support their independent work.

Profile 3: Lori

Lori Vignette 1

> *"Friends, I have to apologize. [Student] pointed out that one of the answers in the Kahoot was wrong. I think I was just going too fast and wasn't careful enough. Next time I make one of these, I'll make sure that I have more time and can be more careful."*

Lori was a 20-year teaching veteran who had taught in multiple schools and districts during her career. She held a bachelor's degree in elementary education from an accredited local public university and a master's degree in elementary education from an accredited local private university. For the decade prior to this study, Lori had taught second grade at a small private P-8 Catholic school with a total population of about 200 students, situated in a first-ring suburb of Saint Paul, Minnesota. Lori had a total of 19 students in her class, some of whom occasionally filtered in and out for pullout services. Being tuition-driven and religiously affiliated, Lori's school differed from the public schools of Kathy and Terry in two ways that were important for the purposes of this research. First, the population of her class did not reflect the surrounding community's racial demographics. Of Lori's 19 students, only three were non-white, which was not representative of the surrounding community which was just barely majority white, with Latinos making up the largest minority, followed by African Americans and Asian Americans. Socioeconomically, based on anecdotal evidence of overheard conversations between students and conversations with teaching staff, the student population seemed roughly representative of the surrounding community, with a mix of working, middle and upper-class incomes among them.

Second, before anyone could work or volunteer in any classroom in the school, it was mandatory that they attend a Virtus training session. Virtus training focuses on mitigating sexual abuse by helping participants identify predatory behavior and providing resources anyone could use to take action against predatory

behaviors. This training and requirement is a direct result of the recent abuse scandals that have occurred in the Catholic Church and illuminated the church's concern for addressing abuse in its schools and creating safe spaces where children can focus their attention on academics. None of the other institutions that participated in this research required training of this sort before research could occur.

Although I did not have an opportunity to take pictures in Lori's room because there were always students present during my visits, it would be immediately recognizable to anyone with a US-based K-12 public education experience. During the first two observations, student desks were arranged in rows, and during later observations in groups of four facing each other. Both of these configurations created an obvious focal point on the teacher at the front of the room next to the digital projector, Smartboard, and a series of whiteboards. There was a small table off to the side for doing one-on-one and small group work with Lori or a specialist. Along the back wall of the classroom, were open hooks for hanging coats near the student storage cubbies, and a sink, drinking fountain, bathroom and large storage closet.

Lori Vignette 2

> "(Softly) *Friends, I need your attention. [*Pauses to let students focus on her*] Do you remember when we talked about poetry the other day? I was thinking that the fog this morning might make for interesting poetry. Who can share with us about how the fog was this morning?"*

In terms of student interaction and pedagogy, Lori had the sort of calming, quiet presence among her students that is prevalent among highly experienced teachers. When addressing her class as a whole group, Lori would use a voice that was perfectly balanced between being just loud enough to be heard, and just quiet enough to make students strain to listen to hear what was coming next. Lori's deep repertoire of pedagogical tools helped her engage and focus students, including giving individual encouragement and guidance as needed, knowing just when students needed to move on to a new activity, and keeping her primary focus on student needs when designing new learning experiences. Lori's experience, demeanor, and toolset meant that she could rapidly address student needs, and during my observations, it was apparent that students were focused on the tasks at hand and enjoyed being in the classroom.

Lori Vignette 3

> *"Friends, please make sure that your screens are closed for a moment; I need to give you directions. Who remembers what we talked about for geometry the other day? [*Students raise hands, Lori calls on them*] Good! Since our study of geometry is about shapes, I wanted to see what you could come up with for a shape on your geoboard app. Let's open up your iPads, and go to the geoboard app…"*

Lori's pedagogically oriented focus on student needs also played a part in her considerations about when and what kinds of technology to use in her class. Based

on her deep experience, Lori believed that any technology use must be worthwhile, easy to use, and beneficial for students. Given the concerns about abuse and exploitation also reflected in the Virtus training requirement, Lori was also conservative in her use of technology for fear that students might be tracked or otherwise targeted online.

Participants' Schools and Contexts

Given that outside factors can impact an individual's belief or practices connected to technology, the study thus also collected additional contextual information to help answer the research questions and better understand the findings gathered from the participating teachers. This section provides additional information about the school environment and supplemental data about each participant that was gathered during the study.

For each participant, I gathered information from additional sources to better understand the contexts of the teaching decisions participants were making, provide outside perspectives not often used in educational research, enrich my follow-up interviews with each participant, help ensure researcher objectivity (Mama & Hennessey, 2013), and triangulate findings to help broaden the applications of this research (Merriam, 1998; Stake, 1995). This additional information was gathered through interviews and informal conversations with building and district administration officials and colleagues of each teacher, all of whom are referred to below with pseudonyms. Collecting this additional data was an unstructured and organic process, occurring via a single conversation that

naturally arose with people during my time onsite and while I was obtaining permissions to conduct research.

Kathy's School and Context

Kathy's district had recently passed a successful property tax levy that was in large part aimed at improving existing technology infrastructure and increasing the devices and training available for teachers. Even before the levy passed, the school had moved toward 1:1 deployments of devices for second grade and higher, and a 1:2 ratio for students in grades K-1. Additionally, the school in which Kathy worked was the leader in technology integration within this particular district, at least from the perspectives of the school principal and a district director of curriculum and instruction. Because of the high levels of administrative support, Kathy's access to technology and the levels of integration felt quite normal to Kathy. Furthermore, Kathy was a vanguard teacher and technology liaison for her school, where she was given dedicated time to evolve her teaching practice and technology integration as a way to disseminate best practices among others at the school. Combined, these factors meant that Kathy was attuned to thinking about technology integration, and had a robust infrastructure to use along with community and administration support of her technology integration efforts.

Kathy's director of curriculum: Personalization is key. Kathy's director of curriculum, Carol, was very interested in the research I was conducting. During our conversation, Carol spoke at length about the district-level efforts to push teachers toward increasing their technology integration by adopting personalized

instructional practices. Teachers' efforts were supported by the district through a model using an open framework that afforded teachers structured autonomy. Carol discussed how she and her staff worked to ensure that all teachers knew they had the full support of the department and each district staff person would stop anything they were doing to support a teacher, should they need help. During our conversation, Carol mentioned that Kathy was seen as a vanguard teacher by the district in terms of embracing technology integration thoughtfully as part of the move toward personalized learning. Additionally, when asked about the issues with the ThinkMath curriculum and the problems caused by the design of the onscreen calculator, Carol admitted that inadequate testing contributed to the adoption of a problematic curriculum, and that they were working on the problem. She also felt that teachers would not have selected anything different given the options available at the time, although she mentioned she was open to discussing things with teachers like Kathy.

This conversation with Carol highlighted a disparity between teachers' needs, especially surrounding autonomy, and the ways those needs are met or unmet by a district. It also made clear how much effort is sometimes necessary to enact change in complex systems. Finally, the conversation illuminated the idea that additional technology knowledge could both directly help teachers integrate technology in their practice and increase their credibility in making technology-related decisions with district administration.

Kathy's principal: We've come a long way. Kathy's principal, Jeanine began her role as principal when the school was performing poorly, and during her tenure, the school became the highest performing elementary school in the district. Jeanine noted that she tried to give each of her teachers as much autonomy as possible when making instructional decisions for their classroom and that she saw part of her job as being a liasion between district mandates and teachers who needed support. Jeanine reported having worked for more than 7 years to get teachers moving toward technology integration, and that some in the building were still "dragging their feet because of age, or poor experiences, or whatever." When pressed further, Jeanine talked about how some of the building's early technology integration efforts went poorly because of a misalignment between teacher expectations and the capabilities of the earlier technologies were capable of, which led some teachers to feel that all technology integration efforts were not worth their effort.

Jeanine felt that Kathy was a good teacher in her own right and had used the district technology integration framework and personalization efforts effectively. In turn, this lead Jeanine to take a somewhat hands-off approach with Kathy, holding her up as an example for the district as to why the approach worked with other teachers as well. Jeanine felt that the district's structured autonomy was more effective than prior initiatives, but also voiced a desire for teachers to have greater autonomy regarding technology decisions that directly impacted their practice. It was clear after this conversation that Kathy was highly regarded by her principal,

and that her performance was being used as a benchmark for other teachers in the building. This conversation also illuminated that the process of enacting change in schools can be difficult when teachers refuse to change, and that managing the process of change can be influenced by relative levels of technology knowledge.

Terry's School and Context

Terry's experience in his school and district were both in stark contrast to Kathy's experience. The cultures of both Terry's district and school administrations considered technology to be an add-on that was limited to enhancing curriculum rather than as a tool that offered new opportunities for teachers to significantly change or personalize their pedagogies. As a result of the defeated tax levy, Terry had to continue using a mix of technology devices including aging Dell desktops and HP laptops mixed with more recent iPads that had to be shared within the studio space. While the desktops and laptops still ran the web applications and sites the students needed, they were unreliable and often broke down, which forced Terry to take on a tech support role fixing things after hours instead of dedicating time for instructional planning or other efforts.

While this may sound grim on the surface, Terry's situation was not necessarily bad. While the administration was neither advocating for technology integration on behalf of teachers nor pushing teachers into technology integration as a part of developing their teaching practices, it also did not hinder such efforts by teachers. One example of the administration's approach is the aforementioned attempt by Terry to get headphones to work across multiple Bluetooth devices.

Administrators supported his attempt at trying, but when the effort did not work, they had no additional resources or further support to offer. Terry's building administration did help get him in contact with district tech support resources, even though the ultimate result was a failed effort. Terry felt that the existing technology and its integration levels would remain the same until the curriculum was changed. The next curriculum review cycle was scheduled to start about two years after the research was completed.

Terry's principal: Optimistic but pragmatic. Terry's principal, Jim, voiced that he was aware of Terry's effectiveness in connecting directly with families. Jim felt that recent failures to pass a tax levy to expand technology integration efforts in the district were unfortunate in two ways. First, the school's location near a border with another school district enables families to move between districts rather easily, and his school had experienced a small enrollment drop when the levies failed. Secondly, Jim felt that the levy failures highlighted "a lack of vision for what technology could do for students," and expressed hopefulness that additional work on this in the district combined with improved communication about how the district would utilize the technology would make future efforts more effective. This suggests that increased teacher and administrator technology knowledge could improve the prospects for passing a tax levy to gain funding that could then overcome a barrier to teachers' and students' levels of access to technology.

When asked about his hands-off approach regarding technology integration, Jim stated that he was "only in a position to use the resources he had towards other

efforts", but that he wanted to give teachers like Terry as much freedom as possible to try new things. Jim felt that the experience of participating in this research project would be beneficial both to Terry and possibly other teachers with regard to technology integration. Jim stated that he felt Terry and other staff were doing the best they could with what they had, while acknowledging that the current technology was aging quickly and wishing that more could be done. It was clear from this conversation that the finite resources of this school were being aligned to district priorities and community needs that were less focused on technology. This demonstrated how difficult changing can be to enact in complex systems, especially when the primary stakeholders had little context for why changes might be needed.

Terry's colleague: Good enough as is. One of Terry's colleagues, a long-term parent volunteer named Dave, was in a unique position to provide longitudinal anecdotal information. Dave had had grandchildren in Terry's class every year Terry had been a teacher and commented positively on the changes he had witnessed, noting that Terry's "style and teaching had gotten more refined and more organized, with more effective discipline of students and much less chaos than at first." Dave felt Terry's presence was positively paternal and clearly showed that Terry cared deeply for the students in his class. Dave believed that the technology in the class was "just about right, even though I'm not a teacher" because of concerns he had about too much screen time. My conversation with Dave reinforced my impression that the priorities of the community were not focused on technology and that these stakeholders were satisfied with the current state of how their children were being

educated. It further reinforced how much effort is required to effect change in large, complex systems.

Lori's School and Context

Lori was seen as *the* technology leader among the grade K-3 teachers at her school, based on conversations with other teachers and the building-level technology integration specialist. In fact, Lori's technology leadership role was taken so seriously by her colleagues that the single classroom set of iPads available to the primary grade teachers was located semi-permanently in Lori's classroom, with other teachers checking out the devices from her, even though they all shared responsibility and access to those devices. (Lori was not expected to handle tech support or trouble shooting duties, however, as these were specifically part of the technology integration specialist's role in the building.) Teachers in the higher grades reported they could easily identify which students had been in Lori's class because of their fluent use of technology for learning. When informed of the perceptions elicited by her coworkers, Lori was very humble and surprised about her colleagues' praise, demurring that she knew there was more she could do with technology if she had more time and resources.

During my classroom observations, Lori used technology for instructional and learning purposes throughout the day, intermixed with traditional pedagogies and analog activities. An unique aspect of Lori's school among the three schools in this study was, despite being a private school it had formed a partnership with the surrounding public school district that enabled them to engage in collective

purchasing of devices, which in turn helped both entities receive the best possible pricing on devices. Perhaps more importantly, the arrangement enabled continuity between the experiences of both private and public school students, which was important for students who might move between schools located within the district. Even with the advantages and cost savings flowing from the partnership, Lori's school experienced occasional hiccups with their technology and had some suboptimal infrastructure. One such example was that the sporadically unstable wireless network where Lori's class was located would sometimes cause students to get dropped from in-class online activities, such as playing a Kahoot (an online game-based assessment tool) or accessing work in Storybird (an online book creation website).

Lori's technology specialist: Lab focused. Lori's technology specialist, Barb, provided the initial insight into how Lori was viewed by other colleagues and was very complimentary about the technology integration work Lori did with her students. Barb also mentioned that resource constraints impacted what was available at their school. She wished she had more time to help plan technology integration efforts and lesson designs with teachers and lamented that her current role was largely relegated to onsite traditional tech support and procurement concerns. Barb felt that the location of the computer lab near the fourth and fifth grade rooms meant that they got the lion's share of her attention, but that this was "ok, since the primary folks had Lori to rely on." Barb's statement made it clear that the perception of Lori's as a technology leader within her grade unit meant she did

not receive significant guidance from others in the building, which in turn limited additional technology knowledge she might create. Furthermore, this conversation brought to light that the lack of technology-focused professional development slowed the integration of technology among these teachers.

Lori's colleagues: To each their own. The other teachers in Lori's grade unit made it clear that they felt Lori's technology integration efforts were impressive and that those efforts engaged her students, but they also made it clear that they were not in a position to try and do the same. These conversations revealed that Lori's use of technology had effectively distanced her from her colleagues, keeping her successes with technology isolated to her room. Teachers in higher grades felt that students who had come through Lori's class were better equipped to use technology in more ways in their learning and wished other primary grade teachers would do more in that regard. While it was clear that the teaching staff in the building knew of Lori's efforts in technology integration and viewed those efforts positively, the school culture was resistant to change. Teachers here largely felt content to exist within their own room doing their own thing with little collaboration.

Data Analysis

Once the interviews and observations had been conducted, and the data entered into Atlas.ti software, my first cycle of analysis utilized values coding and generated a total of 77 codes reflecting a belief or practice related to the integration of technology in a teacher's practice. The sheer number of codes was too great to reach deeper meanings as I attempted to answer the research questions and build a

thick narrative; it was clear that an additional an additional round of analysis was required. In order to look for repeated ideas, meanings, and possible theoretical constructs, I made a strategic decision to categorize the initial 77 codes through theming the data (Saldana, 2016).

Saldana (2016) asserted that "theming data can be just as intensive as other coding methods" (p.198), which reflects the multiple rounds of analysis and evolution of themes. The refinement that came with early theming work resulted in some codes being consolidated, leaving a total of 73 codes for the final analysis. I began with three initial themes grounded in the three domains of TPACK – content knowledge, pedagogy knowledge, and technology knowledge (Mishra & Koehler, 2006). As a normal product of theming the data these initial three themes evolved as I searched for repeated ideas, deeper meaning, and theoretical constructs (Saldana, 2016). As a result, eight total themes were initially noted; two of these eight themes were eliminated in the final report, which is also a normal product of additional analysis in this stage (Saldana, 2016). The two dropped themes also happened to align with TPACK (Mishra & Koehler, 2006): content knowledge and pedagogical knowledge.

The content knowledge theme was dropped because the codes within it did not delve into connections between beliefs and practices that weren't explained elsewhere. In other words, there was no deeper meaning or repeated ideas within the content knowledge theme, so it was dropped from the report. The theme of pedagogy knowledge was originally standalone, but with further analysis it was

clear that the pedagogies employed by these teachers focused on how they used different pedagogical strategies in order engage their students and create more effective learning experiences, even when technology was not a tool being used to do so. Therefore, the standalone theme of pedagogy knowledge was eliminated because it was redundant with the pedagogy and student focus theme listed below.

The final six themes each convey repeated ideas and form theoretical constructs for understanding why these teachers expressed particular beliefs or had certain experiences within the context of their teaching practice. In order of prevalence, these six themes are as follows:

1. Pedagogy Knowledge and Focus on Students
2. Technology Knowledge
3. Technology as a Barrier
4. School as an Ecosystem
5. Teachers' Needs
6. Change Management

To maintain transparency and validity, Saldana (2016) suggests that the write up of thematic analysis should include a demonstration of how the theoretical constructs created via thematic analysis integrate or relate to each other. To that end, figure 4.3 graphically illustrates how I see the themes intersecting and overlapping. I then move into narrative description to provide further detail into these connections as well as discuss how the data serves to support my interpretations (Saldana, 2016).

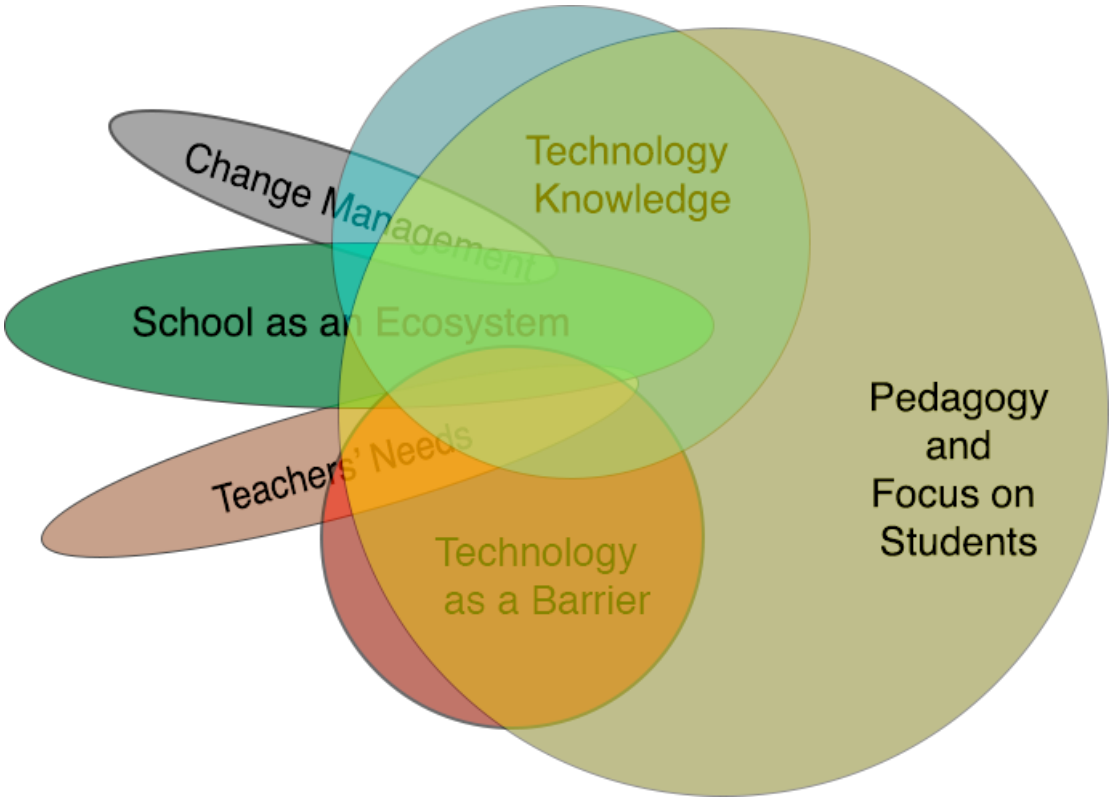

Figure 4.3. Diagram of relationships among the six themes. This diagram shows both the magnitude of different themes from the data as well as intersections and overlaps between different themes.

Theme 1: Pedagogy Knowledge and Focus on Students

The 37 codes that constitute the pedagogy knowledge and student focus theme, along with their counts, can be seen in table 4.1. The large number of codes and of individual mentions in this theme reflect that every observation or interview generated data related to pedagogy and the ways that each teacher focused on student needs, whether or not we directly discussed the use of technology. I discuss 10 codes that both occurred frequently and provided deep insights for understanding why participants made certain decisions or held particular beliefs about technology integration. The first five codes seen in themes 1.1 through 1.5 demonstrated that these teachers' focus was primarily on student aspects, such as

well-being and engagement or on student-teacher interactions. The next five codes seen in themes 1.6 through 1.10 illustrate times when teachers considered technology early on in connection to pedagogy, they did so with an explicit intent to meet a student need or learning goal.

Table 4.1

Pedagogy Knowledge and Student Focus

Code	*n*
Belief: Technology makes assessments easier.	10
Belief: Independence is a good thing.	21
Belief: School should be a family or community.	21
Belief: School should be fun.	6
Belief: School should feel safe.	7
Belief: Technology can personalize or individualize learning.	10
Belief: Technology has to meet a need.	6
Belief: Technology empowers learners and helps them choose.	11
Belief: Technology helps students learn more.	6
Belief: Technology increases engagement.	30
Belief: Technology is not always the best tool.	36
Belief: Technology supports student creativity.	7
Belief: Technology to helps students explore via open-ended learning.	8
Practice: 1 to 1 technology ratio opens new doors.	8
Practice: Connect technology and student creativity.	7
Practice: Developmental appropriateness of teaching.	80
Practice: Differentiated instruction	50
Practice: Flexibility to group students and work on independent work ethic.	14
Practice: Pedagogical changes lead to developmental appropriateness.	12
Practice: Pedagogical requirements.	8
Practice: Pedagogy making work more social.	9
Practice: Pedagogy making work social within whole group instruction.	7
Practice: Pedagogical choice for whole group instruction.	4
Practice: How is pedagogy aligned?	31
Practice: Pedagogy decisions leading to student trust.	27
Practice: Pedagogy more important than technology.	6
Practice: Being resilient when trying new technology.	3
Practice: Students are part of a complex ecosystem.	41
Practice: Teaching literacy through excitement.	1
Practice: Teaching students to be independent.	9
Practice: Technology enabling immediate feedback.	7

Practice: Technology enables more gamification.	17
Practice: Technology equals learning.	6
Practice: Technology has to be worthwhile to use.	6
Practice: Technology makes time management easier.	1
Practice: Technology should be easy to use.	4
Practice: Technology-based assessments are worthwhile.	16

Theme 1.1: Practice: Developmental appropriateness. Among the codes in this theme without a primary focus on technology, this one occurred 80 times when teachers were considering students holistically to determine if the material was at an appropriate level for each student. All three participants demonstrated attention to developmental appropriateness, which manifested in many ways. Kathy, for instance, used instructional strategies such as data-based ability grouping to give her increased fidelity of information for personalization than if she used more generic data such as age for a measure of appropriateness. Terry provided direct instruction for logging into a website or app and then check to ensure everyone got in before going to the next step. Terry also enabled his students to move around in the classroom during reading time because he thought it was developmentally appropriate for first grade students to do so. Lori wanted to have her students create large narrative projects and not deterred by possible spelling errors, so she frequently enabled her students to read their work aloud so that "the audience was just listening and not worried about punctuation or spelling."

Theme 1.2: Practice: Students as part of an ecosystem. I noted when teachers were considering all of the individual actions and stakeholders at work in a modern classroom 41 times. The students in these three classrooms had many needs, some of which the teachers had control over, and some of which teachers had no control

over. When teachers had no control, they often had to make changes in their teaching practice to find the best solution to support the student. Kathy would have to alter her teaching to better accommodate Spanish-speaking students or alter groups and projects because of students being pulled out for other services. Terry would explicitly try to relate reading material to real life and what students already knew. Lori would often deliver direct instruction to the whole group, but did so in a way that had her seeking from her students, such as pausing to ask "Who got this right?" with a follow up of "…and how did you get that?" Lori's technique enabled students to demonstrate their own knowledge and understanding in unique ways. Even small efforts in addressing students as part of an ecosystem were seen to have an effect in these classrooms, such as Lori continually referring to her students as "friends" when addressing them as a whole group, helping to build a sense of community in the classroom.

Theme 1.3: Belief: Technology is not always the best tool. There were 36 instances when technology-based systems simply weren't the best solution in context. This could be true for a variety of reasons, including lack of resources, devices, or technology knowledge. At times, however, it was also clear that the intersection of technology knowledge and pedagogy knowledge as shown in figure 4.3 indicated even with resources available that the best solution for the student was not technology-based. Participants' discussions of when technology may not be the best tool from a pedagogical standpoint often revolved around participants trying to balance screen time with real-world activities. Kathy reported that she felt

maintaining this balance was important for engagement purposes and because her students would be expected to also participate in real-world activities as they got older. Kathy chose to use a spelling curriculum that was entirely analog but that had proven to be effective over years of use. Terry felt that students should be comfortable with reading materials both on screen and printed on paper. Lori also used multiple analog activities to engage students, such as a "two adjectives, one noun" activity where students selected two random adjectives and one noun, then had to draw the results.

Theme 1.4: Practice: Pedagogy aligned with student needs. There were 31 times noted when teachers altered teaching methods, lessons, and materials based on individual student needs. When aligning their pedagogy with students' needs, participants would alter instruction to meet particular student needs at a particular time. An example of this alignment process was seen in Kathy's partially flipped instructional model to deliver learning materials the night before in-class presentation of learning materials and have students take a pretest that showed if they had mastered the material or needed additional help. Kathy used this data to ability-group students and deliver different instruction based on pretest results and their needs. At the end of each day, Kathy had students reflect in a journal about how they felt about their work that day and what they might do differently next time to improve.

Theme 1.5: Belief: Pedagogy and teacher trust. There were 27 occurrences when teachers worked explicitly to build a trust relationship with students in order

to better engage them in schoolwork. This sort of relationship meant that teachers had to be firm in setting expectations, while also being understanding about each student's background, needs, and development. These three participants would use pedagogical techniques to help build trust relationships with students. I observed both Kathy and Lori remember details about students and work them into lessons later on. Not only did this technique engage the students directly mentioned, but also helped them feel valued as part of a learning community.

While these teachers clearly had a focus on interpersonal aspects of teaching that did not utilize technology within this theme, they also often thought about and integrated technology as a means to meet student needs or help them achieve a learning goal. In this context, those efforts were connected to providing students with developmentally appropriate materials in personalized or differentiated ways that wouldn't have been workable using traditional methods.

Theme 1.6: Belief: Technology increases engagement. These teachers expressed a belief that using technology was a way to increase engagement 30 times. During the initial interviews these teachers seemed to easily parse the complex environments occurring in their classrooms, but made it seem as though they were simply adding technology to existing lessons would make those lessons more engaging for students. When observed naturally during classroom teaching there were other factors at work with this belief, such as pedagogical changes that made use of the technology to make the experience more engaging for students. Increasing engagement of students is a goal for many teachers. All participants

stated they believed that technology increased engagement, but they each implemented this belief in different ways. Kathy saw technology offering opportunities to do new things, such as "new ways to interact with students as a teacher and ways for students to interact with each other." Kathy also noted that "using technology helped streamline ways for students to demonstrate their learning" and that the increased timeliness helped students to focus more on the learning process rather than the creation of an artifact. Terry had both digital and analog reading centers, but noted that students seemed more engaged when using the technology-based materials. Terry felt that the increased engagement was due to a combination of graphics and an increase in "student choice in material and getting to see new words they didn't know before, making them more excited to read." Lori found using technology to be helpful in providing immediate feedback on tests and quizzes, which helped students understand where they could improve.

Theme 1.7: Practice: Differentiated instruction. This code was seen 50 times during observations when teachers worked to personalize learning experiences for students and align the lesson more closely with an individual's ability level. Differentiated instruction as a pedagogical technique isn't new, but it is often facilitated by technology use in the classroom. For example, Kathy used a flipped model of instruction combined with technology to administer instructional material and preassessments and then grouped students by those results, in order to tailor instruction based on ability. Lori used technology to track and store data on students reading levels and abilities and then used technology to deliver reading

materials to all students on the same topic, but aligned with each individual student's reading ability.

Theme 1.8: Practice: Flexible grouping and independent work. Teachers grouped students in order to specifically encourage them to work independently 14 times. This code did not rely on preassessment data, in contrast to the code practice: differentiated instruction in theme 1.7. When trying to flexibly group students and support their independent work, it should be made clear that the goal wasn't to have students work alone. Rather, the idea of independence applied to these students was to have them generate their own learning, in a constructivist tradition. For example, Terry would group students during reading times to different stations. When Terry was at a station working with a group, students with questions were instructed to start with themselves and the computers to find answers, then ask friends, and then come to him as a last resort. Terry's use of technology in this case helped him to sort the students and also facilitated their individual learning.

Theme 1.9: Practice: Gamification. Teachers used technology to increase a sense of game play in the learning experience of students 17 times. Overlapping with other codes in this theme, gamification was used as a pedagogical tool to engage students or provide ways to differentiate instruction. These participants used technology to enable gamification, in which game-like experiences for students helped engage them or expand on analog material. One example was when Kathy assembled a virtual scavenger hunt using Google Maps and street view to get

students to look for examples of angles, which had just been covered in class. Kathy also used Osmo, an app-based mathematics curriculum that tied together physical manipulatives with virtual gameplay. Another example was when Lori held a Kahoot in her class as a good-natured competitive exercise for her students to demonstrate understanding.

Theme 1.10: Practice: Technology-based assessments. Teachers specifically noted how technology made a given assessment more valuable for them or their students 16 times. When looking at how technology-based assessments were worthwhile it is necessary to state that these teachers had each found a balance of paper-based and technology-based assessments within their practices that felt right for them and their students. When these teachers used technology for assessments it was for explicit purposes and embedded in other pedagogical techniques. One example was Lori using reading-level data gleaned from technology-based reading assessments to deliver material at just the right difficulty for individual students. In this case, the technology-based assessment facilitated more individualized instruction and supported individual students' growth of reading ability.

Summary. These teachers considered pedagogy frequently, both when it came to technology integration efforts and when technology was not being considered. When considering technology in their teaching these teachers considered the needs of students as a primary factor before moving onto technology solutions. I observed that these teachers first identified a student's need, such as how to engage them or to meet a learning goal. Then, also using their technology

knowledge, teachers would consider the resources and support they had within the school. Finally, teachers began looking at what technologies might accomplish their goals. When technology was not being considered, observations of these teachers suggest it might be that student needs were perceived as more easily addressed through pedagogical tools than through technology. Further, because student and teacher interactions are typically face-to-face and interpersonal, the teachers may have been trying to address student needs through a similar medium. With the participants in this study, pedagogy provided the foundation on which the rest of the teacher's practices were built.

In context, the technology-related codes in this theme represent ways that these teachers used technology to meet the needs of their students in ways that wouldn't have been otherwise possible. As one example, consider Lori's use of technology-integrated literacy curricula leveraging student assessment data to deliver modified versions of the same text aligned to each individual student's reading abilities. Differently leveled reading material isn't a new or even novel idea and can be accomplished both with analog and digital media. Using paper-based books and reading materials, however, is cost-prohibitive since one must have several sets of materials at multiple levels, and then teachers must frequently assess how students are doing at that level. In contrast, technology-based content delivery systems provide materials to students across a broad range of topics and reading levels, at a very reasonable price tag once devices are procured. The particular example used above offered three key advantages, with two focused on students

and one focused on the teacher. The first student-focused advantage of using technology-based systems is that students can all participate in the experience of reading the same book subject, even if at different levels. This shared experience eliminates stigmas associated with reading outside of what is seen as a cultural norm by students. The second student-focused advantage of these technology-based systems is that students are far more likely to find a text on a subject they find interesting that is also at their level. Having reading material can help a learner remain engaged, and can help improve reading abilities when covering other subjects too. From a teaching perspective, the technology-based systems provide greater fidelity and frequency of student reading level assessments. Greater frequency of assessment helps ensure students are offered reading material at the appropriate levels to keep their skills growing (Vygotsky, 1978).

Theme 2: Technology Knowledge

There were 22 codes connected to technology knowledge as can be seen in table 4.2. Generally, these codes were wide ranging, appeared throughout the data, and were often connected to the themes of pedagogy knowledge and student focus as well as technology itself as a barrier. The three codes discussed in deeper detail below provided the most insight into how these teachers' technology knowledge impacted their beliefs and practices. The codes of belief: right way to use technology and practice: poor design results in problems for students can be seen in this data table, but are discussed in theme 3 because in context they were more related to barriers than to technology knowledge by itself.

Table 4.2

Technology Knowledge

Code	*n*
Belief: The right way to use technology.	27
Belief: Technology can personalize or individualize learning.	10
Belief: Technology has to be easy to use.	7
Belief: Technology empowers learners to choose.	11
Belief: Technology makes things easier.	8
Belief: Technology is not always the best tool.	36
Belief: You have to trust technology.	1
Practice: Use caution with new technology.	12
Practice: Differentiated instructional practice.	50
Practice: A lack of skill or experience with tech is a barrier.	1
Practice: Poor design results in problems for students.	28
Practice: Technology integration requires support.	4
Practice: Inadequate technology support for teachers.	11
Practice: Technology-related professional development needed.	4
Practice: Technology affords new or other options for teaching.	19
Practice: Technology can introduce barriers.	14
Practice: Technology enables immediate feedback.	7
Practice: Using technology equals learning.	6
Practice: Technology has to be worthwhile to use.	6
Practice: Technology makes time management easier.	1
Practice: Technology should be easy to use.	4
Practice: Technology-based assessments are worthwhile.	16

Theme 2.1: Practice: Differentiated instruction. These teachers used their technology knowledge to facilitate differentiated, personalized or individualized instruction 50 times. All of these instances also interconnected with pedagogy knowledge. For example, both Kathy and Lori used technology knowledge in part to differentiate learning for their students. This included Kathy's partially flipped model, where students would interact with instructional material the night before, and then based on pretest results, be grouped the next day by score results. In this model, the technology enabled Kathy to more efficiently address the needs of students who needed more help while also providing data to support enabling

students who had mastered the material to move forward at their own pace. In this particular case, Kathy's technology knowledge facilitated her pedagogical decision to use a flipped model. Lori similarly identified a pedagogical need to deliver reading material at multiple levels to her students, and then used her technology knowledge to tie reading assessment scores to her school's content delivery system. The result was that her students could access reading materials on the same topic, but tuned to their specific reading level for whole group reading, and they had access to a broad range of topics for individual reading work that was also at their level.

Theme 2.2: Practice: New options for teaching. There were 19 times that knowledge about a technology's capability enabled a teacher to open up new ways to deliver instruction or have students complete work that were different than explicitly personalized methods. All three participants provided useful examples of this practice. Kathy used a virtual field trip (conducted in Google Maps' street view) of classical architecture to reinforce mathematical concepts like *ratio* and *angle*. Terry utilized the mobile aspect of iPads to empower his students to move around in ways they felt comfortable when reading and completing work on the device. In this case, rather than being forced to always sit at a desk or table, Terry's students could lay down on the ground, pace in one area of the classroom and ask friends questions if they arose. Lori used a Kahoot to gamify some assessments and engage students, had students create shapes on a virtual geoboards in a whole group to show what

they knew about geometric concepts, and had student create virtual poetry books with art in Storybird for later publication and showcasing at conferences.

Theme 2.3: Belief: Technology is not always the best tool. There were 36 times when teachers felt the best way to address a student's learning need was to avoid the use technology**.** This belief lends credence to the assertion within TPACK that effective teaching is about a balance of technology, pedagogy, and content knowledge (Mishra & Koehler, 2006). Adding to TPACK, this code also suggests that knowing when *not* to use technology is also an important skill within an effective teaching practice. One example was when Lori used analog media to engage students in a grammar exercise. In this case, students received two slips of paper with adjectives, one more slip with a noun, and then had to draw the resulting word combination on a separate sheet of paper. Students found examples like *silly shiny scientist* fun to say and draw while also making connections between the words themselves and imagery, reinforcing Lori's pedagogical imperative for this lesson. Conducting this activity onscreen would have been clumsy in comparison to the analog version without significant changes in the lesson design.

Summary. These teachers' technology knowledge was embedded in ways to use the technology to meet students' needs or to make particular experiences more effective. With their focus on students, it is then not surprising that these teachers also showed that there were times in their teaching when technology was not the best tool to meet students' needs. Increased technology knowledge may help mitigate the design problems by enabling teachers to identify better technology

solutions, find better workarounds to the problems encountered, as discussed in theme 3. Increased technology knowledge could also increase the credibility of teachers during district-level technology decisions, discussed as issues of autonomy within theme 5.

Theme 3: Technology as a Barrier

As seen in chapter 2, there are four identified barriers to technology integration in the literature. As such, I was looking for codes that suggested barriers to these teachers' practices, and found that sometimes technology was also a barrier. The four codes constituting this theme are shown in table 4.3, with the two codes discussed in depth below illuminating two particular aspects of how these teachers encountered barriers to their technology integration efforts due to the technology itself.

Table 4.3

Technology as a Barrier

Code	*n*
Belief: There is a right way to use technology.	27
Belief: Technology design as a barrier.	10
Practice: Poor design results in problems for students.	28
Practice: Technology can introduce barriers.	14

Theme 3.1: Belief: The right way to use technology. I noted 27 times when a technology's intended design purpose did not align with the teacher's requirements. In turn, this misalignment frustrated integration efforts by these teachers. One example of this phenomenon was when Lori's students were creating online multimedia texts. When building these texts in an open ended, freeform such as Google Docs, Lori reported that her students often "had some strange photos from

home or other places that weren't appropriate for the classroom." In this case, Lori's belief surrounding how she would use photos and multimedia within Google Docs differed significantly from how students actually ended up using the medium. The dissonance between Lori and her students resulted in Lori requiring several students to go back and redo large portions of their initial project and pushed Lori away from using Google Docs as a medium for future projects.

Theme 3.2: Practice: Poor design of technologies resulted in problems for students. A designer's apparent lack of knowledge about the needs of students led to design decisions that negatively impacted students' learning experiences 28 times. As an issue of practice, when the poor design of technology products resulted in problems for students, teachers then had to search for a workaround, which, even if successful, required time or other resources that might be better used in another way. Two poignant examples of this are included here, with the first being when Kathy found that the ThinkMath curriculum, when used with iPads, had a problematic onscreen calculator that blocked portions of math problems from view, creating a significant barrier to students completing their math homework. While Kathy determined that students could use the iOS calculator app instead, doing so made for a convoluted student experience that Kathy thought made the focus "more about how to use a calculator than deeper thinking about math" and introduced the potential for other errors in student work because of having to go back and forth between apps. A second example of how poor design negatively affected students was seen in Terry's classroom when a student reported a problem with his desktop

computer. In this case, the student was right-clicking the mouse rather than left-clicking. Being a first grader, his grasp of left versus right was still tenuous. While this particular example was overcome with a quick discussion with the student about left and right, the very nature of the technology being used created a problem and was a barrier to the student completing the work at his assigned station. Students of this age do not encounter similar problems when using a touchscreen.

Summary. When technology was a barrier it appeared that this was either part of a belief system for the teacher, or that there was a design failure in the technology that negatively impacted learning experiences for students. When a teacher's belief was involved, it is possible that increased technology knowledge could overcome the barrier although an improved design could illustrate other possible applications for the technology. The codes in this theme had a high degree of overlap, and also intersected the concepts of autonomy expressed in the teachers' needs theme examined later in this chapter.

Theme 4: Schools as Ecosystems

Within theme 1: pedagogy and focus on students, the code of practice: students part of an ecosystem was seen 41 times, as noted in table 1. Modern schools are complex environments that include factors such as students having needs that can't be met via technology, student trust issues because of prior negative interactions with adults, or when decisions that get made about technology that directly impact teachers but which those teachers have little input on. As such, I wanted to dig deeper into how these factors might impact a teacher's practice, and

so used the code practice: students as part of an ecosystem as a theme to group data, and found 13 codes that fed into this theme, as shown in table 4.4. The four codes discussed below illustrate specific, insightful examples of how teacher technology integration efforts can be hindered due to other needs or constraints, and are also part of the intersectional area of themes 2, 4, and 5 as shown in figure 4.3.

Table 4.4

Schools as Ecosystems

Code	*n*
Belief: Students are digital natives.	2
Belief: Involve parents via tech.	5
Belief: Technology is expensive.	2
Belief: Technology is not always the best tool.	36
Practice: Curriculum is influencing technology choices.	20
Practice: Parental hesitation hinders tech integration.	2
Practice: Pedagogy decisions leading to student trust.	27
Practice: Social component of technology decisions	12
Practice: Students part of a complex ecosystem.	41
Practice: Teaching affected by administration or outside decisions about technology.	24
Practice: Teaching and technology can be driven by testing.	11
Practice: Technology use by people can get in the way.	2
Practice: Wanting to use technology as return on investment.	13

Theme 4.1: Belief: Technology is not always the best tool. Participants noted that technology would not offer an effective solution to the problem they were tackling 36 times. Kathy offered a very succinct summary when she said "effective teaching isn't driven by technology. You have to find a balance between real life and screen time." Terry provided evidence of this code by enabling his students to get up and move, ask questions and find additional ways to learn as they felt necessary, such as lying on the floor while reading. Lori mentioned that she had been frustrated with trying to send information to the office for mundane things like

lunch counts, and rather than spend time trying to trouble shoot the problems, it was still workable to have a student volunteer bring a piece of paper with lunch counts down to the office each morning. Increased technology knowledge might mitigate the problems these teachers encountered, but the time to do so was unavailable because of their other needs.

Theme 4.2: Practice: Pedagogy and creating student trust. There were 27 times that these teachers made explicit efforts to build a trust relationship with students by ensuring they felt feel cared about and valued. This code speaks to the complex interpersonal aspects of the teacher-student relationship, in which many students felt they needed to be treated more as individuals before they would begin engaging with schoolwork. As such, it manifested in subtly different ways for each teacher. Kathy had signage up in her room that had positive messages such as "Mistakes are proof that you're trying" and ideas to empower yourself for next time when mistakes are made. Terry trusted his students to make appropriate choices when offered the freedom to move around during class time. When students made choices that prompted intervention, Terry ensured that he spoke in a calm manner and validated the students while also providing correction. When addressing students, Lori would use language that helped mitigate power differentials in her classroom, such as "*friends*, I need your attention" rather than using more traditional diction such as *children* or *students*. All of this language contributed to a sense of inclusion and building a trust relationship between the teacher and their students.

Theme 4.3: Practice: Teaching affected by outside decisions. Teachers felt that some important technology decisions were made at levels above them, with inadequate autonomy or resources in their classroom 24 times. Lori provided an interesting example of how this can manifest. She had been asked by administration to conduct formative reading assessments during class using a new technology-based system from Heinemann that recorded students reading while simultaneously enabling teachers to make notes, providing a comprehensive snapshot of that particular student. Lori reported she asked administration for a substitute teacher to conduct class in order to complete the tests. The sub was needed since even the low levels of background noise during class time in the classroom interfered with recording, and Lori felt it was unfair to ask students to stay inside during recess to take a test.

Theme 4.4: Practice: Curriculum driving technology decisions. There were 20 times when curriculum locked teachers into a particular technology. One such example is that Lori reported that one factor in her consideration of a new app was if it "worked well with the curriculum", and if not, she was generally satisfied to just use "whatever came with our curriculum." In practice, this means that teacher technology decisions are being influenced by the curriculum adopted by the school or district, and that teachers are more likely to use apps that come with the curriculum even if they are poorly designed.

Summary. Modern public schools can be viewed as a sort of ecosystem, with complex social systems involving many interconnected parts and stakeholders. It

can be easy to forget that the balance of these systems can be damaged when changing just one piece. Technology integration is part of this ecosystem too. As any of these teachers teacher tried to integrate technology into their practice, accommodations to resources or time for instructional planning had to be adjusted in compensation. Sometimes, decisions made above the teacher created barriers to student learning. Other times, students had needs that took precedence over technology or coursework, especially when they felt a need to be valued and have a more meaningful relationship with the teacher.

Theme 5: Teachers' Needs

The 15 codes and counts of this theme can be seen in table 4.5. This theme presented itself as a result of teachers talking about or demonstrating a need, connected to technology integration, that had gone unmet and was an impediment to their integration efforts. In the four codes discussed below, the first two revolve around issues of autonomy, while the second two illustrate barriers that teachers can experience related to their needs when integrating technology.

Table 4.5

Teachers' Needs

Code	*n*
Belief: Constraints are helpful for process of technology integration.	2
Belief: A lack of technology is a barrier.	14
Belief: Teachers have little power to decide which technology gets used.	44
Belief: Technology has to meet a need.	6
Belief: Technology integration models not very helpful.	8
Belief: You have to trust technology	1
Practice: Teachers need autonomy for choosing technology.	12
Practice: A lack of skill or experience with tech is a barrier.	1
Practice: Limited resources can be a barrier.	6
Practice: Technology integration requires support.	4

Practice: Inadequate technology support for teachers.	11
Practice: Technology-related professional development needed.	4
Practice: Technology has to be worthwhile.	6
Practice: Technology makes time management easier.	1
Practice: Technology should be easy to use.	4

Theme 5.1: Belief: No autonomy. There were 44 times when participants felt that top-down decisions about technologies were thrust upon them. Kathy had the most illustrative example of having little power to decide which technology got used, as shown with the top-down mandate of adopting the ThinkMath math curriculum. While ThinkMath is designed to be used on a tablet device such as an iPad and contains multiple tools to assist students, the on-screen calculator sometimes occluded part of the math problem a student was working on, the *Clear* function of the calculator would lock the app, prompting a restart and possible lost work, and there was no way to copy results from the calculator onto the homework creating an opening for possible errors. Neither Kathy's grade level nor Kathy herself was consulted on the adoption of the ThinkMath curriculum by district administration, locking teachers into several years of frustration and having to find alternate solutions or workarounds. Kathy felt that having more autonomy in deciding on a curriculum could have avoided this issue. It is worth noting that in Kathy's district, there is an effort from district administration to engage teachers more in technology decisions and to personalize the processes of integration for themselves, but these efforts are in beginning stages.

Theme 5.2: Practice: Inadequate feedback. There were 12 instances when participants had some degree of autonomy to make decisions about technology,

inadequate resources negatively impacted their efforts. While both Lori and Terry had autonomy for technology within their classrooms, they both reported that they felt constrained by a lack of direction or guidance stemming from the hands-off approach of their administrations. Lori's perception as *the* technology integrated teacher meant that her teaching colleagues would merely affirm her ideas as "great" without offering critical feedback, and Lori's tech support person was often too busy with other projects in the school to provide meaningful guidance. Terry's principal was similarly busy with other administrative priorities and was unable to offer critical feedback.

Theme 5.3: Practice: Tech support. There were 11 times when participants experienced inadequate technical support. Both Terry and Lori experienced significant issues with inadequate tech support in their practices. Terry would often find himself doing technical support after hours on the aging laptop computers in his room when students reported a breakdown during the school day. Terry voiced that he would "rather spend the time building new lessons" than fixing computers. Lori was reluctant to engage the building tech support person, Barb, out of concern that doing so "took her away from other teachers who might need the help more than I do." For example, when Lori had an issue with one iPad losing connection to the wireless network during an online Kahoot quiz, she would have students restart the quiz rather than engage Barb in trying to figure out the problem. While student motivation didn't seem to be negatively affected by this, the worries about technology breaking had a chilling effect on Lori's use of technology.

Theme 5.4: Belief: Lack of access to technology. There were 14 times when a lack of access to technology code impacted these teachers. Given that part of the definition for the first order barrier is an external locus of control (Hechter & Vermette, 2013), then the lack of access to technology experienced by these teachers could be considered first order barrier (Hechter & Vermette, 2013; Lin, 2012; Mama & Hennessey, 2013). One example of this was Terry's desire to update and modernize some of the technology in his classroom, as the four desktop computers and six laptops were all aging and broke down often. The breakdowns meant that Terry was forced to use time and resources to fix these systems after school hours, rather than on instructional planning and design.

Summary. All teachers have needs connected to technology integration, and these teachers were no exception. The needs these teachers had centered mainly on issues of autonomy and control, but also touched on a lack of access. Leaving these needs unmet ultimately resulted in some negative learning experiences for students as well as the reducing the potential impact that technology could have in their teaching. The needs of autonomy and tech support could be partially met through increased technology knowledge, so that teachers could have increased credibility with districts when making technology decisions or find additional ways to use the technology they already have. A lack of access to technology is largely beyond the control of individual teachers given the costs and necessary resources involved with technology purchases and deployments. Here again though, increased technology knowledge for groups of teachers could potentially mitigate this through enabling

teachers to better elucidate underlying purposes of increased technology integration.

Theme 6: Change Management

This theme was derived from teachers voicing beliefs and exhibiting aspects of their practice that showed how the process of enacting change can be difficult, both with and without technology. The 11 codes that made up this theme can be seen in table 4.6, with the four most prevalent and informative codes discussed below.

Table 4.6

Change Management

Code	*n*
Belief: An apprenticeship of observation.	21
Belief: Fear of change.	6
Belief: Fear of failure.	5
Belief: Involving parents through technology is worthwhile.	5
Belief: The right way to use technology.	27
Practice: Technology decisions stick around a long time.	5
Practice: Use caution with new technology.	12
Practice: Parental hesitation hinders tech integration.	2
Practice: Technology affords new or other teaching options.	19
Practice: Technology can introduce barriers.	14
Practice: Trying something new can be difficult.	27

Theme 6.1: Belief: Apprenticeship of Observation. There were 21 times when teachers encountered difficulty in trying to overcome preconceptions from students, families, or themselves. An apprenticeship of observation originally referred to the idea that teachers tend to teach as they have been taught (Lortie, 1975). Extending this concept here includes the observation that parents and families often want their children to be taught as they themselves were instructed. For example, Kathy

encountered resistance to using her technology-facilitated flipped classroom model, when students engage with learning materials and take a preassessment the night before the lesson was presented in class. This flipped concept, very different than the way many parents were taught, was something that Kathy felt her parents didn't seem to be able to grasp. Without at-home support and encouraging students to do the work as the teacher had suggested, the flipped model Kathy was attempting to use was much less effective than she had hoped.

Theme 6.2: Belief: The right way to use technology. Teachers expressed a belief that there was one objectively correct way to use a certain technology or lacked the resources to repurpose that technology for their needs 27 times. Two poignant examples of this belief were brought up by Lori discussing how her students would sometimes use a technology differently than she had imagined. In the first example, students were making digital books about their lives, and would take photos using at home about during their usual days. Lori mentioned that students often "had strange photos that weren't appropriate for school" when making the books, and that she had to take corrective action with students when they seemed to be just playing with taking photos rather than focusing on their work. As such, Lori had to modify her pedagogy and add more constraints to the student book projects when using digital photos. The second example was Lori's statement that the "school nurse has had to recommend kids get additional hearing checks because of how loud they're listening to music and other things with earbuds

in." In this case, Lori took steps to ensure students kept the volume down when listening to audio on their devices.

Theme 6.3: Practice: Difficulties when trying something new. There were 27 times when teachers encountered challenges when integrating technology into their teaching practice, simply for the sake that what was being attempted was new with specific examples provided by Kathy and Terry. Kathy mentioned that while she felt supported by the district and administration in trying personalized learning techniques, the aforementioned resistance she felt from parents was hindering her effectiveness. Kathy also disclosed how sometimes miscommunications among teaching staff hindered efforts to try something new, such as when a big research project was started by other grade level teachers with an expectation that all third graders would finish the project, without consulting Kathy. In her professional opinion, Kathy's students' needs and abilities were clearly going to be a barrier to successfully completing the project, and Kathy felt that the positioning of the project risked stigmatizing her students in the eyes of their peers and generating an internalized sense that they were inadequate. Terry experienced an issue when trying to push audiobooks to his students as a learning station. Terry envisioned using an iPod to push the same audio book out to students at multiple Bluetooth-connected headphone stations. However, Bluetooth technology only allows one device connection, effectively terminating Terry's project. In this example, Terry had spent his own money trying to make this work, and the technology coordinator for the building was unable to offer alternate possible solutions. This had a dampening

effect for Terry's consideration of new technology integrations efforts for the beginning of the school year, although he was once again looking at technology by the time this research was conducted.

Theme 6.4: Practice: New options for teaching and learning. Across all three classrooms, there 19 times when technology opened up new avenues to engage students, improve student learning experiences, or otherwise make the teacher's job better. Kathy's students were clearly motivated by gameplay style learning materials when using the Dreambox app to explore math concepts, and Kathy herself was very excited about the potential that her flipped classroom model held for students. Students in Terry's class were excited to use RAZkids or other apps to show what they knew. Lori reported that her use of technology "mainly helped in my assessments and improved student creativity." When discussed in follow up interviews, participants were energized and excited by the changes they could see happening, and motivated to continue trying new technology integration efforts even when faced with other challenges.

Summary. Trying to do new things in a classroom can be hard, as teachers sometimes have to overcome through their own thoughts and experiences (Lortie, 1975). Resistance to change in complex organizations like schools can also come from institutional factors or other stakeholders. Institutional resistance might be inherent to the culture of a particular school building, a function of resource constraints such as funding for devices, professional development, or paying for substitute staff, or even an issue of not knowing what isn't known yet. Stakeholder

resistance can occur through the stakeholders' apprenticeship of observation (Lortie, 1975) if their own experiences with how learning should be done prevent then from understanding how or why a new method or device might serve students better.

Summary

This chapter presented profiles of three teachers, additional information to add context to their unique situations, and discussed what was found in the data once it was analyzed. The data was then grouped into six themes, which were often interconnected. The findings show that the teachers in this study had many beliefs and practices related to technology integration efforts in their teaching practices, and faced multiple barriers from a variety of sources, which were often interwoven in complex ways. Next, in chapter 5, I discuss conclusions, make recommendations, point out some implications and discuss limitations for the research findings.

Chapter 5

Conclusions, Recommendations and Limitations

In this chapter, I present a brief overview of the research study and summarize the findings as they relate to the three research questions. I next discuss the implications of the research findings, and the limitations of this study. Next, I include recommendations for actionable steps to address the most pressing issues identified in the study. Finally, I end the chapter by identifying future directions for additional research.

Summary of the Research Study

This study explored teachers' technology integration beliefs and practices in order to better understand how those beliefs and practices impact their teaching. First, an overview of what is currently known in connection with technology integration was presented, with an emphasis on the identified barrier of belief systems (Ertmer et al., 2012; Funkhouser & Mouza, 2013; Lin, 2012; Liu, 2012). Then an exploratory case study using qualitative methods was used to deeply explore three current teachers' beliefs and practices connected to technology integration. These beliefs and practices were explored through initial interviews and naturalistic observations. Additional sources, unique to each teacher, were engaged to provide contextual information to enrich understanding and aid in triangulation through outside perspectives (Stake, 1995). Lastly, follow up interviews were conducted with the three teachers to enable them to reflect upon their technology integration beliefs and practices and provide further explanations

(Mama & Hennessey, 2013; Schon, 1983) as well as to validate the research findings that were generated up to that point (Mama & Hennessey, 2013).

The purpose of case studies is to emphasize interpretation and understanding (Stake, 1995). The purpose of this case study is to help teachers, district administrators, and educational researchers in elementary education contexts understand the challenges and requirements of effective technology integration into modern classrooms. Three research questions guided this inquiry: (Q1) What are the experiences of grades 1-3 teachers trying to integrate technology? (Q2) What beliefs do grades 1-3 teachers have, connected to technology integration? (Q3) What other factors affect how grades 1-3 teachers integrate technology?

Summary of Research Findings

Research findings were presented through profiles of each teacher and what was learned from their respective additional sources. The profile of each teacher in conjunction with additional sources of information was used to construct a rich narrative description for each teacher's context, aimed at helping understand the reasons why teacher might hold a certain belief or exhibit certain practices. Following the narrative, themes that developed from the 73 codes generated through a values coding method (Saldana, 2016) were explored. Based on the themes present, these teachers' technology integration efforts were connected to issues of pedagogy and focus on their students, technology knowledge, technology

as a barrier, schools as ecosystems, teachers' needs, and change management. These themes tie back to the research questions (Q1, Q2, Q3) that guided the inquiry.

Q1: Teacher technology integration experiences. When trying to integrate technology, these teachers have a range of experiences. 45 of the 73 codes were directly connected to issues of practice. Given the unique combinations of student needs and abilities, school and community cultures, teachers' own pedagogical and technology beliefs coupled with varying levels of resources, there is no universal model of technology integration for teachers to follow as of this writing. Pragmatically, teachers can be left largely to themselves to integrate technology, as seen with Lori and Terry or have some administrative guidance as shown by Kathy's experience, but teachers would still likely need to give pedagogy their primary attention.

A unifying theme that cut across all of these factors is that these teachers focus on technology to facilitate developmentally appropriate learning experiences as part of pedagogical requirements in the classroom. In practice, teachers are using technology to differentiate instruction, foster an independent work ethic, or to include additional media or game playing opportunities. However, these uses are all tied to pedagogy.

In practice, not everything goes well when integrating technology into a classroom. Product design failures mean that technology might actually create barriers for students. Being part of a complex system, teachers sometimes must address other factors that cannot be met with technology, and addressing those

needs may take away resources from technology integration or even teaching. There is also an issue that trying new things can be difficult, especially in light of the resource constraints present in so many schools.

Q2: Teacher technology integration beliefs. Teachers hold many beliefs about technology, with 28 of the 73 codes connected to beliefs. These beliefs can be positive or negative towards the use of technology. When technology is imposed upon them, these teachers felt as though they have too little autonomy, and especially so when the technology doesn't perform as desired or meet expectations. This can be seen with Kathy's experiences of the ThinkMath curriculum and the problems it generated for her students. Kathy felt that she would have likely selected a different curriculum, given the option to do so.

These teachers also believed that in the context of working with their students, technology is often not the best tool to meet students' needs or to best support them, and there are a variety of possible reasons why. Students need to feel valued and part of a community, and these teachers believed that technology cannot replace interpersonal relationships or social experiences when building relationships. These teachers also strived for a balance between screen time and hands on opportunities, and so retained analog experiences their students found engaging due to preference or because the task at hand was easier to complete using analog media.

Conversely, when these teachers believed that technology would lend a positive experience for students, they embraced it and found ways to make it work.

Directly connected to student work, teachers may believe technology could increase creativity afforded to students in a given assignment, that gameplay may be more engaging for students, or additional choice of media would facilitate students' demonstration of what they know. Indirectly connected to technology teachers may believe that technology would help improve the efficacy of their instruction such as through increased fidelity of information via tech-based literacy assessments, or with a pedagogical shift that helped leverage technological affordances such as a flipped classroom model that grouped students by ability level and mastery of pretest material.

Q3: Other factors affecting technology integration. Two specific factors arose from this data that weren't covered in literature, but bear additional consideration. The first factor is that as a subset of technology knowledge, knowing when *not* to use technology is a valuable asset for teachers. Trying to force fit a technology into an instructional design without having a deeper reason why can introduce its own set of problems. The second factor is that when trying new pedagogical methods, especially when facilitated by technology, the resulting model looks very different from what many stakeholders experienced as students themselves. This disparity can result in resistance from parents, families, or other community members because the technology-facilitated model seems so different than their own experience of what school should be like. Ultimately, this disparity raises the potential for stakeholders to view technology-integrated learning as not real learning and diminishing support for technology integration efforts.

Conclusions

Each of the three teachers participating in this study taught within very different contexts that would make a universal technology integration model difficult at best to use. The primary focus on pedagogy in these teachers' practices and beliefs reflects the resource constraints they experienced because of the time and effort required to teach in their respective contexts. In short, these teachers focused on teaching methods first because that was what they had adequate resources to do. When considering technology to use with students, participants used technology knowledge to situate the technology within their teaching practice. Participants encountered barriers directly with technology when it or its design created problems for students and indirectly when students' families were unable to adapt to new models of instruction that took advantage of technology but looked very different than past modes of instruction.

Limitations of the Study

This study has three distinct limitations that should be kept in mind if applying the conclusions elsewhere. First the study has a small sample size, with an *n* of 3, which limits the transferability of the conclusions. The teachers in this study had a wide range of experiences and beliefs, so it would seem reasonable to expect that another set of three teachers would also have a wide range of beliefs and experiences which may not overlap at all. Thus, a solution designed for the teachers in this study may not be applicable to other contexts. Closely connected to small sample size is the concentrated geography of this study.

While efforts were made to ensure that the schools represented a diverse student body and teaching traditions, the research was limited in geographic scope. It is certainly possible that different educational traditions, priorities, and resources of communities beyond the scope of this research would contribute to contexts with enough difference to impact teacher beliefs and practices. The resulting differences in beliefs and practices could then make for a set of needs very different than those observed during this study. There is also a limitation of researcher bias.

My own experience as a teacher, and especially my views on pedagogy, should be considered a limitation of this study. Within my own teaching practice, I have a decade of experience teaching pre-service K-12 teaching licensure candidates ways to use technology within their future classrooms. Figure 5.1 illustrates how my focus on pedagogy differs from the original TPACK (Mishra & Koehler, 2006) diagram. Given that the content I am teaching about is largely technology itself, the content knowledge and technology knowledge domains overlap significantly more than in typical teaching scenarios. Furthermore, technology itself changes frequently, meaning that if I am to meet the needs of students the

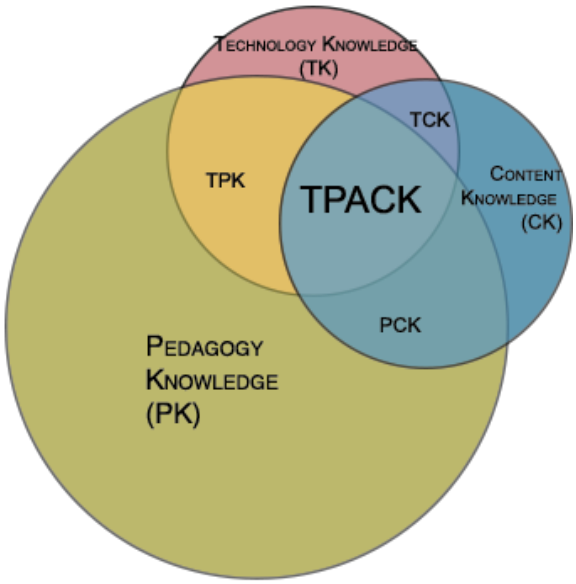

Figure 5.1. Personal TPACK diagram. This figure illustrates my own relationship with, and usage of, TPACK in my own teaching.

technologies I suggest for students must remain dynamic which necessarily limits my knowledge of newer technologies. Additionally, the courses I teach attract licensure candidates from across the K-12 teaching spectrum, so I must maintain a broad sense of what different the content areas of teaching might use for technologies. As a result, I find that pedagogy is by far the most important element of TPACK within my practice. Being attuned towards the role of pedagogy may have influenced the attention paid to the role of pedagogy with the teachers in this research.

Recommendations

The participants in this study all reported that formal academic models of technology integration did not enter into their teaching, with only one teacher even vaguely aware of a model's existence at all. When combined with the uniqueness of each teaching context once factors such as student needs, school resources, and district priorities perhaps practicing teachers could be better served through models rooted in the classroom and their experiences. As such, my recommendations from this study are aligned to the themes generated earlier: pedagogy and focus on students, technology knowledge, technology as a barrier, school as ecosystem, teachers' needs, and change management.

Theme 1: Pedagogy and focus on students. Pedagogy was of primary importance for these teachers, and all of the subsequent themes connected to it. This suggests that future work on technology integration for teachers should be embedded in teaching methods to be effective. Pre-service teacher technology

preparation could be taught within methods courses. Professional development within schools could be embedded within the classrooms themselves, with individualized feedback and recommendations for each teacher. Skill-based technology integration work, such as how to use a particular iPad app or software package could be administered by online video rather than using a conventional workshop model.

Theme 2: Technology knowledge. Increased technology knowledge may enable teachers more ways to use technology to meet students' needs and also enable additional autonomy if more knowledgeable teachers were included in high level technology-integration related decisions. Increased technology knowledge could also reduce the need for technology support, mitigating a teacher need. In connection with the *school as ecosystem* theme, increased feedback and technology knowledge could enable teachers to try out models such as using students as primary tech support resources, which would help the students feel valued, give teachers more time and autonomy, and mitigate some need for adult tech support staff to maintain technology infrastructure.

Theme 3: Technology as a barrier. The large overlap of the codes in this theme suggests two possibilities. The first possibility is that increased technology knowledge could help mitigate the belief that there is only one way to use technology and broaden how teachers use the tools at their disposal. At the same time, given the context of the teachers' needs theme, simply adding static resources for teachers to increase their technology knowledge is unlikely to be effective. The

second possibility is that tech companies that are developing products for the education market could use professional educators as consultants. Having design input rooted in classroom experience could benefit both the teachers and the companies they work with. Teachers would be less likely to have to find workarounds due to design failures, and might even have a direct channel to figure out solutions when things do break, and companies would have higher quality products for their intended market while gaining a competitive advantage over companies without educators as consultants. The ultimate result could also be beneficial for students, since they would have better products to use during learning, potentially leading towards improved learning experiences. For example, using the onscreen calculator from Kathy's experience, a designer might do further use-case testing on different devices, or utilize different code to ensure the calculator can be moved around the screen without causing other problems. This finding suggests that perhaps designers who create products for the education community could adopt a more user-centered design philosophy (Norman, 2013) or at least conduct iterative testing with different devices as they become widely adopted to ensure that products remain usable (IDEO, 2015; Tsai & Chai, 2012).

Theme 4: School as ecosystem. Students have many needs that are often indirectly connected to learning, such as mental and physical health concerns, building healthy relationships with supportive adults, and very different experiences outside of school. The current model of US public schools means that schools are often the primary place where these services are delivered. Rather than

simply increasing the resources available within the existing model, perhaps a new model of what the school experience should be like is needed. This new model of schooling could not only consider factors such as individual criterion-based mastery of content as a basis for continuing on to new units of study or increasing difficulty, but also situate that learning within relationship building and social connectedness for students. Admittedly, a model like this constitutes a massive change to the existing system of US public education making it unlikely to gain enough support to be implemented.

Theme 5: Teachers' needs. Connected to students needing to feel valued and build a trust relationship with teachers as seen in theme 4 along with an increase in technology knowledge could enable teachers to have more autonomy and empower them to embrace more radical changes such as using students as tech support. In order to begin down this path however, school districts require more resources. US public school teachers spend an enormous amount of their time in classrooms in comparison to countries like Finland (Sahlberg, 2015). The result is that teachers don't have time to more deeply consider issues of technology integration because they are spending all of their available time in the classroom.

Theme 6: Change management. Lortie's (1975) apprenticeship of observation applied to both teachers and school stakeholders as seen in this study. Teachers' apprenticeship of observation may be overcome through a combination of increased technology knowledge and meeting their needs for resources such as time to more deeply consider technology integration. To address stakeholder preconceptions of

what school should be like and improve the process of change, it may be helpful to consider multiple elements from these themes in concert. For example, if teachers are able to build stronger trust relationships with their students, the students themselves could be de facto advocates within their families for innovations in learning that would be very different than what their families experienced. Increased teacher technology knowledge, especially through consulting work with tech companies, could be communicated through plain language centered on what benefits students might realize through new models of learning, thereby focusing on the learning experience rather than the technology itself.

Future Directions

An advanced model. The current models of technology integration have not made significant impact to the ways teachers consider technology in their practice. Given the unique, complex nature of each individual classroom, it is possible the current models of integration are of limited use because they are too generic. Therefore, a future direction for this research could include the development of a meta-model of technology integration. This meta-model would take individual teacher beliefs, needs, pedagogies and contextual factors into account before guiding teachers towards a plan that embeds technology integration within the act of teaching. Based on the importance of individual classroom differences seen in this study, however, any future model of this type could have limited transferability, but attempts at universal design or application are likely to undermine the effectiveness of the model.

Teacher preparation changes. Given the impact that belief systems have on teaching practices, teacher education programs may look to change their technology-related focus to one of helping teacher candidates look at both how and why they can use technology in their own practices. For example, my own course with pre-service teacher candidates is an experience-based course designed to show students what technology can do, offering ways to use technology to demonstrate their own learning, all while simultaneously pushing students to challenge their own beliefs about what technology can and should do. The likely next step would be to help them align their beliefs about technology with pedagogical strategies while helping them develop technology knowledge to continue interrogating uses of technology once they are in their own classrooms.

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Appendices

Appendix A: Case Study Criteria Generator

A purposeful sampling technique is one in which samples are taken in order to discover, understand and gain the most insight of the phenomena (Merriam, 1998). The criteria below both list the criteria as well as show the purpose and justification for including that criterion in the sample. Additionally, there are factors listed at the end which will not necessarily be used to select participants, but that will be noted in the research write up in order to provide a more holistic picture of the contexts each participant works in.

1. Practicing K-12 teacher
    a. Grade level not as important, in order to find what works in older grades and use with younger i.e., not reinventing the wheel
2. Diverse student population within the classroom
    a. A process developed from this research should be widely applicable, and the vast majority of classrooms in K-12 in the US are diverse environments.
    b. Diversity can be defined racially, socioeconomically, or on an achievement basis. Not all three factors need be present for a classroom to be selected.
    c. It is possible that a classroom will be included because it provides an increase in variability, leading to richer data and, ultimately, more reliable results (Glaser & Strauss, 1967; Patton, 2000).
3. Resource and time constraints require locations within 50 miles of Saint Paul campus
    a. This is a function of limited resources, and is a constraint present in most any research. I don't believe this to be a factor limiting the scope of the research, since the other criteria listed here are covered within
4. Participants must be willing and able to have me observe in their classroom as a participant-observer. Without this access, critical data can't be obtained.
5. Sample size target of 2-4 participants
    a. More participants may need to be engaged, assuming some may drop out, or just not work due to factors beyond our collective control
    b. May use some aspects of network sampling, assuming that network referrals also meet the criteria of the research.

There are also factors that will be noted, but are not necessarily limiting for participant selection

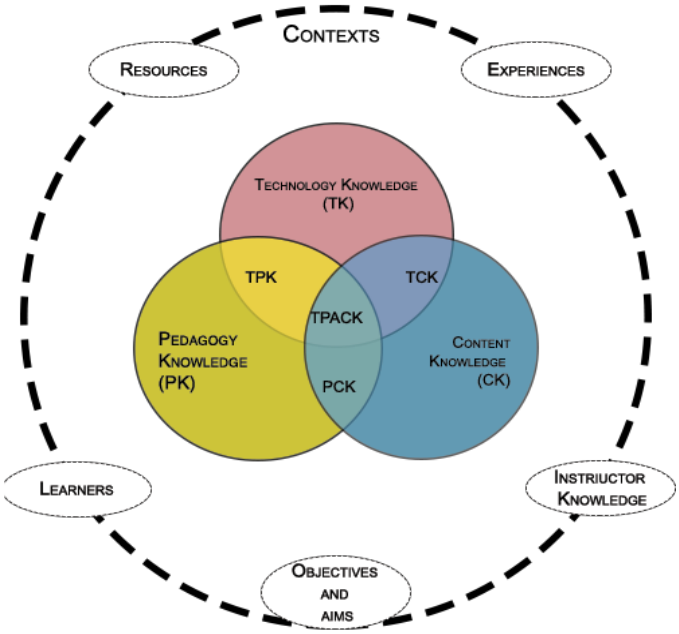
1. Levels of parental and/or community support for technology integration.
    a. This is variable across the whole of the public school environment in the US. While it is an important factor that may be an indicator as to what a teacher's technology integration process looks like, it will not be used to select participants.

2. Resources available for technology integration
    a. Assuming that the criteria above are met, the levels of resources available to a teacher will not be used to select individuals. Local resources are often made available when positive results are seen. While resource levels are important to how a teacher performs in the classroom, resources are variable, and are often made available once once positive changes are seen, with leadership changes, or with innovative practices.
3. Career development
    a. Early career teachers, defined as those with 4 or fewer years of experience, constitute approximately 16% of all elementary teachers (NCES, 2016b). Early career teachers are also the most vulnerable in terms of job loss, and element of pragmatic value from this research may be to help them bolster their technology integration skills. Given the turnover of later career teachers, this number is expected to increase over the coming years. As such, inclusion of early career teachers is essential to providing a tool that is applicable to the current state of the teaching field.
    b. Direct experience as a teacher educator suggests that late career teachers, defined as those with 10 or more years of teaching experience, are the ones doing the most innovation. This group of teachers also constitutes a majority of elementary school teachers, with a total of 57% (NCES, 2016b). They are more secure in terms of employment and tenure, have a depth experience behind them when it comes to classroom innovation, and are more likely to have the foundational elements of teaching, such as classroom management and pedagogical development, established. With this level of work already done, there is more mental space for change within the teacher's work.
    c. Selection will include *both* early and late career teachers, to provide for variability and richness in the sample.

Appendix B: Semi-structured Interview Protocol

Adapted from Doering, et al, 2014 and Anderson & Groulx, 2015

1. Tell me about the process you use when considering integrating technology into a lesson, unit, or your teaching as a whole.
2. For some teachers, technology has greatly impacted their teaching. Others, there hasn't been much impact. What's your experience with using technology in your teaching?
3. Tell me about how much it matters if a technology seems easy to use and if you think it be of value to your students.
4. What can you say about what technology can do in terms of learning for your students?
5. What are some challenges you currently, or expect to face in the future, about using technology in your teaching practice?
6. What can you tell me about the support you receive for integrating technology in your classroom?
7. With technology becoming an increasingly important part of daily life across most aspects of our society, what roles do you think teachers and formal education should play in teaching learners about using technology? Is there room for that role in a modern classroom with modern challenges?
8. What would you say are your beliefs about technology, as it relates to using technology in your teaching? Where would you say those beliefs were formed?
9. Where might you place yourself on this diagram, showing the intersections of pedagogy, content, and technology integration? Tell me more about why you think that.



Appendix C: Observation Protocol

Observation protocol

Teacher: _____

Subjects observed: _____

Grade: _____

Date: _____

School: _____

Time: _____

General School culture notes:

Lesson observed:

1. Student info

#students:____

Room arrangement: (see photos)

Student grouping:

- ☐ Independent work
- ☐ Learning Center(s)
- ☐ Pairs
- ☐ Small Groups
- ☐ Whole Group
- ☐ Workshop
- ☐ Other

2. Teacher Technology Use

- ☐ Activate Prior Knowledge
- ☐ Assessments
- ☐ Cues, questions, organizers
- ☐ Demonstration
- ☐ Differentiated Instruction
- ☐ Facilitation/Guiding
- ☐ Lecture
- ☐ Providing Feedback
- ☐ Questioning
- ☐ Reinforcing/recognition
- ☐ Scaffolding
- ☐ Setting objective
- ☐ Summarizing
- ☐ Other

3. Assessment Methods(Technology used)

- ☐ Oral Response
- ☐ Product
- ☐ Performance
- ☐ Selected Response
- ☐ Written Response
- ☐ Other

4. Technology used during observation (code T/S for Teacher or Student)

5. Technology being used for…

	Teacher	Student	TPACK	Notes
Problem Solving (e.g., graphing, design)				
Communication (e.g., document prep)				
Information processing				
Research				
Personal Development				
Group Productivity				
Formative Assessment				
Summative Assessment				
Brainstorming				
Computer-Assisted instruction				
Face to face classroom discussion				
Face to face group discussion				
Asynchronous discussion				
Drill and practice				
Generating/testing hypotheses				
Identifying similarities and differences				
Time/classroom management				
Summarizing/note taking				
Other				

6. Beliefs exhibited during observation

7. Questions

8. Big thoughts/epiphanies:

Appendix D: Participant Consent Form

DESCRIPTION: You are invited to participate in a research study on the beliefs, practices, and experiences of integrating technology in your teaching practice. You will be asked to participate in an initial interview, be observed in your classroom with audio/video recording possible, and then conduct a follow up interview. The purpose of this research is to both build a technolkogy integration process for grade 1-3 teachers and to provide a way for teacher voices to directly contribute to research and policy.

TIME INVOLVEMENT: Your participation will take approximately 5 hours across 2-6 weeks.

RISKS AND BENEFITS: There are no foreseeable risks associated with this study. Benefits to expect from this study include a certificate for 5 hours of professional development from the University of Minnesota, 5 hours of assistant time from the researcher in your classroom, and in situ professional development.

PAYMENTS: You will not receive payment for your participation.

PARTICIPANT'S RIGHTS: If you have read this form and have decided to participate in this project, please understand your **participation is voluntary** and you have the **right to withdraw your consent or discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled**. **The alternative is not to participate.** You have the right to refuse to answer particular questions. The results of this research study will be presented in academic databases. Your individual privacy will be maintained in all published and written data resulting from the study.

CONTACT INFORMATION:
Questions: If you have any questions, concerns or complaints about this research, its procedures, risks and benefits, contact the researcher, Derek Schwartz, at 612-206-5475 **or email schw0262@umn.edu.**

Independent Contact: If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the University of Minnesota Institutional Review Board (IRB) to speak to someone independent of the researcher at 612-626-5654 or email at hrpp@umn.edu. You can also write to the IRB board at: Human Research Protection Program, University of Minnesota, D528 Mayo Memorial Building, 420 Delaware St. Se, Minneapolis, MN 55455.

Consent indications:
Indicate ***Yes*** or ***No***:
I give consent to be interviewed during this study.
___Yes___No
I give consent to be audio recorded during this study.
___Yes___No
I give consent to be video recorded during this study:

___Yes___No

The extra copy of this signed and dated consent form is for you to keep.

SIGNATURE _____ DATE _____

Print name of participant _____

Appendix E: IRB Approval

UNIVERSITY OF MINNESOTA

Twin Cities Campus

Human Research Protection Program
Office of the Vice President for Research

D528 Mayo Memorial Building
420 Delaware Street S.E.
MMC 820
Minneapolis, MN 55455

Phone: 612-626-5654
Fax: 612-626-6061
Email: irb@umn.edu
http://www.research.umn.edu/subjects/

NOT HUMAN RESEARCH

May 2, 2017

Derek Schwartz

612-626-9285
schw0262@umn.edu

Dear Derek Schwartz:

On 5/2/2017, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title of Study:	Investigating technology integration processes in K-2 classrooms
Investigator:	Derek Schwartz
IRB ID:	STUDY00000158
Funding:	None
Grant ID:	None
IND, IDE, or HDE:	None
Documents Reviewed:	• Case Study Generator, Category: IRB Protocol; • Investigating technology integration processes in K-2 classrooms , Category: IRB Protocol; • Case Study Generator, Category: Other; • Interview Protocol, Category: IRB Protocol; • Interview Protocol, Category: Other;

The IRB determined that the proposed activity is not research involving human subjects. IRB review and approval is not required.

The IRB determined your planned activities described in this application do not meet the regulatory definition of research with human subjects and do not fall under the IRB's purview for the following reason:

Researchers will not obtain private identifiable information from living individuals [45CFR 46.102(f)]. Interviews of individuals where the questions focus on things not people (e.g. questions about policies, practice or procedures) do not require IRB review.

Although IRB review may not be required for case studies, you still may have HIPAA obligations. Please contact the Privacy Office at 612-624-7447 for their requirements.

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are being considered and there are questions about whether IRB review is needed, please submit a study modification to the IRB for a determination. You can create a modification by clicking **Create Modification / CR** within the study.

Sincerely,

Bri Warner
IRB Analyst