BEESON, MELISSA WALKER, Ph.D. The Influence of Teacher Beliefs and Knowledge on Planning for Technology Integration in Technology-Rich Classrooms. (2013)
Directed by Dr. Barbara B. Levin. 266 pp.

The purpose of this qualitative study was to examine the decisions three teachers made to integrate technology in technology-rich elementary classrooms. An additional purpose of this study was to understand how the teachers' beliefs about technology and their knowledge of content, pedagogy, technology, and learners influenced the decisions they made during planning for technology integration. Guiding the study was a conceptual framework that suggests that both teachers' beliefs about their technology and their knowledge of learners influence teacher decision-making during planning. Teacher beliefs are defined as the attitudes teachers have about teaching and learning (Pajares, 1992). Teacher knowledge is represented through the Technological Pedagogical Content Knowledge (TPCK) framework (Mishra & Koehler, 2006) situated within knowledge of learners. When teachers are thinking within the TPCK framework, they are concurrently considering what they know about technology, pedagogy, and content as they are making decisions about instruction. A multiple case study approach with within-case and cross-case analysis was used. Three teachers who were each awarded $20,000 grants for classroom technology participated in the study. Multiple data sources (interviews, observations, and lesson plan review) were collected and analyzed for emerging themes (within-case analysis). Three descriptive cases were written and then compared for common themes (cross-case analysis). The Think-Aloud method was used to understand the process of planning for each teacher when considering technology integration (Peterson & Clark, 1978; Peterson & Comeaux, 1990). Cross-case findings revealed that, when planning for technology integration, the teachers made decisions about a) the content they were teaching and the desired end result, b) the learners, and c) the technology tools. Beliefs about technology including a) technology engages students, b) students should be exposed to content through the use of technology, and c) students should be exposed to technical skills through the use of technology, influenced the decisions the teachers made when integrating technology. Strong technological knowledge also influenced the decisions the teachers made during planning. Data analysis suggested that the teachers were still developing their technological content knowledge (TCK) and technological pedagogical knowledge (TPK) (Mishra & Koehler, 2006) and relied mainly on technological knowledge to plan for the integration of technology. The study findings have implications for teacher educators, teachers, and school and district leaders. Specifically, teacher education methods courses need to explore ways to engage preservice teachers in thinking about the pedagogical affordances and limitations of using technology to teach the content. Additionally, technology professional development needs to take a curriculum-focused approach to technology professional development in order to support teachers as they develop their technological content knowledge (TPK) and technological pedagogical knowledge (TPK).

THE INFLUENCE OF TEACHER BELIEFS AND KNOWLEDGE ON PLANNING FOR TECHNOLOGY INTEGRATION IN TECHNOLOGY-RICH CLASSROOMS

by

Melissa Walker Beeson

A Dissertation Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
2013

Approved by

____

Committee Chair

To my husband, Travis, and my son, Zachary,

for your unwavering support and unconditional love.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair ________________________________

Committee Members ________________________________

____

____

____
Date of Acceptance by Committee

____
Date of Final Oral Examination

ACKNOWLEDGEMENTS

Thank you to my dissertation committee for the support and guidance you provided over the last two years. Dr. Ann Davis and Dr. Holt Wilson, thank you for the ideas, suggestions, time, and expertise you shared with me. Dr. Judith Howard, thank you for the support you've given me for the last seven years during my time in Elon's M.Ed. program and my time at UNCG. You have given me so much of your time through advising, being a reference, and serving on my dissertation committee and I will forever be grateful.

A special thank you to Dr. Barbara Levin, chair of my dissertation committee and my advisor all four years at UNCG. Thank you for your tireless support of my work. Our discussions and your comments on my work pushed me deeper than I ever knew I could think. I will always use you as a model for how I would like to be as a teacher educator and mentor.

I would also like to offer a special thank you to Dr. Ye He. Although you were not officially on my dissertation committee, I feel like you were an honorary member because of the support, guidance, and friendship you offered to me. I feel so fortunate to have worked with you the last four years and I hope that we continue to work together for many years to come.

Thank you to the three teacher participants of this study and the teacher participant of the pilot study for offering your time to me. I learned so much from all four of you. Thank you for sharing your lessons, and your hearts, with me so that I could do this study.

Also, thank you to my supportive family (the Walkers and the Beesons), especially my parents for always encouraging me to pursue my dreams. A special thank you to my Mom for being such a good Nana to Zachary so that I could collect data and write. Your support allowed me to finish, Mom, so I will always be thankful for your role in this dissertation.

Thank you to my little family- my husband, Travis, and my son, Zachary. Travis, only you truly know the time, and sometimes tears, that went into this work. Thank you for your unwavering support and unconditional love. Most importantly, thank you for not being an HC when I needed to write. Zachary, above any other title I could earn, I am most proud of the title you gave me, Mommy. Thank you for the smiles, laughs, hugs, and kisses that always put my stress into perspective. You inspire me to be the best mommy I can be.

TABLE OF CONTENTS

Page

LIST OF TABLES xi

LIST OF FIGURES xii

CHAPTER

I. INTRODUCTION 1

Rationale for the Study 3
Conceptual Framework..4
Research Questions...7
Research Design..8
Assumptions...9
Importance of the Study...9
Summary...10
Definitions...11

II. REVIEW OF THE LITERATURE 15

Introduction..15
21st Century Skills and the Common Core 16
The Partnership for 21st Century Learning 17
ISTE's National Educational Technology
Standards for Students (NET-S) 18
21st Century Skills in the Classroom...18
The Common Core 20
Frameworks for Technology Integration 22
Technological Pedagogical Content Knowledge (TPCK) 22
Other Frameworks for Technology Integration 25
Factors Influencing Technology Integration: Teacher Change 26
Knowledge 28
Self-efficacy..32
Pedagogical Beliefs 33
Culture 35
Facilitating Teacher Change 37
Research on 1:1 Initiatives..39
Apple Classrooms of Tomorrow...40
Significant 1:1 Laptop Initiatives 43
Other 1:1 Initiatives 50

Technology in the Content Areas 53
Technology and Language Arts 54
Technology and Mathematics 63
Technology and Music 73
Technology and Science 76
Technology and Social Studies 81
Utilizing Technology in the Content Areas 91
Technology and Diverse Learners 91
Universal Design for Learning (UDL) 92
Socioeconomic Status and the Digital Divide 94
English Language Learners 96
Exceptional Learners 98
Teacher Planning 104
Models of Lesson Planning 108
Teacher Planning for Technology Integration 112
The Influence of Knowledge and Beliefs on Planning for Technology Integration 114
Summary 116

III. METHODOLOGY 118

Research Design 118
Multiple Case Design 119
Research Questions 120
Setting 120
Oak Tree Elementary School 120
Hillendale Elementary School 121
Blue Ivy Elementary School 121
Participants 122
Innovation Grant 123
Hope Moore, Oak Tree Elementary School 124
Ella Rose, Hillendale Elementary School 124
Jan Richards, Blue Ivy Elementary School 125
The Pilot Case Study 128
Research Procedures 129
Data Collection 131
Teacher Interviews 132
Classroom Observations 135
Lesson Plans 135
Summary of Data Collection 136
Data Analysis 137
Within-Case Analysis 138
Cross-Case Analysis 140

Summary of Data Analysis 140
Validity and Reliability 141
Construct Validity 141
External Validity 142
Reliability 142
Ethical Issues 143
Researcher Role and Potential Bias 143
Summary 144

IV. FINDINGS 145

The Case of Hope Moore 145
Hope's 3rd Grade Classroom 147
Hope's Beliefs about Technology in the Elementary Classroom 148
Planning in a Technology-Rich Elementary Classroom 150
Factors Influencing Technology Integration 156
Summary 158
The Case of Ella Rose 158
Ella's 5th Grade Classroom 160
Ella's Beliefs about Technology in the Elementary Classroom 161
Planning in a Technology-Rich Elementary Classroom 163
Factors Influencing Technology Integration 169
Summary 170
The Case of Jan Richards 170
Jan's Music Classroom 172
Jan's Beliefs about Technology in the Music Classroom 175
Planning in a Technology-Rich Music Classroom 180
Factors Influencing Technology Integration 186
Summary 187
Cross-Case Analysis 187
What does Meaningful Technology Integration Look Like in a Technology-Rich Elementary Classroom? 187
What Kinds of Decisions Does the Teacher Make (and Why) When Planning for Technology Integration? 191
How do Teacher Beliefs Influence Planning for Integration of Technology in the Classroom? 194

How does a Teacher's Knowledge about Technology, Pedagogy, Content, and Learners Influence her Planning of Meaningful Lessons that Integrate Technology? ... 195
Summary of the Cross-Case Analysis ... 201

V. DISCUSSION AND IMPLICATIONS ... 202

Discussion of the Findings ... 202
Meaningful Technology Integration in Technology-Rich Classrooms ... 202
Decisions Made During Planning for Technology Integration ... 204
The Influence of Teacher Beliefs on Planning for Technology Integration ... 207
The Influence of Teacher Knowledge about Technology, Pedagogy, Content, and Learners on Planning for Technology Integration ... 209
Using TPCK and the Lessons from the ACOT Studies as a Framework for the Influence of Teacher Knowledge on Planning for Technology Integration ... 216
Developing TCK and TPK ... 217
Implications of the Study ... 223
Teacher Educators ... 223
Teachers ... 228
School and District Leaders ... 231
Limitations ... 233
Implications for Future Research ... 237
Additional Cases of Teacher Decision-Making during Planning ... 238
Technology Professional Development ... 238
Universal and Specialized Technology Tools in the Elementary Classroom ... 239
Technology Integration Addressing Specific Learning Needs ... 240
Conclusion ... 241

REFERENCES ... 242

APPENDIX A. INITIAL INTERVIEW PROTOCOL ... 260

APPENDIX B. INTERVEIW PROTOCOL ... 262

APPENDIX C. CONTACT SUMMARY 263

APPENDIX D. THINK-ALOUD INTERVIEW PROTOCOL.......................................264

APPENDIX E. OBSERVATION PROTOCOL...266

LIST OF TABLES

Page

Table 1. Comparison of 21st Century Skills Frameworks 18

Table 2. Stages of Concern (CBAM) (The National Academies, 2005) 39

Table 3. Stages of Instructional Evolution (Sandholtz & Reilly, 2004) 42

Table 4. Participants in the Study 126

Table 5. Technology in the Classroom 127

Table 6. Schedule of Observations 129

Table 7. Data-Planning Matrix 131

Table 8. Data Collected....136

Table 9. Start Codes for Within-Case Analysis 139

Table 10. Example of Cross-Case Analysis....140

LIST OF FIGURES

Page

Figure 1. Conceptual Framework 7

Figure 2. Framework for 21st Century Learning 17

Figure 3. Technological Pedagogical Content Knowledge (TPCK)..................................23

Figure 4. Expanded View of the Conceptual Framework..117

Figure 5. Data Coding for Within-Case and Cross-Case Analyses 138

Figure 6. Hope's Knowledge 196

Figure 7. Ella's Knowledge 198

Figure 8. Jan's Knowledge 200

Figure 9. Decisions Made During Planning...206

Figure 10. Reaching the Invention Stage...219

CHAPTER I

INTRODUCTION

As we move further into the 21st century, instructional technology is becoming more affordable and accessible to schools (Penuel, 2006; Warschauer, 2006; Windschitl & Sahl, 2002). Sensing the demand to produce global 21st century learners (International Society for Technology in Education, 2007; Partnership for 21st Century Learning, 2009), many schools are purchasing large amounts of technology, including creating 1:1 learning environments with tools such as laptops, tablets, or handheld devices. According to the National Center for Education Statistics (Gray et al., 2010), 99% of teachers either had one or more computers in their classrooms or could bring personal computers to school and 95% had daily Internet access in their classrooms.

Despite the fact that access to technology is almost universal in schools, technology is still underused in schools (Cuban, 2001; Grimes & Warschauer, 2008; Zhao & Frank, 2003). For example, of the 99% of teachers who had daily access to computers in their classrooms, only 40% reported using the computers often during instruction (Gray et al., 2010). One factor influencing the use of technology is teachers' knowledge of how to effectively integrate it into instruction. Levin and Wadmany (2006) acknowledge, "without teachers' skilled pedagogical application of education technology, technology in and of itself cannot provide innovative school practice and educational change" (p. 158). With careful consideration for the ways technology can support content and pedagogy, teachers could meet the various learning needs of students in their classrooms.

Along with their knowledge about technology and how to integrate it into their teaching, teacher beliefs play a large role in the way teachers integrate technology in instruction (Ertmer & Ottenbreit-Leftwich, 2010; Windschitl & Sahl, 2002). Teachers' pedagogical beliefs about technology integration often reflect their instructional practices (Angers & Machtmes, 2005; Ertmer, 2005; Ertmer, Addison, Lane, Ross, & Woods, 1999; Kemker, Barron, & Harmes, 2007; Lim & Chai, 2008), suggesting, for example, that a traditional teacher might use technology in traditional ways, including for drill and practice (Mouza, 2008). Often, beliefs about pedagogy and instructional practices remain the same for teachers, despite the amount of technology available to them (Cuban, 2001; Palak & Walls, 2009; Swan & Hofer, 2008). In fact, Zhao and Frank (2003) suggest that "unless a teacher holds a positive attitude toward technology, it is not likely that he or she will use it in teaching" (p. 809).

Given that less than half of the 99% of teachers who reported having daily access to computers in their classrooms use the computers often, and that teachers' knowledge and pedagogical beliefs influence technology integration, there is a need to examine teachers who *are* using the technology they have for meaningful instructional tasks. Meaningful instructional tasks can be defined as those that enable "students to construct deep and connected knowledge, which can be applied to real situations" (Ertmer & Ottenbreit-Leftwich, 2010, p. 257). One way to examine how teachers are meaningfully integrating technology is to observe the decisions they make when planning. Although articles on teacher planning discuss the thought processes and decisions teachers make when planning, few, if any, give rich description as to what that looks like in the planning process and in the classroom when teachers are considering the integration of technology. Therefore, the purpose of this multiple case study is to understand the thought processes and decisions three teachers make while planning to integrate technology into their lessons and how their knowledge and pedagogical beliefs affect those processes. I am also interested in describing how their planning plays out in the classroom based on my observations of three teachers who regularly integrate technology into their teaching, so this is another goal in this study.

Rationale for the Study

Currently, there is a gap in the research on how teachers plan for technology integration. Past empirical research offers examples of technology integration across content areas (e.g., Bos, 2009; Clements, 2002; Friedman, 2006; Hansen, 2008; Konold, 2002; Savage, 2007; Suhr, Hernandez, Grimes, & Warschauer, 2010; Woolsey & Bellamy, 1997; Yerrick & Johnson, 2009), as well examples of technology initiatives in schools (e.g., Barron, Harmes, & Kemker, 2006; Dunleavy, Dexter, & Heinecke, 2007; Garthwait & Weller, 2005; Grimes & Warschauer, 2008; Penuel, 2006; Sandholtz, Ringstaff, & Dwyer, 1997; Warschauer, 2006; Windschitl & Sahl, 2002). Research has also addressed the ways in which technology use supports diverse learners (e.g., Bray, Brown, & Green, 2004; Freeman, 2012; Hasselbring & Glaser, 2000; Hofer & Swan, 2008; Lee, 2006; Lewis, 1998; Shaunessy, 2007; VanTassel-Baska & Stambaugh, 2006; Watson & Watson, 2011). Finally, the factors that influence technology integration are commonly included in empirical research on instructional technology (e.g., Becker & Ravitz, 1999; Berg, Benz, Lasley, & Raisch, 1998; Ertmer, 2005; Ertmer et al., 1999; Ertmer, Ottenbreit-Leftwich, & York, 2006-2007; Levin & Wadmany, 2006; Miranda & Russell, 2011; Palak & Walls, 2009; Park & Ertmer, 2007; Windschitl & Sahl, 2002; Zhao & Frank, 2003). A more detailed discussion of this research is in Chapter II.

A few case studies (e.g., Beeson, 2011; Harris & Hofer, 2011; Hofer & Swan, 2008) offer descriptions of teachers thinking about technology, pedagogy, and content when planning for technology integration, but there remains a need to continue to examine how teachers' knowledge and beliefs about teaching and learning influence planning. This multiple case study of three teachers planning for technology integration in technology-rich classrooms is designed to contribute to the literature on how teachers plan for technology integration by sharing rich descriptions of the decisions the teachers made when considering integrating technology.

Conceptual Framework

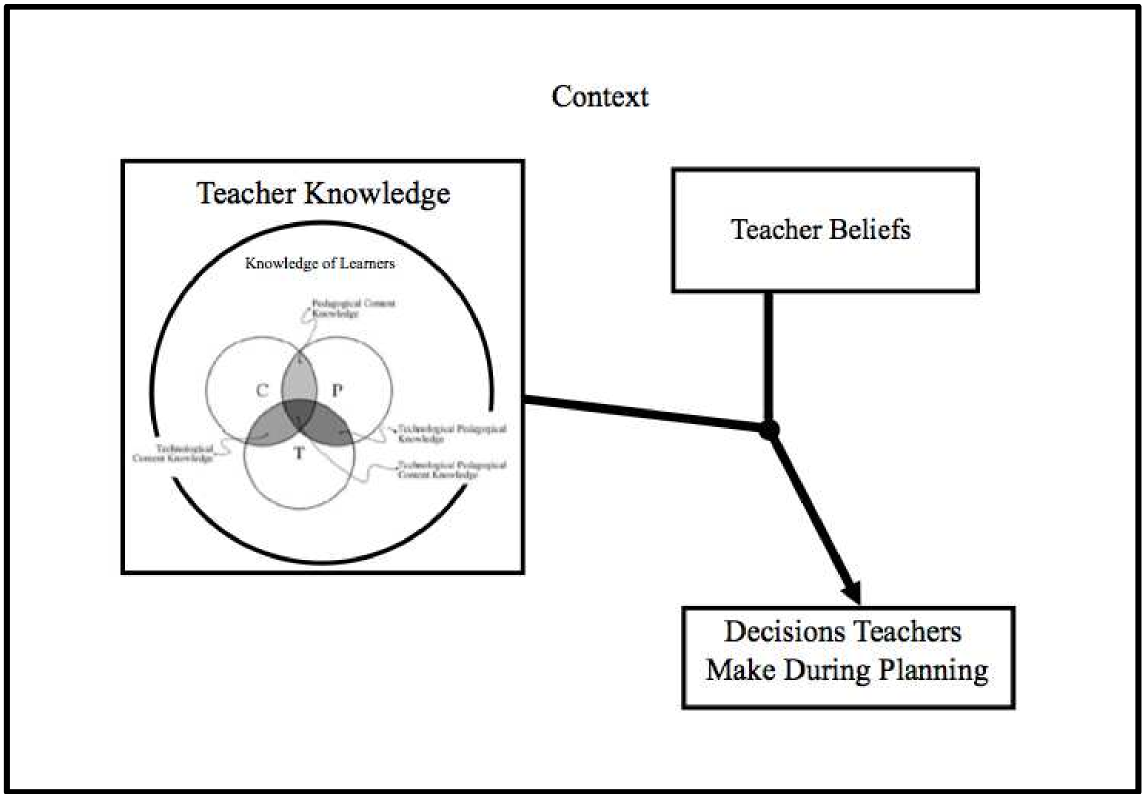
The conceptual framework guiding this study posits that teacher knowledge, as represented through the Technological Pedagogical Content Knowledge (TPCK) framework (Mishra & Koehler, 2006) and teachers' beliefs work together to influence the decisions teachers make during planning (Figure 1). First, teacher knowledge is represented in the conceptual framework as the interaction between the TPCK framework and teachers' knowledge of their learners. The TPCK framework represents the relationship between what teachers know about content, pedagogy, and technology. The TPCK framework is discussed in more detail in Chapter II, but to summarize, when teachers are thinking within the TPCK framework, they are concurrently considering what they know about technology, pedagogy, and content as they are making decisions about instruction. Although the authors of the TPCK framework locate knowledge of learners under pedagogical knowledge, I believe that teachers' knowledge of content, pedagogy, and technology, as well as the relationships between the three types of knowledge, all operate within the context of teachers' knowledge of learners. In short, I assume teachers are constantly thinking about what they know about their students as they are considering what they know about content, pedagogy, and technology.

Second, I believe that understanding teachers' beliefs about teaching and learning and their knowledge of content, pedagogy, and technology, can help to explain why particular instructional decisions are made because teachers' knowledge and beliefs strongly affect and predict their behavior (Angers & Machtmes, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Pajares, 1992; Penuel, 2006; Windschitl & Sahl, 2002). Teachers' beliefs are their attitudes about education, including teaching, learning, and students (Pajares, 1992). Together, teachers' knowledge and teachers' beliefs influence the decisions teachers make when planning for technology integration. For example, ideally, a teacher who has (a) sophisticated understanding of the content, and (b) can transform the content in multiple effective ways, while (c) appropriately using technology, as well as (d) believes that technology offers innovative ways for students to construct knowledge, most likely will see the use of technology as an integral part of her planning process. Whereas, a teacher who enjoys using technology and believes students should also use it, but lacks deep knowledge of the content and how to represent it in multiple ways, may struggle with ways to effectively plan for technology integration in her instruction. Similarly, a teacher who has strong pedagogical content knowledge (Shulman, 1986, 1987), but does not believe in the benefits of using technology in the classroom to teach content may also struggle when trying to integrate it during planning. These scenarios suggest that there is an interaction between teachers' knowledge and teachers' beliefs that influences the way teachers make decisions during planning and that neither knowledge or beliefs should be overlooked when considering how teachers plan.

While research addresses how teachers' beliefs impact the integration of technology (e.g., Becker & Ravitz, 1999; Ertmer, 2005; Ertmer et al., 1999; Ertmer, Ottenbreit-Leftwich, & York, 2006-2007; Levin & Wadmany, 2006; Palak & Walls, 2009; Windschitl & Sahl, 2002) and gives some examples of teachers thinking within the TPCK framework (e.g., Harris & Hofer, 2011; Hofer & Swan, 2008), there is currently a gap in the literature addressing how both teachers' knowledge and teachers' beliefs influence the decisions teachers make while planning as the conceptual framework for this study suggests. A detailed discussion of how the current literature informed my conceptual framework is in Chapter II.

Figure 1

Conceptual Framework



Research Questions

To understand how teachers make decisions during planning and how their knowledge and beliefs influence those decisions, the following research questions guided the study:

1. What does meaningful technology integration look like in a technology-rich elementary classroom?

2. What kinds of decisions does the teacher make when planning for technology integration?

2a. Why were those decisions made when planning for technology integration?

3. How do teacher beliefs influence planning for integration of technology in the classroom?

4. How does a teacher's knowledge about technology, pedagogy, content, and learners influence her planning of meaningful lessons that integrate technology?

Research Design

To understand the thought processes and decisions teachers make to plan for the integration of technology, I used a multiple case study approach with within-case and cross-case analysis. Three teachers who were each awarded $20,000 grants for classroom technology participated in the study. The participants were chosen based on their receiving the aforementioned grant awards and their willingness to participate in the study. Case study methodology offers a detailed look into each teacher as a bounded case, investigating a contemporary phenomenon, which in this study is their planning for technology integration over the course of one semester (Stake, 1995; Yin, 2009). Multiple data sources (interviews, observations, and lesson plan review) were collected and analyzed for emerging themes (within-case analysis). Three descriptive cases were written and then compared for common themes (cross-case analysis). Data collection and data analysis procedures are discussed further in Chapter III.

Assumptions

Based on my experiences as an elementary school teacher, my experiences as a technology lead teacher, my knowledge of current research in instructional technology, and my practical knowledge of instructional technology, I have three assumptions about the teacher participants in this study. First, because the three teacher participants were awarded large technology grants based on applications that presented how they would integrate the technology with their respective curriculums, I assume that these teachers will plan for the integration of technology. Second, I assume that the teacher participants will not articulate their planning specifically through the TPCK framework (Mishra & Koehler, 2006), but will plan while simultaneously thinking about content, pedagogy, and technology. However, this assumption, as my other assumptions begs for empirical research. Finally, as experienced teachers, I assume that the teacher participants will consider what they know about the learners in their classrooms as they are planning for technology integration. Based on this last assumption, teacher knowledge in the conceptual framework is represented as the TPCK framework within the context of knowledge of learners (Figure 1).

Importance of the Study

As instructional technology continues to become increasingly accessible to teachers and students, the idea that students are digital natives (Prensky, 2001) with native-like fluency and ease with using technology is becoming ubiquitous to the field of education. Therefore, students' learning needs must be recognized through thoughtfully planned technology integration in K-12 classrooms. If technology is underused in most schools, despite being accessible to teachers (Cuban, 2001; Grimes & Warschauer, 2008; Warschauer, 2006; Zhao & Frank, 2003), then maybe we need to look beyond the barrier of access when considering why teachers do not integrate technology consistently or effectively. Both teachers' knowledge and teachers' beliefs influence the way teachers integrate technology in instruction (Angers & Machtmes, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Koehler & Mishra, 2008; Mishra & Koehler, 2006; Pajares, 1992; Penuel, 2006; Windschitl & Sahl, 2002) suggesting that both need to be considered when studying how teachers plan for technology integration.

Summary

The purpose of this study was to understand the thought processes and decisions teachers make to integrate technology into their lessons and how their knowledge of content and of students, their pedagogical beliefs, and their knowledge of and access to technology affect those thought processes. A multiple case study with within-case and cross-case analysis allowed me to present a detailed description of how three teachers in technology-rich classrooms planned for the use of technology within the elementary curriculum.

Chapter II will review the literature in instructional technology and teacher planning as related to the study's conceptual framework. Chapter III will describe the research design of the study and explain the methods followed for data collection and data analysis. Chapter IV will present the findings for individual teachers as separate cases, and then the results of a cross-case analysis. Chapter V will discuss implications for teacher educators, teachers, and administrators, as well as possible directions for future research.

Definitions

Within the context of this study, the following definitions are used:

21st century skills: Skills students need to be globally competitive upon graduation, including creativity and innovation, collaboration, communication, and critical thinking skills (problem-solving and decision-making). Two national frameworks guide teachers in promoting 21st century skills in instruction: The Partnership for 21st Century Learning's Framework for 21st Century Learning (2009) and the International Society of Technology in Education's National Educational Technology Standards for Students (ISTE's NETS-S) (2007). I will be using the above named 21st century skills as start codes when analyzing my interview and observation data.

Common Core State Standards: The Common Core Standards aim to provide a consistent national framework for preparing students for college and the workforce in the 21st century (Common Core Standards Initiative, 2010). The standards "establish consensus on expectations for student knowledge and skills that should be developed in grades K-12" (Porter, McMaken, Hwang, & Yang, 2011, p. 103). Adopted by North Carolina in 2010, the Common Core State Standards were expected to be used by teachers in Language Arts and Math beginning in the 2012-2013 school year, the same year of data collection.

Meaningful instructional tasks: Instructional tasks which enable "students to construct deep and connected knowledge, which can be applied to real situations"

(Ertmer & Ottenbreit-Leftwich, 2010, p. 257). Observations and interviews will be analyzed for examples of deep, connected, applied, and real applications of knowledge learned through the use of technology.

Meaningful learning: As defined by Jonassen, Howland, Marra, & Crismond (2008), meaningful learning includes students being engaged in a task that involves active, constructive, intentional, authentic, and cooperative activities (p.2). Jonassen et al. (2008) posit that when technology is used to "engage students in active, constructive, intentional, authentic, and cooperative" ways, "the students will make more meaning" of the learning (p. 2). Activities observed or talked about in interviews that are active, constructive, intentional, authentic, or cooperative will be coded as such.

Teachers' beliefs: Teachers' attitudes about education, including teaching, learning, and students, are generally referred to as teachers' beliefs (Pajares, 1992). Teachers' beliefs tend to reflect their practices, including the ways they integrate technology (Angers & Machtmes, 2005; Ertmer, 2005; Ertmer et al., 1999; Hermans, Tondeur, van Braak, & Valcke, 2008; Kemker, Barron, & Harmes, 2007; Lim & Chai, 2008).

Teacher knowledge: Teacher knowledge about teaching practices and students is commonly represented through Shulman's (1986, 1987) pedagogical content knowledge (PCK) model. In the 21st century, teacher knowledge has been represented through the Technological Pedagogical Content Knowledge (TPCK) model (Mishra & Koehler, 2006). It is suggested that, in order for teachers to effectively integrate technology, they need to have knowledge of the relationship between the content they are teaching, the best practices for teaching the content, and the technology they are using (Ertmer & Ottenbreit-Leftwich, 2010; Koehler & Mishra, 2008; Mishra & Koehler, 2006).

Teacher planning: Clark and Peterson's (1986) definition of teacher planning is used in this study:

> Teacher planning includes the thought processes that teachers engage in prior to classroom interaction but also includes the thought processes or reflections that they engage in after classroom interaction that then guide their thinking and projections for future classroom interaction. (p. 258)

Therefore, I will attend to coding the participants' thoughts and actions while planning during the preactive, interactive, and pos-active phases of teaching.

Technological Pedagogical Content Knowledge (TPCK): The Technological Pedagogical Content Knowledge (TPCK) framework represents the relationships among a teacher's knowledge about technology, pedagogy, and content (Mishra & Koehler, 2006). In this framework, types of knowledge that teachers possess are briefly defined as: content knowledge is knowledge about the material being taught; pedagogical knowledge is knowledge about the processes and methods of teaching, and learning, and the knowledge of learners; technological knowledge is knowledge about new and old technologies; and TPCK is the relationship formed among the three types of knowledge.

Technology: Technology includes any tools for advancement, such as the pencil. However, for the purpose of this study, the term technology refers to digital technologies, such as computers, interactive whiteboards, tablets, or other devices controlled by a computer or computer chip, as well as Web 2.0 tools.

Web 2.0 tools: Web 2.0 tools are interactive and allow users to contribute information rather than just receiving information. Examples of Web 2.0 tools include blogs, wikis, message boards, and websites that allow sharing and creation such as YouTube (http://www.youtube.com/), Glogster (http://www.glogster.com/), and VoiceThread (http://voicethread.com/). Web 2.0 tools typically promote the 21st Century skills of communication and collaboration.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

This literature review examines the research done on elements of teacher planning and technology integration, beginning with 21st Century Skills as the overarching skills that all students are expected to have to compete globally for jobs. Second, two frameworks for technology integration are reviewed, focusing on the Technological Pedagogical Content Knowledge (TPCK) framework (Mishra & Koehler, 2006), which will guide data analysis in this study. Considering that teachers face barriers to technology integration, the third section of the literature review examines factors that influence technology integration, such as teacher beliefs, and includes research on facilitating teacher change. After discussing why teachers may or may not integrate technology, the focus of the literature review shifts to how teachers integrate technology. The fourth section addresses research on 1:1 initiatives. Fifth, based on the teacher participants in this study, the use of technology in the following subject areas is reviewed: Language Arts, Mathematics, Music, Science, and Social Studies. Sixth, the ways in which technology is used to meet the needs of diverse learners is considered. The seventh section of the literature review focuses on both teacher planning in general and teacher planning for the integration of technology, the primary focus of this study.

Finally, a discussion of how the literature guided the study's conceptual framework is provided.

21st Century Skills and the Common Core

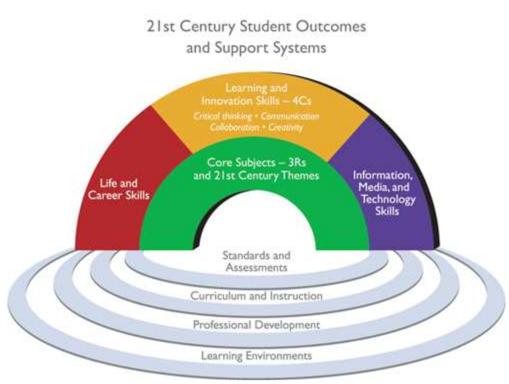
Businessmen, teachers, administrators and parents often use the term, 21st Century skills, when describing the need for preparing students who will be ready to compete globally for jobs upon graduation (Partnership for 21st Century Learning, 2009; Sardone & Devlin-Scherer, 2010). Two sets of national standards addressing 21st Century skills are available to guide teachers and administrators working to integrate technology into the curriculum. The first one was developed by the Partnership 21st Century Learning (2009), which suggests a framework that represents the skills and knowledge students need to be successful in their future lives. This framework includes the core subject areas, and promotes 21st century skills that include critical thinking and problem solving; communication, collaboration; and creativity and innovation (http://www.p21.org/). The second set of standards is from the International Society for Technology in Education (ISTE), which has developed technology standards for students (2007), administrators (2009), and teachers (2008) that integrate 21st Century skills (http://www.iste.org/standards.aspx). These standards are called the ISTE National Education Technology Standards, or the ISTE-NETS. North Carolina is currently reorganizing its standards to align with the Common Core Standards (Common Core State Standards Initiative, 2010) including their Information and Technology Essential Standards (2011) for Kindergarten through 12th grade. However, these standards focus less on technology skills, and more on the use of technology to support classroom concepts and activities (http://www.dpi.state.nc.us/curriculum/infotech/).

The Partnership for 21st Century Learning

The Partnership for 21st Century Learning (2009) offers the Framework for 21st Century Learning (see Figure 2). This framework suggests that student outcomes and student support systems are critical to preparing students in the 21st Century. Focusing on student outcomes, the Framework tells us that the skills, knowledge, and expertise students need to have to succeed as adults in the 21st Century include creativity and innovation, critical thinking and problem solving, and communication and collaboration. Of the Framework for 21st Century Learning's components, this study focuses on these Learning and Innovation Skills (Partnership for 21st Century Learning, 2009).

Figure 2

Framework for 21st Century Learning



ISTE's National Educational Technology Standards for Students (NET-S)

The International Society of Technology in Education (2007) also offers a framework for 21st Century learning through their National Educational Technology Standards for Students (NETS-S). In addition to the standards for students, standards are available for administrators (2009) and teachers (2008). These standards for students indicate that, in order to be successful in the 21st Century, students must be able to demonstrate creativity and innovation, communicate and collaborate, and think critically, solve problems, and make decisions (International Society for Technology in Education, 2007). Table 1 shows how the two frameworks closely align.

Table 1

Comparison of 21st Century Skills Frameworks

21st Century Skill	Framework for 21st Century Learning	ISTE NETS-S
Creativity and Innovation	✓	✓
Collaboration	✓	✓
Communication	✓	✓
Critical Thinking Skills ▪ Problem Solving ▪ Decision-making	✓	✓

21st Century Skills in the Classroom

There continues to be a need for empirical research addressing 21st century skills in the elementary classroom. Current research on 21st century skills is lacking in K-12, but several studies have addressed 21st century skills with pre-service teachers (Lambert & Gong, 2010; Sardone & Devlin-Scherer, 2010). For example, Lambert and Gong

(2010) used the ISTE NETS-S (2007) to restructure their technology course for pre-service teachers. The course moved from focusing on technology skills, such as word processing, to being guided by 21st century skills, such as collaboration and communication through the use of Web 2.0 tools. They found that the pre-service teachers became significantly less anxious about the use of technology and more confident in their ability to integrate technology into the curriculum after taking the course. Sardone and Devlin-Scherer (2010) also used 21st century skills to frame a course for pre-service teachers. The authors used the Partnership for 21st Century Learning's framework (2009) to guide the course, with the goal of having the pre-service teachers identify 21st century skills through the use of gaming. They found that, through the use of games, the pre-service teachers were able to identify ways to use games to encourage 21st century learning in their classrooms.

In addition, 21st century skills have been addressed in recent practitioner articles geared toward administrators and in-service teachers (e.g., Rotherham & Willingham, 2010; Sawchuk, 2009; Silva, 2009), as the promotion of 21st century skills remains a hot topic in K-12 classrooms among administrators, teachers, parents, and community members (Partnership for 21st Century Learning, 2009, Sardone & Devlin-Scherer, 2010). These practitioner journal articles tend to make a case for using 21st century skills in the classroom based on how they will prepare students to be globally competitive in the 21st century workplace, but they do so without citing specific classroom examples or empirical research. Therefore, more empirical research about what 21st century skills look like in the elementary classroom is needed to show teachers how to promote those skills because teachers need models from which to expand their knowledge and pedagogy to include technology.

The Common Core

Coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) in collaboration with classroom teachers, administrators, and other educators, the Common Core Standards aim to provide a consistent national framework for preparing students for college and the workforce in the 21st century (Common Core Standards Initiative, 2010). The standards "establish consensus on expectations for student knowledge and skills that should be developed in grades K-12" (Porter, et al., 2011, p. 103). Porter et al. (2011) suggest that a national curriculum could present the following benefits:

> 1) Shared expectations. A national curriculum would offer consistency in what is expected of students.
>
> 2) Focus. A national curriculum could bring greater focus to what is being taught, improving the popular "mile wide and an inch deep" approach to the state curriculums.
>
> 3) Efficiency. A national curriculum would alleviate the development of standards by individual states. This could also improve the quality and applicability of instructional materials, professional development, and teacher education.
>
> 4) Quality of assessments. A national curriculum could provide for consistent assessments that could be delivered electronically. (p. 103-104)

However, empirical research still needs to be done in states using the Common Core Standards in order to see if a national curriculum does in fact provide these benefits to educators and students.

In June 2010, North Carolina adopted the Common Core Standards in K-12 Mathematics and Language Arts (Public Schools of North Carolina, n.d.). According to a search on the Public Schools of North Carolina website (http://www.ncpublicschools.org/), professional development on the Common Core Standards has been ongoing, most recently throughout the 2011-2012 school year. The Common Core Standards are expected to be used in planning and instruction by Math and Language Arts teachers during the 2012-2013 school year (Public Schools of North Carolina, n.d.). North Carolina's Common Core Standards for Math and Language Arts can be viewed on the Public Schools of North Carolina website (http://www.ncpublicschools.org/acre/standards/common-core/). North Carolina's Essential Standards for other subject areas can also be viewed on the Public Schools of North Carolina website (http://www.ncpublicschools.org/acre/standards/new-standards/). Because data for this study was collected during the 2012-2013 school year, it is important to keep in mind that the teachers were experiencing a transition in their planning from the North Carolina Standard Course of Study to the Common Core Standards. This transition will be addressed as related to the experiences of the three teacher participants in Chapter IV.

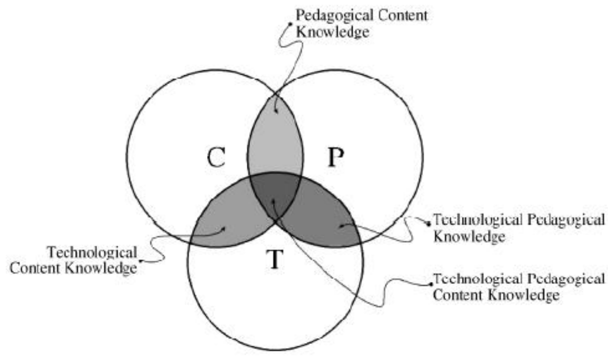
Frameworks for Technology Integration

Technological Pedagogical Content Knowledge (TPCK)

Modeled after Lee S. Shulman’s (1986) work on teacher knowledge, specifically teachers’ pedagogical content knowledge, the Technological Pedagogical Content Knowledge (TPCK) framework represents the relationships among a teacher’s knowledge about technology, pedagogy, and content (Mishra & Koehler, 2006). In this framework, types of knowledge that teachers possess are briefly defined as: content knowledge is knowledge about the material being taught; pedagogical knowledge is knowledge about the processes and methods of teaching and learning based on knowledge of students; technological knowledge is knowledge about new and old technologies; and TPCK is the relationship formed among the three types of knowledge. A visual representation of the TPCK framework is seen in Figure 3. When teachers are thinking within the TPCK framework, they are simultaneously considering what they know about technology, pedagogy, and content as they are making decisions about instruction.

Figure 3

Technological Pedagogical Content Knowledge (TPCK)



Defining technology integration. Rodney S. Earle (2002, as cited in Harris & Hofer, 2011, p. 227) suggests that technology integration is about more than just the technology:

> Integrating technology is not about the technology—it is primarily about content and effective instructional practices. Technology involves the tools with which we deliver content and implement practices in better ways. Its focus must be on curriculum and learning. Integration is defined not by the amount or type of technology used, but by how and why it is used. (p.8)

In the past few years, there has been more empirical research available regarding uses of the TPCK framework in the classroom as researchers are becoming increasingly interested in how this framework is translated into instruction. However, beliefs about pedagogy and instructional practices often remain the same for teachers, despite the amount of technology available to them (Cuban, 2001; Swan & Hofer, 2008). This dilemma is often attributed to barriers teachers face, such as lack of access, time, support, as well as beliefs about technology integration (Ertmer et al., 1999). However, any shift in the way teachers think about the role of technology in planning that can be observed through the presence of the TPCK framework needs to be empirically examined in classrooms.

Such examination is complex because as Hofer and Swan (2008) suggest, the TPCK framework in the classroom is a “moving target” (p. 196) and teacher knowledge varies from teacher to teacher. It is important to remember that teacher knowledge can be impacted by many factors including “culture, socioeconomic status, and school organizational structures” (Harris & Hofer, 2011, p. 213). In addition, the application/use of TPCK will vary depending on the situation, including the content being taught and the resources available. Mishra and Koehler (2006) also support the idea that teacher knowledge and the TPCK framework are not fixed entities:

> There is no single technological solution that applies for every teacher, every course, or every view of teaching. Quality teaching requires developing a nuanced understanding of the complex relationships [among] technology, content, and pedagogy, and using this understanding to develop appropriate, context –specific strategies and representations. (p. 1029)

Further, Hofer and Swan (2008) posit that teachers need to work within their own Zone of Proximal Development (Vygotsky, 1978 as cited in Hofer & Swan, 2008) in regard to content, pedagogy, and technology and the relationship between the three types of knowledge.

A few qualitative studies have sought to study the use of the TPCK framework in teacher planning and implementation of instruction (e.g., Beeson, 2011; Harris & Hofer, 2011; Hofer & Swan, 2008). These studies offer rich description of teachers thinking within the TPCK framework when planning for technology integration, but there remains a need to continue to observe the presence of the TPCK framework in planning and instruction, especially in the elementary classroom. However, challenges still remain in how to measure and represent the presence of TPCK in technology integration (Abbitt, 2011), which more research may remedy.

Other Frameworks for Technology Integration

The TPCK framework (Mishra & Koehler, 2006) is popular among researchers as a way to define teachers' knowledge of how to effectively integrate technology in the curriculum. Therefore, the TPCK framework will guide this study as I examine how teachers plan for the integration of technology within a technology-rich classroom. However, other frameworks for technology integration have been developed. For example, Groff and Mouza (2008) propose the Individualized Inventory for Integrating Instructional Innovations (i5) "to help teachers predict the likelihood of success of technology-based projects in the classroom and identify potential barriers that can hinder their technology integration efforts" (p. 21).

Groff and Mouza's (2008) i5 framework addresses the Context (school), the Innovator (teacher), the Innovation (project), and the Operators (students) and their relationship to the factors that influence technology integration, including, but not limited to, organizational culture and support, technology proficiency, and beliefs and attitudes (for a graphic representation of the i5 framework see Groff & Mouza, 2008). Broken into categories of 1 through 3, teachers scoring a 3 in technology proficiency, for example, would not be able to integrate the technology into their lessons while teachers scoring a 1 in technology proficiency would have the knowledge to effectively integrate the technology into instruction. By reviewing the i5 graphic before planning for a lesson integrating technology, a teacher could identify possible barriers to successful integration and address them prior to instruction (Groff & Mouza, 2008). The i5 framework is still being tested with teachers to determine its effectiveness in predicting possible barriers to technology integration. I will not be using this framework in this study because there is little empirical evidence supporting its predictive validity.

Factors Influencing Technology Integration: Teacher Change

According to the National Center for Education Statistics (Gray et al., 2010), 99% of teachers had one or more computers in their classrooms or were allowed to bring their own computer to school and 95% had daily Internet access in their classrooms based on a national survey given in the Spring of 2009. The ratio of students to computers in the classroom was 1.7 to 1. In addition to computers, teachers also listed items, such as projectors (36%), interactive whiteboards (28%), and digital cameras (64%) as being available to them on a daily basis. However, of the 99% of teachers who had daily access to computers in their classrooms, only 40% reported using the computers often during instruction (Gray et al., 2010).

If access to technology in the classroom is not the issue, then why do less than half of teachers who have technology available to them use it consistently during instruction? Research indicates that computers are underused in most schools, despite being available for instructional use (Cuban, 2001; Grimes & Warschauer, 2008; Zhao & Frank, 2003). Groff and Mouza (2008) suggest the following factors as influencing technology integration: (a) legislative factors, (b) district/school-level factors, (c) factors associated with the teacher, (d) factors associated with the technology-enhanced project, (e) factors associated with the students, and (f) factors inherent to the technology itself (p. 23). Since this study focuses on how teachers plan for technology integration, this section will focus on factors associated with the teacher.

When considering the ways teachers integrate technology, factors that influence this integration can be categorized as first order or second order barriers. Ertmer et al. (1999) suggest that barriers, such as lack of access, time, or support, can be classified as first-order barriers mentioned by teachers who struggle with technology integration. Teachers are often initially discouraged from using technology because of first-order barriers (Cuban, 2001; Grimes & Warschauer, 2008; Ertmer et al., 1999). Second-order barriers, which are intrinsic to teachers –such as their beliefs about teaching, integrating technology, classroom practices, and change- are more difficult to influence. In their study of factors that influence technology integration, Ertmer et al. (1999) noted that all of their teacher participants experienced the same first-order barriers, but that those barriers did not affect their integration of technology in the same way because their beliefs shaped the way they allowed first-order barriers to impact their instruction. Therefore, it is important to consider influences other than access to technology, or first-order barriers, when thinking about whether or not teachers integrate technology into their instruction. Furthermore, first-order barriers are becoming less common because access and support for technology integration have increased in schools (Ertmer et al., 1999). Gibbs, Dosen, and Guerrero (2009) suggest that “barriers to having technology integrated into the classroom remain, even with the added resources” (p. 13), therefore making the case that research needs to focus on second-order barriers that influence technology integration.

Roschelle, Pea, Hoadley, Gordin, and Means (2000) suggest that “teachers who succeed in using technology often make substantial changes in their teaching style and in the curriculum they use” (p. 91). Windschitl and Sahl (2002) also argue that “*teachers can and do change* their instructional practices when using technology” (p. 166). Ertmer and Ottenbreit-Leftwich (2010) posit that “when teachers are asked to use technology to facilitate learning, some degree of change is required” (p. 258) in some or all of the following areas: (a) pedagogical beliefs, (b) content knowledge, (c) pedagogical knowledge, and (d) knowledge of instructional materials. In order to understand this change in teachers, Ertmer and Ottenbreit-Leftwich (2010) suggest that there are four variables to consider when discussing teacher change: knowledge, self-efficacy, pedagogical beliefs, and subject and school culture.

Knowledge

Discussions of teacher knowledge have shifted in focus over time (Shulman, 1986). Tests of teacher knowledge in the 1870s highlighted content knowledge with minimal space allowed for questioning pedagogical knowledge. For example, on the 1875 California Teaching Exam only 50 of the possible 1000 points came from questions about pedagogy. It was clear that, to be licensed as a teacher, a depth of content knowledge in the areas being taught was most important (Shulman, 1986). By the 1980s, beliefs about what a teacher should know changed. Tests of teacher readiness focused on knowledge of pedagogy rather than content. Questions about time management, instructional tools, planning, and students' needs dominated the test, overshadowing questions about the content being taught (Shulman, 1986). A focus on pedagogy alone suggested that (a) there was not a relationship between content and pedagogy, and (b) knowing *how* to teach was more important than having a depth of knowledge about *what* to teach. For example, Shulman (1986) suggests that no one was thinking about "how subject matter was transformed from the knowledge of the teacher into the content of instruction" (p. 6).

Pedagogical Content Knowledge (PCK). Recognizing the need for a shift in the way we think about teacher knowledge, Shulman (1986, 1987) proposed a framework for teacher knowledge representing the relationship between content knowledge and pedagogical knowledge. When teachers have pedagogical content knowledge (PCK) they are able to make decisions about teaching strategies in relation to the content the strategies are representing. Shulman (1987) refers to pedagogical knowledge as a teacher's "own special form of professional understanding" (p. 8). Pedagogical content knowledge "represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p. 8). According to Koehler and Mishra (2008), essential to effective teaching is

> an awareness of common misconceptions and ways of looking at them, the importance of forging links and connections between different content ideas, students' prior knowledge, alternative teaching strategies, and the flexibility that comes from exploring alternative ways of looking at the same idea or problem. (p. 14)

Key to pedagogical content knowledge is the idea of a transformation occurring as the teacher interprets the content, finds multiple ways to represent it, and adapts instructional materials based on students' needs (Koehler & Mishra, 2008; Shulman, 1986, 1987). Shulman (1986) argues that "since there are no single most powerful forms of representation, the teacher must have at hand a veritable armamentarium of alternative forms of representation" (p. 9). Therefore, in order for these transformations to occur and for teachers to have multiple ways of representing content, teachers need to have pedagogical content knowledge.

Technology and teacher knowledge. With the steady growth of instructional technology in schools, another body of knowledge is recognized as being significant to teachers: technological knowledge. More recently, teacher knowledge has been represented through the Technological Pedagogical Content Knowledge (TPCK) model (Mishra & Koehler, 2006), which includes knowledge of technology. It is suggested that, in order for teachers to effectively integrate technology, they need to have knowledge of the relationship between the content they are teaching, the best practices for teaching the content, and the technology they are using (Ertmer & Ottenbreit-Leftwich, 2010; Mishra & Koehler, 2006). Ertmer and Ottenbreit-Leftwich (2010) recommend that teachers integrating technology have knowledge that allows them to (1) align technologies to specific learning goals; (2) choose technologies for various phases of the learning process; and (3) select appropriate technologies to address issues and needs.

Teacher knowledge of the technology they are using is more complex than just technical knowledge. In their longitudinal case study of a K-8 public school district rich with technology due to a state and federal Technology Innovation Challenge Grant, Sandholtz and Reilly (2004) found that teachers tended to integrate technology more frequently and successfully when the district focused their professional development plan on the curriculum, rather than on the technology. Capitalizing on the teachers' strengths in knowledge of curriculum and planning, the district was able to encourage teachers to integrate new technologies in their instruction. This was done through ample technical support by the district that maintained the teachers' primary role as teacher, rather than technician (Sandholtz & Reilly, 2004).

Ertmer and Ottenbreit-Leftwich (2010) caution us that teacher knowledge of technology is ever-changing, as they compare having a complete knowledge of technology to hitting a moving target. Since digital technologies are constantly changing, teachers can often feel like continuous novices in their knowledge of technology (Ertmer & Ottenbreit-Leftwich, 2010). Bransford, Brown, and Cocking (2000) suggest that "expertise in a domain helps people develop a sensitivity to patterns of meaningful information that are not available to novices" (p. 33). Expert teachers are said to have acquired pedagogical content knowledge (Bransford et al., 2000; Pierson, 2001; Shulman, 1986) and can make instructional decisions while operating within this framework. However, the addition of technological knowledge in the TPCK framework (Mishra & Koehler, 2006) offers a variable that sometimes turned expert teachers into novices again because technology is always changing.

Self-efficacy

The TPCK framework (Mishra & Koehler, 2006) as a model for teacher knowledge tells us that knowledge of content, pedagogy, and technology aid in the integration of technology. However, Ertmer and Ottenbreit-Leftwich (2010) suggest that, while teacher knowledge is an important factor influencing technology integration, self-efficacy could be more important than knowledge for teachers integrating technology in instruction. Self-efficacy can be defined as “people’s beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives. Efficacy beliefs affect how people feel, think, motivate themselves, and behave” (Bandura, 1993, p. 118). According to Bandura (1993), “Teachers' beliefs in their personal efficacy to motivate and promote learning affect the types of learning environments they create and the level of academic progress their students achieve” (p. 117). Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) define teacher self-efficacy as “the teacher’s belief in his or her capability to execute courses of action required to successfully accomplish a specific teaching task in a particular context” (p. 233).

Pajares (1996) explains that researchers “assess self-efficacy beliefs by asking individuals to report the level, generality, and strength of their confidence to accomplish a task or succeed in a certain situation” (p. 546). In her survey of 350 pre-service and in-service teachers, Moore-Hayes (2011) found that despite increasing availability of instructional technology, teachers were still hesitate to integrate it in instruction due to a lack of confidence in their ability to integrate it and an overall feeling of being unprepared to use the technology in the classroom. Moore-Hayes (2011) concluded that teacher self-efficacy is a determining factor in the amount and quality of technology integration. Exemplary technology using teachers tend to have higher self-efficacy in their ability to use technology (Pierson, 2001). Teachers need to feel confident in their ability to integrate technology while facilitating student learning, suggesting that time, such as during professional development, should be spent increasing teachers' confidence for using technology (Ertmer & Ottenbreit-Leftwich, 2010). This can be done by giving teachers time to experience the technology, pairing them with knowledgeable peers, creating professional learning communities, and aligning technology professional development with what teachers are currently doing in their classrooms (Ertmer & Ottenbreit-Leftwich, 2010). Ertmer and Ottenbreit-Leftwich (2010) summarize the literature on self-efficacy as saying that teachers who consistently integrated technology typically had high confidence in their ability to use the technology, even if their knowledge of the technology was not as strong.

Pedagogical Beliefs

Windschitl and Sahl (2002) suggest that "there can be no individual or institutional 'vision of technology use' that exists separately from beliefs about learners, beliefs about what characterizes meaningful learning, and beliefs about the role of the teacher within the vision" (p. 202), indicating that teachers' beliefs cannot be ignored when considering how and why teachers integrate technology into instruction. Research indicates that teachers' pedagogical beliefs about technology integration tend to mirror their practices (Angers & Machtmes, 2005; Ertmer, 2005; Ertmer et al., 1999; Hermans, Tondeur, van Braak, & Valcke, 2008; Kemker, Barron, & Harmes, 2007; Lim & Chai, 2008). Often, beliefs about pedagogy and instructional practices remain the same for teachers, despite the amount of technology available to them (Cuban, 2001; Palak & Walls, 2009; Swan & Hofer, 2008). Zhao and Frank (2003) suggest that “unless a teacher holds a positive attitude toward technology, it is not likely that he or she will use it in teaching” (p. 809).

Teacher beliefs as related to technology integration have been studied many times in the last decade (e.g., Becker & Ravitz, 1999; Berg, Benz, Lasley, & Raisch, 1998; Ertmer, 2005; Ertmer et al., 1999; Ertmer, Ottenbreit-Leftwich, & York, 2006-2007; Hermans et al., 2008; Levin & Wadmany, 2006; Miranda & Russell, 2011; Palak & Walls, 2009; Park & Ertmer, 2007; Windschitl & Sahl, 2002; Zhao & Frank, 2003). The study of teacher beliefs in general preceded the studies that include technology and suggests that there are many ways to define what teachers believe (Pajares, 1992). Pajares (1992) reminds us that beliefs are “deeply personal, rather than universal, and unaffected by persuasion. They can be formed by chance, an intense experience, or a succession of events, and they include beliefs about oneself and others alike” (p. 309). Teachers’ attitudes about education, including teaching, learning, and students, are generally referred to as teachers’ beliefs (Pajares, 1992).

Understanding teachers’ beliefs about education, including the integration of technology, can help to explain why particular instructional decisions are made because teachers’ beliefs strongly affect and predict their behavior (Angers & Machtmes, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Hermans et al., 2008; Pajares, 1992; Penuel, 2006; Windschitl & Sahl, 2002). Pierson (2001) suggests that “unless a teacher views technology use as an integral part of the learning process, it will remain a peripheral ancillary to his or her teaching" (p. 427). In a multi-case study of three teachers using technology in a one-to-one laptop middle school, Windschitl & Sahl (2002) found that the teachers' beliefs about teaching and learning greatly influenced their use of the laptops with the students:

> The influence of ubiquitous technology on instructional decisions was mediated in substantial ways by teachers' interconnected belief systems about learners in that particular school, about what constituted good teaching within the context of the institutional culture, and about the role of the technology in the lives of students. (p. 201)

In their study of primary school teachers in 68 schools in Belgium, Hermans et al. (2008) administered a questionnaire on teachers' beliefs as related to technology use and found that constructivist beliefs were a stronger predictor of classroom computer use and that, in contrast, traditional beliefs about instruction "seem to have a negative impact on the integrated classroom use of computers" (p. 1506).

Culture

Despite having the knowledge, confidence, and beliefs to integrate technology, teachers may still face second-order barriers (Ertmer et al., 1999) that hinder their success. Teachers often face pressures within their schools to conform to the school culture (Ertmer & Ottenbreit-Leftwich, 2010). If there is not a strong support for technology integration within the school by administration or teachers, teachers wanting to integrate technology may be negatively impacted. This pressure may also come from the subject or grade the teacher teaches. Teachers surrounded by discipline- or grade-level teams that do not believe technology has a place in their subject or grade may also be negatively influenced or deterred from trying to integrate new technology (Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007; Zhao & Frank, 2003). Subject culture can be described as the ‘‘general set of institutionalized practices and expectations which have grown up around a particular school subject, and shapes the definition of that subject as a distinct area of study’’ (Goodson & Mangan, 1995, p. 614). Teachers can be reluctant to adopt a new technology that goes against the norms of the subject culture (Hew & Brush, 2007).

In her in depth study of a North Carolina school district implementing a 1:1 laptop program in grades 4-12, Davis (2009) shared lessons learned from the program related to school culture, including strong school level leadership, community support, and the belief that change does not happen overnight. Strong, supportive school leadership is needed to be successful in a 1:1 laptop program (Corn et al., 2010; Davis, 2009). Davis (2009) argues that school leaders do not have to be technology experts, but should model technology integration and positively support its use during instruction. The key to strong leadership is that the teachers feel supported rather than pressured when integrating technology. Technology initiatives also have the power to bring together a school community as administrators, teachers, parents, community members, and students invest in the implementation of the initiative (Davis, 2009; Windschitl & Sahl, 2002), which can be beneficial to a positive school culture. Findings from the Apple Classrooms of Tomorrow project tell us that teachers embrace technology integration at varying degrees over time (Sandholtz et al., 1997) and other researchers have agreed that teachers need time to adjust to changes within a technology initiative (Corn et al., 2010; Davis, 2009; Holcomb, 2009).

Of course, it is important to consider positive peer pressure, as well. A school culture in support of technology integration may also positively influence teachers who are still facing second-order barriers (Ertmer & Ottenbreit-Leftwich, 2010). Pierson (2001) described exemplary technology using teachers as being “surrounded by colleagues who used computers for meaningful activities, enjoyed school- and district-level support for technology use, and had sufficient staff development opportunity” (p. 414). Understanding that change happens over time is important to the maintenance of a positive school culture when implementing technology initiatives.

Facilitating Teacher Change

Ertmer and Ottenbreit-Leftwich (2010) suggest that the facilitation of teacher change for the purpose of technology integration can be done through both teacher education programs for pre-service teachers and professional development for in-service teachers. Pre-service teachers in teacher education programs are still developing their beliefs about teaching and learning. As digital natives (Prensky, 2001b), pre-service teachers may be confident about how to use technology tools, but not as confident or knowledgeable about how to integrate those technologies in their instruction. Therefore, teacher education programs have the opportunity to influence teacher change through explicit instruction in planning for the integration of technology. An example of this would be through the use of the TPCK framework (Mishra & Koehler, 2006) as a way to think about lesson planning.

Teacher change can also be facilitated through professional development for in-service teachers. Unlike pre-service teachers, in-service teachers may already have established beliefs about using technology. In-service teachers may also consider themselves novices in their knowledge of technology and lack confidence in their ability to learn how to use new technologies. In addition to personal barriers, school culture may also influence the way teachers integrate technology. Because these factors affect the ways teachers approach technology integration, Ertmer and Ottenbreit-Leftwich (2010) suggest that professional development programs consider the following ideas when planning technology professional development:

(1) Align experiences with existing pedagogical beliefs and knowledge
(2) Provide examples of other teachers' successes emphasizing student outcomes
(3) Provide support for risk-taking and experimentation
(4) Expand the definition of "good teaching" to include technology integration (p. 276)

Ertmer and Ottenbreit-Leftwich (2010) also suggest that encouraging small changes based on the teachers' comfort levels may lead to larger overall changes in the way they approach technology integration.

When thinking about facilitating teacher change, it is important to think in terms of a continuum that challenges growth without overwhelming the individual. In addition to changing teacher knowledge, self-efficacy, beliefs, and culture, models of change give us checkpoints to consider as teachers adopt new technologies. For example, a popular model of change is the Concerns-Based Adoption Model (CBAM) (http://www.sedl.org/cbam/) that focuses on individual reactions to change (Schrum & Levin, 2009). The CBAM model includes seven stages of concern a teacher may experience (see Table 2; The National Academies, 2005).

Table 2

***Stages of Concern (CBAM)* (The National Academies, 2005)**

Stage of Concern	**Expression of Concern**
6. Refocusing	I have some ideas about something that would work even better.
5. Collaboration	How can I relate what I am doing to what others are doing?
4. Consequence	How is my use affecting learners? How can I refine it to have more impact?
3. Management	I seem to be spending all my time getting materials ready.
2. Personal	How will using it affect me?
1. Informational	I would like to learn more about it.
0. Awareness	I am not concerned about it.

The CBAM model encourages us to think about change as a process, rather than event, and that it is a personal experience for the individual (Horsely & Loucks-Horsley, 1998). Schrum and Levin (2009) suggest that this model is useful in planning professional development opportunities that facilitate teacher change.

Research on 1:1 Initiatives

One-to-one (1:1) technology initiatives, specifically laptop initiatives, are increasingly being implemented in our schools today, due to decreasing costs and rising availability of wireless connectivity (Penuel, 2006; Warschauer, 2006; Windschitl &

Sahl, 2002). Penuel (2006) suggests that 1:1 initiatives are largely defined by the implementation itself since they vary from program to program. Characteristics common to most 1:1 initiatives are:

> (1) providing students with use of portable laptop computers (or other technology) loaded with contemporary (e.g., word processing tools, spreadsheet tools, etc.),
> (2) enabling students to access the Internet through schools' wireless networks, and
> (3) a focus on using laptops (or other technology) to help complete academic tasks such as homework assignments, tests, and presentations. (Penuel, 2006, p. 331)

To date, the most common type of 1:1 initiative in schools is the laptop initiative. Mouza (2008) suggests that "in an effort to bridge the digital divide, several districts have embarked in the implementation of laptop programs" (p. 449). Given that all three of the teachers in this study have 1:1 technology in their classrooms, some discussion of the history and research into 1:1 programs is warranted.

Apple Classrooms of Tomorrow

The nation has seen a strong emergence of 1:1 initiatives since 1985 and the Apple Classrooms of Tomorrow (ACOT) Project (Dunleavy et al., 2007). Beginning with five schools in four states, the ACOT Project placed computers, printers, scanners, laser-disc and videotape players, modems, CD-ROM drives, and software packages in participating classrooms. In addition to each student and teacher having a computer at school, the ACOT Project also initially placed computers in the homes of students and teachers to create a 1:1 environment where students and teachers had constant access to the technology, even though this changed in subsequent years as funding and participating classrooms shifted. Teachers were provided with training on troubleshooting and basic computer operations and each ACOT site helped to fund an onsite technology coordinator to provide technical and instructional support (Sandholtz et al., 1997). Different than previous beliefs about the use of technology that emphasized the computer as a teaching machine, the ACOT Project promoted technology as a tool to support the curriculum and that it should be used in ways that best supported learning goals (Sandholtz et al., 1997).

After studying the ACOT Project for 10 years, Sandholtz et al. (1997) gradually saw changes in the ACOT teachers. Initially, ubiquitous computing did not revolutionize the way teachers were teaching. Over time, however, teachers began to question long-held beliefs about teaching and learning and they began to interact with the students differently, acting as facilitators rather than lecturers. Sandholtz et al. (1997) also found that student engagement with the computers did not decline over time and that teacher collaboration increased over time as they worked together to develop ways for using the computers in their classrooms. ACOT coordinators continued to encourage teachers to use the technology for student-centered practices that included communication and collaboration, challenging traditional teaching practices (Sandholtz et al., 1997).

A significant contribution to the way we think about implementing 1:1 initiatives came from the study of the ACOT Project through the identification of five stages of instructional evolution: entry, adoption, adaptation, appropriation, and invention (see Table 3; Sandholtz et al., 1997; Sandholtz & Reilly, 2004). The time teachers spend in each stage varies depending on the knowledge, comfort level, and beliefs the teacher has about technology. Adequate technical and instructional support can help move teachers through the initial stages faster (Sandholtz & Reilly, 2004). Some recent research on technology integration continues to refer to these stages of implementation, but as teachers become more comfortable with technology in their everyday lives, and digital natives (Prensky, 2001b) enter the teaching profession, the idea that all teachers start at the Entry stage is being challenged.

Table 3

***Stages of Instructional Evolution* (Sandholtz & Reilly, 2004)**

Entry	Learning the basics of using technology; technical issues dominate
Adoption	Move beyond struggling with technology to successfully using technology on a basic level in ways consistent with existing teaching and learning practices
Adaptation	Move from basic use to using technology for increased productivity; More frequent and purposeful use of technology, but little change in existing teaching and learning practices
Appropriation	Use technology "effortlessly" as a tool to accomplish instructional and management goals
Invention	Use technology as a flexible tool in the classroom. Learning is more collaborative, interactive and customized; new teaching and learning practices emerge

Significant 1:1 Laptop Initiatives

According to Warshauer (2006), 1:1 laptop initiatives date back to 1990 when a private school in Australia began a 1:1 laptop program for fifth grade students. Over time, the initiative grew to include other grades at the school and eventually to include other private schools. The program was funded by the parents who either purchased or leased the laptop computers for their children (Warschauer, 2006). Modeled after the early laptop programs in Australia, in 1997, Microsoft began the Anytime Anywhere Learning program putting laptops in over one thousand schools over the next five years. The Anytime Anywhere Learning program struggled to sustain its presence in the schools as funding was not available. Schools that continued with the program were limited to what parents could purchase or lease for their children (Barron et al., 2006; Warschauer, 2006). Although many schools have struggled to maintain their 1:1 laptop programs, similar programs continue to emerge across the nation, one reason being that the access to wireless networks is steadily increasing in schools (Gray et al., 2010; Warschauer, 2006).

Maine's laptop initiative. Maine was the first state to implement a laptop initiative with an entire grade of students beginning in 2002 with all seventh graders and including all eighth graders by 2003 (Barron et al., 2006; Garthwait & Weller, 2005; Warschauer, 2006). By 2004, the program was extended to high schools who volunteered to cover the costs of the laptops. A part of Maine's Education Department, the Maine Learning Technology Initiative (MLTI) guided the 1:1 program (Garthwait & Weller, 2005; Warschauer, 2006). Maine partnered with Apple to provide iBooks with instructional software, such as *AppleWorks*, email, and *The World Book Encyclopedia* to the students, wireless campuses to the schools, and professional development to the teachers (Garthwait & Weller, 2005).

In their multi-case study of two seventh-grade teachers in one of the laptop middle schools in Maine, Garthwait and Weller (2005) found that the way the two teachers used the laptops in the classroom was highly influenced by their beliefs about teaching and learning. One teacher was also strongly affected by first-order barriers (Ertmer et al., 1999), such as technical difficulties when trying to incorporate the technology in her instruction (Garthwait & Weller, 2005). Although these findings cannot necessarily be generalized to the entire middle school, or even the state-wide initiative, Garthwait and Weller (2005) suggest that their findings may "provide a reflective opportunity for any teacher questioning the role of educational computing" (p. 373). The researchers also highlight the need for administrators and educators to recognize that the implementation of 1:1 computing is affected by teachers' beliefs about teaching and learning (Garthwait & Weller, 2005).

A search for *Maine* and *laptops* in the ERIC database, without the parameter of peer-reviewed, returned 35 results, with the majority being reports or practitioner journal articles. The Maine Learning Technology Initiative is referenced often by practitioner journal articles discussing 1:1 computing in schools (e.g., Allan, Erickson, Brookhouse, & Johnson, 2010; Holcomb, 2009; McLester, 2011; Muir, Knezek, & Christensen, 2004; O'Hanlon, 2007; Waters, 2009). Warschauer (2006) suggests that, although Maine is a prime candidate for research on how laptops affect instruction, student outcomes, or diverse learners, minimal empirical research has been done in those areas, with most studies focusing on factors that influence the success of the initiative, such as teachers' beliefs about technology.

Laptop initiatives in other states. Laptop programs have existed in California since 1996 when one district participated in Mircosoft's Anytime Anywhere Learning program. Many schools across California have attempted to combine federal funding with funding from parents to create their laptop programs (Warschauer, 2006). In addition to Maine, one of the largest 1:1 laptop initiatives is in Henrico County, Virginia where all middle school and high school students use laptops (Barron et al., 2006; Grimes & Warschauer, 2008). According to their website, Henrico County Schools teamed with Apple and Dell to provide laptops to all of their middle school and high school students (http://www.henrico.k12.va.us/Technology/InstructionalTechnology.html). After the second year of the program, Henrico County reported higher levels of academic achievement in core subject areas with Standards of Learning (SOL) tests receiving the highest scores ever in all content areas (Barron et al., 2006).

In North Carolina, the Mooresville Graded School District (MGSD) achieved a successful 1:1 digital conversion, including Apple laptops for all students in grades 3-12. From 2007-2011, MGSD systematically rolled out laptops in four phases. High school English classes received laptops on carts and all high school teachers received personal laptops during the winter of 2007. During the same year, all K-2 classrooms received Smartboards with accessories. As school years passed, subsequent phases were implemented, methodically putting laptops in the hands of all students 3-12 by 2011. It is impressive to note that, while embarking on this digital conversion, MGSD's high school end-of-course exam scores rose from 68% proficient in 2006-2007 to 88% proficient by 2010-2011 (Levin & Schrum, 2012). Some lessons learned from MGSD's successful 1:1 laptop initiative include a) the need for beginning 1:1 initiatives with a clear vision that includes input from parents, students, and community members b) the need for district technology leaders to be knowledgeable about curriculum and instruction in addition to technology, and c) encouraging teachers to integrate technology at their own pace while still expecting growth and movement toward student-centered learning (Levin & Schrum, 2012). Other 1:1 laptop initiatives have also occurred in Georgia, Florida, Indiana, Kansas, Louisiana, Massachusetts, Michigan, Missouri, New Hampshire, Pennsylvania, South Carolina, South Dakota, Tennessee, and Virginia (Barron et al., 2006; Davis, 2009; Grimes & Warschauer, 2008; Holcomb, 2009).

Findings from 1:1: laptop initiatives. First-order barriers to technology integration (Ertmer et al., 1999), such as access to technology, can be alleviated by 1:1 laptop initiatives (Grimes & Warschauer, 2008; Penuel, 2006). Providing students with a laptop can change the way in which they learn:

> Providing every student with a laptop, which can also be taken home, can have a tremendous impact on students who are currently left out from the world of technology. Access to laptop computers can change both *how* and *what* students learn, *within* as well as *outside* school boundaries. (Mouza, 2008, p. 449)

In fact, Grimes and Warschauer (2008) posit that "one-to-one laptop programs arguably offer the greatest potential of educational technologies to date in that they place the most power and versatility in students' hands, while wireless network connections open vast new vistas for communication and collaboration" (p. 306). Students in laptop schools have greater access to a variety of information than typical students (Warschauer, 2007). In his multi-site case study of 10 laptop schools in Maine and California, Warschauer (2007) found that 1:1 computing initiated changes to instruction by facilitating:

(1) more just-in-time learning;

(2) more autonomous, individualized learning;

(3) a greater ease of conducting research;

(4) more empirical investigation; and

(5) more opportunities for in-depth learning. (p. 2516)

Laptops as instructional tools provide teachers and students flexibility in the way they teach and learn. For example, laptops are portable, can be used anywhere in the classroom or at home, and can be opened and incorporated into a lesson in a moment's notice (Windschitl & Sahl, 2002). A teacher participant in Windschitl and Sahl's (2002) multi-case study of teachers at a 1:1 laptop middle school suggested that laptops extend the school day for her students because they often continue class investigations at home, using the same resources they had available to them at school.

Three themes emerged from the laptop implementation for Windschitl and Sahl (2002): (1) teachers beliefs greatly influenced the way the laptops were used; (2) the presence of ubiquitous technology did not encourage the movement toward more constructivist teaching practices; and (3) expectations for the use of the technology were initiated by the school, but reinterpreted by the teachers through collaborative moments with students, colleagues, and experiences out of school. Interestingly, Windschitl and Sahl's (2002) second theme is in contrast to the literature. Research on laptop initiatives says teachers tend to teach in more student-centered and constructivist ways when using laptops in the classroom (Dunleavy et al., 2007; Garthwait & Weller, 2005). In a synthesis of the research on laptop implementations Penuel (2006) suggested teachers' beliefs about the value of integrating technology and its benefits for the students, professional development support, and technical support as being crucial to how much teachers used the laptops and to the overall success of 1:1 laptop initiatives. Garthwait and Weller (2005) also found that teachers' beliefs about teaching and learning greatly influence the success of 1:1 laptop initiatives in their multi-case study of two seventh-grade teachers in Maine.

Russell, Bebell, and Higgins (2004) observed fourth and fifth grade classes at one elementary school to see if classes having access to 1:1 laptops daily showed more significant differences in teaching and learning than classes only having access to 1:1 laptops occasionally through portable, shared laptop carts. They found that classroom observations, teacher interviews, and student surveys all indicated that technology was used significantly longer and more often in the permanent 1:1 laptop classrooms than in the classrooms that used the portable laptop cart. Student motivation and engagement was also observed to be higher in the permanent 1:1 laptop classrooms based on observations, interviews, and student surveys. The structure and management of the classes differed as well. The permanent laptop classrooms completed almost all writing activities using the laptops and more time was spent writing in those classrooms as compared to the portable laptop cart classrooms. Collaborative groups and student-led instruction was more often observed in the permanent 1:1 laptop classrooms, whereas whole group and teacher-led instruction still dominated in the portable laptop cart classrooms. Finally, students in the permanent 1:1 laptop classrooms used technology at home for academic purposes more often than students in the laptop cart classrooms (Russell et al., 2004). These findings suggest that although occasional access to technology does benefit the students, significant gains are demonstrated through consistent, daily use of technology.

Dunleavy et al. (2007) conducted a case study in two middle schools implementing 1:1 computing programs. They found that teachers and students in the two schools used the laptops most frequently for online research and productivity tools, such as components of the Microsoft Office suite. Second, the use of laptops for drill and practice for instruction, remediation, reinforcement, and assessment of concepts was observed in both schools. Dunleavy et al. (2007) found the drill and practice exercises to be meaningful in the classrooms they observed because they offered an

> (1) increased ability to formatively assess;
>
> (2) increased ability to individualize instruction and pacing;
>
> (3) increased ability to provide timely feedback;
>
> (4) increase in student interaction and collaboration; and
>
> (5) increase in student engagement. (p. 446)

The third most frequent use of the laptops by teachers and students in Dunleavy et al.'s (2007) study was to access online environments, such as Web 2.0 tools that encouraged communication and collaboration, including the use of audio and video to share information. Overall, Dunleavy et al. (2007) found the use of the laptops at the two middle schools created learning environments that were more “learner-, assessment-, community-, and knowledge-centered” (p. 444), aligning with Bransford, Brown, and Cocking’s (2000) four essential design principles of effective learning environments, because the laptops allowed the teacher to (1) formatively assess learning, (2) individualize instruction, (3) allow for self-guided pacing, (4) access online resources, (5) encourage student interaction and collaboration, and (6) better manage materials.

Challenges of 1:1 laptop initiatives for teachers and students. Despite their benefits, 1:1 laptop initiatives also bring potential challenges for teachers and students. Challenges of hardware issues, the complexity in learning tasks, and distractions from added stimuli created classroom management issues for the teacher participants in the Dunleavy et al. (2007) study. Dunleavy et al. (2007) also found that some teachers at the two middle schools interacted with the students less when using the laptops, suggesting that the teachers viewed the laptops as replacement instructors. Weston and Bain (2010) also argue that 1:1 laptop initiatives can be used as replacements for teachers and existing instructional materials, such as worksheets, without thoughtful consideration for how the technology should be integrated.

Other 1:1 Initiatives

As technology becomes more available to teachers and students, 1:1 initiatives are not limited to traditional laptops. One alternative to the traditional laptop is a smaller personal computer, like a Netbook. Unlike the previously promoted AlphaSmarts that focus mainly on word processing, Netbooks function similarly to more sophisticated laptops at a more cost-effective price for schools (Schrum & Levin, 2009; Warschauer, 2011). In addition to laptops and Netbooks, some schools are implementing 1:1 initiatives with handheld devices, including personal digital assistants (PDAs), gaming devices, and student response systems (van‘t Hooft, 2006; Warschauer, 2006). Norris and Soloway (2004) suggest that handheld devices, such as PDAs encourage interactive 1:1 learning at a low cost for schools in what they call their “handheld-centric classroom.” Warschauer (2006) highlights handheld devices as allowing students to

- brainstorm ideas with graphic organizers,
- copy web pages for viewing outside of class,
- draw and manipulate scientific models,
- share their work with other students and the teacher through beaming, and
- word process and edit their writing with the assistance of portable keyboards (p. 26)

Although handheld devices are more cost effective than laptops, their presence has not been sustainable in K-12 schools (Warschauer, 2006). For example, in one of the largest 1:1handheld device initiative in the United States, a school district in California distributed 1000 Palm Pilots and portable keyboards to all first year students in two middle schools for the 2003-04 and 2004-05 school years. Twenty-two teachers participated in the program covering all subject areas, however, one of the schools determined that the handheld devices were too distracting to teachers and students and terminated the program after the first year. At the second school, teachers were asked if they wanted to continue with the program after the first year and only 3 teachers volunteered to keep the handheld devices (Warschauer, 2006). Warschauer (2006) suggests that handheld devices may not be successful in schools because they do not offer as many features and do not support as many software options as laptops do. In fact, handheld devices, such as Palm Pilots, have not done well with general consumers either, due to cell phones, digital music players, like iPod Touches, and tablets, like iPads, offering greater options for users (Warschauer, 2006). In my opinion, it will be interesting to see future research on current popular handheld devices such as iPod Touches and iPads in the classroom and how they benefit instruction and students' needs.

Student response systems are popular when paired with Interactive Whiteboards to display student responses (Schrum & Levin, 2009). My personal experience with student response systems has led me to believe that they encourage participation because they allow students to respond to a question or ask a question, sometimes anonymously, through the device first, formulating their thoughts before sharing them orally. Some student response systems include software that monitors student responses for assessment purposes (Schrum & Levin, 2009). Currently, some popular student response systems include Promethean's Activ Votes and Activ Expressions compatible with the Promethean Activ Board (http://www.prometheanworld.com/), Smart Technologies' various Smart Response interactive response systems compatible with the Smartboard (http://smarttech.com/us) , and eInstruction's various CPS student response systems (http://www.einstruction.com/). The research on response systems in elementary school settings is limited; therefore, more research needs to be done to determine the benefits of handheld devices and student response systems on elementary student learning. In this study several teachers have response systems and all have Interactive White Boards, so having some prior knowledge about the research on these devices is important.

Technology in the Content Areas

The TPCK framework (Mishra & Koehler, 2006) represents teacher knowledge of technology, pedagogy, and content as having overlapping relationships. The framework suggests that teachers must consider each of these areas when planning for technology integration. Because knowledge of pedagogy and content plays a significant role in the way a teacher integrates technology, it is important to examine how technology is being used in various content areas and whether pedagogical differences in those content areas affects the use of technology. O'Brien (2008) suggests that technology integration within content areas could still be referred to as just a "collection of tools" (p. 132). He reminds us that, "having access to the tools and learning how to use them are critical, but so is the context in which you learn about them and how you are asked to apply them" (O'Brien, 2008, p.132). Goldenberg (2000) agrees that the way technology is used within the content area is more important than the technology tool itself. He presents six principles teachers should consider to effectively integrate technology. Goldenberg's (2000) principles are described in more detail in the Technology and Mathematics section of this chapter. The following sections address literature regarding the use of technology in Language Arts, Mathematics, Music, Science, and Social Studies. These content areas were chosen to align with the content areas taught by the teachers in this study. For each content area, technology is broadly defined as computer-based or digital hardware and software, such as, but not limited to, Internet resources and Web 2.0 technologies, computers, gaming, interactive whiteboards, response systems, cameras, audio and video players, and handheld devices.

Technology and Language Arts

The National Council of Teachers of English (NCTE) recognizes how current digital technologies have changed the face of literacy. NCTE (2008) posits that 21st century readers and writers need to be able to do the following:

> (1) develop proficiency with a variety of technology tools,
>
> (2) build relationships with others to pose and solve problems collaboratively and cross-culturally,
>
> (3) design and share information with global communities to meet a variety of purposes,
>
> (4) manage, analyze and synthesize multiple, simultaneous streams of information,
>
> (5) create, critique, analyze, and evaluate multi-media texts, and
>
> (6) attend to ethical responsibilities required by these complex environments.

Suhr, Hernandez, Grimes, and Warschauer (2010) extol the benefits of acquiring these skills when they suggest that new technologies can contribute to improving literacy instruction:

> New digital technologies, if used wisely, are believed to have the potential to expose students to a wide range of academic language; provide scaffolding so that students can comprehend challenging and interesting texts; engage students in

> text-based simulations that spark their interests and motivate their learning; and provide a wide range of tools for analyzing texts, brainstorming their ideas, organizing their thoughts, writing, peer editing, and publishing their work. (p. 7)

Throughout history, elements of literacy have always been tied to communication technology, thus linking literacy instruction and technology (Karchmer, 2001). Hansen (2008) posits that “researchers and practitioners have changed the question of *should* technology be integrated in early literacy instruction to *how* can early literacy instruction be enhanced with technology in the best interests of beginning readers and writers” (p. 109).

Hansen (2008) attributes increased comprehension, vocabulary, fluency, and achievement with the integration of technology. In his study of three second grade inner city public school teachers who participated in a technology professional development program, Hansen (2008) noted that the teachers most often used technology in literacy instruction when presenting whole group mini-lessons, such as setting the purpose for what they were going to read. The students, however, most often used technology during the application stage of literacy instruction. Hansen (2008) describes applying as when “… students are actively involved in utilizing knowledge gained through literacy mini-lessons to extend comprehension, provide for reflection, and increase the value of the reading experience” (p. 114). Hansen (2008) cited examples of the applying stage as students using PowerPoint, the Internet, Microsoft Word, digital cameras, iMovie, KidSpiration, electronic books, listening centers, and miscellaneous computer software. Hansen (2008) suggests that the three second grade teachers did not change the literacy curriculum in order to use the technology, but instead used the technology to enhance their literacy instruction.

Karchmer (2001) argues that the Internet has changed the definition of literacy and has given students access to electronic texts that contain features not typically found in traditional print-based texts, such as hyperlinks, graphics, audio, and video. Electronic texts are interactive and malleable, whereas print-based texts are fixed. Electronic texts also provide opportunities for students to experience resources beyond the primary text through features not found in print-based texts, such as hyperlinks. A limitation of print-based texts is that students are confined to what is written on the page, usually in a linear manner, whereas electronic texts remove those boundaries and allow for multiple methods of text navigation (Karchmer, 2001). However, it is important to remember that the features unique to electronic texts may only be beneficial to literacy instruction if explicitly taught. For example, a student interacting with an electronic text may read it as he is accustomed to reading a print-based text without exploring the additional features (Karchmer, 2001). In a study of thirteen K-12 teachers chosen for their exemplary use of the Internet in the literacy classroom, Karchmer (2001) found that elementary teachers needed more time to assess the appropriateness of the text when using electronic texts, unlike using print-based texts that claim a particular reading level. The elementary teachers in the study also cited the amount textual aids within the electronic text as contributing to whether or not they chose the text to use with their students. One teacher highlighted textual aids, such as hyperlinks, audio, and graphics as being engaging to her students who would not typically read an entire print-based text.

Electronic books (e-books) "not only simulate the experience of reading or listening to a book, but often provide additional decoding supports, comprehension supports, interactive elements, or entertaining features" (Zucker, Moody, & McKenna, 2009, p. 48). Zucker et al. (2009) define electronic books as:

> a form of electronic text that contains key features of traditional print books, such as a central topic or theme and pages that "turn," but e-books may also contain digital enhancements that make the reading experience qualitatively different, and perhaps more supportive. (p. 49)

E-books are different from electronic text because they contain purposefully placed digital enhancements that aid in telling the story, maintaining a closed environment unlike texts designed for the Internet (Zucker et al., 2009). Andries van Dam coined the term electronic book in 1967, referring to hypertext on a mainframe computer; however research on electronic books began only in the mid-1980s when computers became more affordable (Zucker et al., 2009). Today, e-books include animated, interactive versions of popular children's books, such as those on the International Digital Children's Library (http://en.childrenslibrary.org/) , and educational software like *Thinking Reader* (http://www.tomsnyder.com/products/product.asp?sku=THITHI) designed to provide teachers with specific e-books that target comprehension strategies (Zucker et al., 2009).

Most e-books contain supportive elements that aid in decoding, pronunciation, fluency, and comprehension of the text (Rhodes & Milby, 2007; Zucker et al., 2009). Because these supports are built into the text, unlike in traditional print-based texts, e-books nicely align with the Universal Design for Learning's (UDL) three principles: 1) To support recognition learning, provide multiple methods of presentation, 2) To support strategic learning, provide multiple, flexible methods of expression and apprenticeship, and 3) To support affective learning, provide multiple, flexible options for engagement (Rose & Meyer, 2002, p. 75). UDL is a framework for learning that encourages the use of curriculum materials that are universally accessible to all students because instructional supports are built-in to the materials (Rose & Meyer, 2002). An early example of a product that aligns with the UDL framework is *WiggleWorks* (http://teacher.scholastic.com/products/wiggleworks/index.htm), an e-book program created by a partnership between CAST, the home of UDL, and Scholastic. The e-books in *WiggleWorks* are characterized by features that provide access to all students, such as the option to select large text or the read aloud feature for students with visual impairments (Rose & Meyer, 2002). This interaction with the text is what distinguishes e-books as being effective for all types of readers (Zucker et al., 2009). However, Zucker et al. (2009) caution teachers that built-in supports in e-books may also provide distractions for readers. As with any technology tool that is used in the classroom, students should be taught how to interact with e-books and to make decisions about what they should click based on their knowledge of the text.

In addition to pre-existing e-books found either on the Internet and in software programs, teachers and students can also create e-books (Putney, Bennett, & Head, 2004). Electronic books can be created simply using Microsoft PowerPoint, or by employing websites such as CAST UDL's BookBuilder (http://www.cast.org/learningtools/book_builder/). BookBuilder offers a free template for teachers and students to create e-books with built-in supports for readers such as read aloud, coaches designated to read words, ask questions, or offer tips, and vocabulary words linked to a glossary. More empirical research needs to be done evaluating the effectiveness of the use of e-books with struggling readers (Zucker et al., 2009), but the idea of creating an instructional material, like an e-book, that is universally accessible to all readers (Rose & Meyer, 2002) is promising for integrating technology in literacy instruction.

Leu, Zawilinski, Castek, Banerjee, Housand, Liu, and O'Neil (2007) suggest that it is important to consider how the Internet has changed literacy and access to information for students today when they say that, "In the history of literacy, no other technology for reading, writing, and communication has been adopted by so many, in so many different places, in such a short period of time" (p. 39). In fact, today's employers often seek candidates who can read, write, and communicate on the Internet to solve problems (Karchmer, 2001; Leu et al., 2007). Atkinson and Swaggerty (2011) also highlight the Internet as being a powerful resource in literacy instruction and posit that schools should provide students experiences that allow them to sharpen their skills as Internet learners who are able to examine the relevancy, accuracy and reliability of online resources. Atkinson and Swaggerty (2011) explored the use of the Internet in fourth grade literacy instruction by using Web 2.0 tools. Web 2.0 tools are interactive and allow users to contribute information rather than just receiving information. In the fourth grade classroom, Atkinson and Swaggerty (2011) examined the use of the Web 2.0 publication tool, Scrapblog (http://www.scrapblog.com/), an e-scrapbooking site, which they cited as an alternative to using Microsoft PowerPoint to share information through images and text. Although obstacles always exist when incorporating new technologies in the classroom, Atkinson and Swaggerty (2011) found that the students quickly embraced Scrapblog as a new way to share information and began to read, write, and communicate (Karchmer, 2001; Leu et al., 2007) through it at school and at home for individual purposes beyond the school assignment. They partly attributed the success of the Web 2.0 tool integration on the instructional approach of peer-to-peer learning networks and allowing the students to lead the creation of the Scrapblog, only providing them with minimal instructions.

Other Web 2.0 tools like blogging encourage collaboration and communication among students, two skills recommended for 21st century learners (Boling, Castek, Zawilinski, Barton, & Nierlich, 2008; ISTE NETS-S, 2007; Partnership for 21st Century Learning, 2009). Boling et al. (2008) note that blogging encourages reserved readers and writers to join the conversation and expand their ideas. Kid Blog (http://kidblog.org/home.php) is one example of a free, safe site for teachers and students to interact collaboratively through blogging.

Karchmer (2001) suggests the writing process is interactive and malleable in digital environments. In her study of exemplary technology using K-12 teachers, seven of the eight elementary teachers related student motivation to being able to publish work on the Internet, in most cases the teacher's classroom website, suggesting that students invested more time in their writing when they had a global audience (Karchmer, 2001). One second grade teacher in Karchmer's (2001) study cited her students as being more motivated to write when they were able to type because handwritten assignments tended to be laborious. Studies also show that the most frequent use of laptops in one-to-one laptop schools is in Language Arts, when students write and publish work and interact with electronic texts (Suhr et al., 2010). In a study of eight fourth grade classes in two one-to-one laptop schools, Suhr et al. (2010) found that the most common student uses of laptops were for writing with word processing programs and looking up information on the Internet through search engines to support their writing. The teachers in the study noted higher student engagement in writing and that the students spent more time revising their papers resulting in longer papers than when papers were handwritten. The researchers observed that the fourth grade laptop classroom walls were rich with showcased student work, including brainstorming, first drafts, and final drafts (Suhr et al., 2010).

In addition to word processing programs, moviemaking software has been shown to motivate student writers. In a grant-funded enrichment program integrating Language Arts and technology for 100 fourth and fifth graders, Bedard and Fuhrken (2011) found that script writing and the filming and editing of movies encouraged multiple levels of storyboarding and revision during the writing process because the students' "attention was sustained while they worked toward making a text evolve" (p. 123). During the movie creation process, students read novels for inspiration, brainstormed ideas for transforming the novels to movie scripts, and completed multiple revisions to their writing as they began filming. They then participated in the movie editing process, adding voiceovers, sound effects, and music, as well as changing scenes when necessary. Bedard and Fuhrken (2011) argue that moviemaking helped the students to see themselves as writers with something important to share to an audience beyond the teacher.

Similar to creating a movie script, digital storytelling allows students to transform their ideas from paper to a multimedia format. Digital storytelling combines the art of telling a story with digital multimedia, such as images, audio, and video (Kieler, 2010; Robin, 2006). Putney, Bennett, and Head (2004) argue that technology makes creating, revising, and adding graphics to stories more accessible to students.

> At its core, digital storytelling allows computer users to become creative storytellers through the traditional processes of selecting a topic, conducting some research, writing a script, and developing an interesting story. This material is then combined with various types of multimedia, including computer-based graphics, recorded audio, computer-generated text, video clips, and music so that it can be played on a computer, uploaded on a web site, or burned on a DVD. (Robin, 2008, p. 222)

The Center for Digital Storytelling (http://www.storycenter.org/) offers examples of digital stories and developed the Seven Elements of Digital Storytelling which is cited as a useful place to begin when creating a digital story (Robin, 2006). Previously made digital stories can be viewed by students or used during lessons by teachers. Digital stories also can be created by teachers and students. Teacher-created digital stories can be used to enhance lessons, such as when introducing a topic. Student-created digital stories are interactive ways to teach students to research a topic, develop text and images that support the topic, and present the information using multimedia tools. A popular use of digital storytelling is the telling of personal narratives, but digital stories are also often used to inform or instruct the viewer about a topic or to examine historical events (Robin, 2008). Kieler (2010) posits that digital storytelling facilitates an emotional connection to the content as students creatively try to capture an audience. The Educational Uses of Digital Storytelling website (http://digitalstorytelling.coe.uh.edu/) at the University of Houston offers examples for teachers and students of digital stories and resources for digital storytelling.

Technology and Mathematics

The National Council of Teachers of Mathematics (NCTM) includes technology as one of their Six Principles for School Mathematics (2000). NCTM supports the idea that “technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning” (p. 3). NCTM (2000) believes that technology supports the use of 21^{st} century skills in mathematics, such as decision making, reflection, reasoning, and problem solving. The Association of Mathematics Teacher Educators, or AMTE, (2009) also believes that students PreK through college benefit from technology enriched environments. AMTE (2009) suggests that “mathematics educators serve their students by considering the potential impact of a variety of forms of 21st Century digital technologies and planning accordingly” (p. 1). Although mathematics is traditionally viewed as a paper and pencil subject that requires pages of calculations, with maybe the use of a calculator, the current math classroom can be enhanced by a multitude of available technology that allows for “implementing data-driven curriculum; using virtual manipulatives and allowing representation of mathematical principles; and motivating, skill building, and practice” (Crompton, 2011). Technology in the math classroom encourages students to explore math problems that move beyond paper and pencil to complex, real-world situations that promote mathematical transfer (Franz & Hopper, 2007). Technology in the math classroom also supports English Language Learners:

> Early in the second language learning process, multimedia or coordinated sets of manipulatives, calculators, and other conceptual aids can help students deal with mathematical patterns, and also represent and communicate their ideas with little demand for translation. Later, students may progress to tasks that require limited written or oral responses, and in the more advanced stages use their second language as they manipulate technology collaboratively to solve problems. It is through such technology-based experiences, by translating among forms of representation (e.g., from written text to symbols to graphs to oral exposition) that students develop both competence in the English of math instruction and also competence in mathematics. (Ganesh & Middleton, 2006, p. 104)

Clements (2002) suggests that “problem solving computer activities motivate children as young as kindergartners to make choices and decisions, alter their strategies, persist, and score higher on tests of critical thinking” (p. 167).

In 2009, the Association of Mathematics Teachers Educators (AMTE) Technology Committee created standards aligned with the ISTE NETS for students (2007) and teachers (2008), as well as the TPCK framework (Mishra & Koehler, 2006) in response to a desire to investigate how mathematics teachers should integrate technology (Niess et al., 2009). These standards were based off of the following themes: 1) An overarching conception about the purposes for incorporating technology in teaching mathematics; 2) Knowledge of students’ understandings, thinking, and learning of mathematics with technology; 3) Knowledge of curriculum and curricular materials that integrate technology in learning and teaching mathematics; and 4) Knowledge of instructional strategies and representations for teaching and learning mathematics with technologies (Niess et al., 2009; for a detailed version of the standards, visit http://www.amte.net/sites/all/themes/amte/resources/MathTPACKFramework.pdf). According to Niess et al. (2009), “the Mathematics Teacher TPACK Standards provide a lens for considering the actions of teachers who have an integrated knowledge of technology, content, and pedagogy” (p. 10). Bos (2011) also used the TPCK framework (Mishra & Koehler, 2006) with 30 inservice elementary teachers enrolled in a graduate mathematics education course as they created units using Web 2.0 tools and mathematical objects to “verify whether technology increased their knowledge and enabled them to assimilate technology into an instructional unit adhering to TPACK” (p. 168). Although most of the teachers were able to create instructional units integrating technology with math content and pedagogy in mind, Bos (2009) suggests that a definition of TPCK’s knowledge structures as it should be applied in the classroom is still evolving.

In his article, *Thinking (and Talking) about Technology in Math Classrooms*, Goldenberg (2000) shares a set of principles to assist or guide mathematics educators in making decisions about the appropriate use of technology tools in relation to mathematics instruction. Goldenberg (2000) suggests that the way technology is used is of more importance than the technology tool itself. He explains that with computers, as well as with pencils, “it is the *problems* that are posed, not the technology with which they are attacked, that make all the difference” (Goldenberg, 2000, p. 1). Goldenberg (2000) presents the following principles as effective ways to think about integrating technology in mathematics instruction:

1. <u>The Genre Principle:</u> The Genre Principles suggests that teachers need to consider classroom goals, students' needs, and the different roles of technology when choosing appropriate technologies to integrate. The choice to integrate should not be about the tool, but, instead, about how the tool will support goals and students' needs.

2. <u>The Purpose Principle</u>: The Purpose Principle suggests that the purpose of the lesson should be considered when deciding if technology should be used. For example, if the purpose of the lesson is to explore ratios, then calculator use for long division would not hinder student outcomes. However, if the purpose of the lesson is to master long division, then calculator use would not be appropriate.

3. <u>The Answer vs. Analysis Principle</u>: As an extension of the previous principle, the Answer vs. Analysis Principle suggests that the outcome of solving the problem should be considered when using technology. For example, if the purpose of the computation is to find an answer, a calculator may be appropriate. However, if the teacher desires a student to be able to explain the process of finding the answer to a problem, the use of a calculator may distract from the steps in the process.

4. <u>The Who Does the Thinking Principle</u>: The Who Does the Thinking Principle suggests that teachers need to consider how the technology is going to be used when solving a problem. For example, will the technology replace the student's thought process or will it encourage and develop the student's ability to think about the problem independently?

5. The Change Content Carefully Principle: The Change Content Carefully Principle recognizes that content sometimes changes when technology is used based on what the technology can do. Teachers need to carefully consider content being taught based on the students' needs rather than the technology tool being used.

6. The Fluent Tool Use Principle: Finally, the Fluent Tool Use Principle encourages teachers and students to master a few technologies, ultimately being able to transfer knowledge of use from one technology to another. In this approach, students understand the purpose of the technology as related to the mathematical operation and can translate that to similar technologies.

Although presented specifically for mathematics instruction, Goldenberg's (2000) six principles offer insight into effective practices across content areas. However, empirical research examining teachers who plan for technology use with these principles in mind is still needed to determine their effectiveness in guiding teachers to make decisions about the appropriate use of technology in mathematics – and in other content areas as well.

Bos (2009) examined six commonly used methods of technology integration in math classrooms, including their strengths and weaknesses and their role in guiding mathematical thinking in the classroom. She suggests that the most commonly used methods of technology integration in the math classroom include: game formats, informational formats, quiz formats, activity mats with virtual manipulatives, static tools that generate calculations, tables, or graphs, and interactive math objects format. She found that among the six methods of technology integration represented the interactive math object format, which uses multiple representations that are interactive and change with the given input, was the only method of instruction that promoted high cognitive fidelity. In addition, Bos (2009) defines cognitive fidelity as “whether a concept is understood when an object is acted on. Because of an action preformed on it, does it make sense and add depth of understanding and meaningful schema to the concept?” (p. 111). To achieve high fidelity, the interactive math object can be described by the following characteristics: multiple representations are accurate, representations are easy to manipulate, representations are intuitive rather than contrived, transitions occur in a logical, sense-making sequence, multiple representations are possible, and inquiry, problem posing and testability are possible for conjectures (Bos, 2009).

Based on the literature, the gaming format is a popular method of technology integration in math (Bos, 2009; Main & O’Rourke, 2011). Empirical research in mathematics shows two gaming trends: 1) the quiz-like digital game that promotes recall (Bos, 2009), and 2) the more sophisticated video game (Main & O’Rouke, 2011). Ganesh and Middleton (2006) suggest that the interactive game features of math computer programs can motivate English Language Learners to use their second language. Lindstrom, Gulz, Haake, and Sjoden (2011) state that many researchers in math education argue that digital games for educational purposes are problematic because they do not encourage reflection time for the student, often penalizing the student for taking time to stop and think. However, when a math game is designed to promote collaboration and discussion among students, it has the potential to enhance a students’ understanding of the mathematical concept (Ke, 2008; Lindstrom et al., 2011). The enhancement of mathematical understanding must be accompanied by guidance in working in collaborative groups because students may not naturally know how to do this effectively (Ke, 2008). In a study of a math game used with fifth grade students, Ke (2008) found that, when given the opportunity to collaborate, students tended to only share answers, rather than understandings of how to reach the answer. Ke (2008) reminds us that all math computer games should not be considered equal and "the instructional effectiveness of a computer game depends on its characteristics and how it is used" (p. 430).

James Gee (2007) and Marc Prensky (2001a) encourage us to critically study what it is about video games that intrigues and engages our children. However, many teachers fear gaming in the classroom as an eventual way to replace the instructor (Gee, 2007). Main and O'Rourke (2011) recognized the growing interest in gaming in students in their area schools and examined the use of handheld gaming consoles to encourage mathematical calculations and self-concept toward mathematics in fourth and fifth grade students. They found that the intervention math group using the *Nintendo DS* handheld gaming consoles with the software *BrainTraining* made significant gains in speed and accuracy of basic math facts and self-concept toward math. They attributed these gains to the student engagement they observed when students used the handheld game consoles, as well as the support the classroom teacher had for the use of the handheld game consoles.

In addition to the popular use of gaming in mathematics, math teachers often use websites and software specifically designed to teach math concepts. For example, websites such as the National Library of Virtual Manipulatives (NLVM) (http://nlvm.usu.edu/) developed at Utah State University offer teachers and students interactive math manipulatives similar to the wooden and plastic manipulatives used in classrooms. Because they are virtual, the manipulatives on the NLVM site can be used at home, as well as at school to support math concepts. Research in mathematics and technology indicates that the use of manipulatives that the students can touch and the use of manipulatives on a computer offered similar benefits to the students (Clements, 2002). In fact, computer manipulatives offer advantages to students and teachers, such as:

- Flexibility in their use- Virtual or computer manipulatives are often malleable and can take on different representations. For example, a base ten block can be broken into 10 ones on the computer, but may not be able to change in its concrete form. Computer manipulatives can also be resized or cut.
- Long-term projects- Computer manipulatives can be saved and revisited without having to be cleaned up, as their concrete counterparts have to be.
- Recording actions- The manipulation of computer manipulations can easily be recorded through a screencast offering a unique tutoring or reviewing option for the student and the teacher.
- Concrete and symbolic connections- Computer manipulatives offer students the opportunity to explicitly connect the actual manipulative to its symbolic representation, such as showing base ten blocks linked to numerals. (Clements, 2002, p.168)

Some math programs have been developed with the benefits of technology in mind. For example, *Building Blocks* (http://www.ubbuildingblocks.org/), a National Science Federation-funded project, focuses on research-based technology-enhanced math materials for Pre-K through 2nd grade (Clements & Sarama, 2007). The *Building Blocks* program integrates three types of media: computers, manipulatives (and everyday objects), and print (Clements, 2002; Clements & Sarama, 2007). The basic approach of *Building Blocks* is "finding the mathematics in and building the mathematics from children's activity" (Clements, 2002; p. 138; Clements & Sarama, 2007, p. 168). The materials are designed to build off of children's everyday experiences, encouraging them to see math in routine activities, such as playing with blocks or completing a puzzle (Clements, 2002; Clements & Sarama, 2007). *Building Blocks* is based on learning trajectories for each math topic and activities move students through a developmental progression of several levels and tasks (Clements & Sarama, 2007). In their study of two preschool programs serving low-income families, Clements and Sarama (2007) reported learning gains in the experimental groups using *Building Blocks* similar to the effect of individual tutoring. Relatively large learning gains were reported in the areas of subitizing, sequencing, shape identification, and composition of shapes (Clements & Sarama, 2007).

Popular examples of other computer programs designed for mathematics learning are *The Geometer's Sketchpad* (http://www.keycurriculum.com/products/sketchpad) and *TinkerPlots* (http://www.keycurriculum.com/products/tinkerplots). *The Geometer's Sketchpad*, designed for students in elementary through high school, is dynamic geometry software that allows learners to manipulate, or click and drag, geometric shapes in order to formulate theories and draw conclusions (Hannafin, 2004). Instead of providing practical scenarios, like *Building Blocks*, *The Geometer's Sketchpad* requires teachers to determine what they want the student outcomes to be; however, *The Geometer's Sketchpad* product site (http://www.keycurriculum.com/products/sketchpad) does claim that the software supports the Common Core Standards. An advantage to using *The Geometer's Sketchpad* is that the students are able to focus on conclusions they draw from manipulating the computer geometric shapes rather than on creating the manipulations with pencil and paper (Obara & Jiang, 2009).

TinkerPlots was created through the *TinkerPlots Project* funded by the National Science Foundation (Scientific Reasoning Research Institute, 2012). *TinkerPlots* is useful in both math and science as students collect, analyze, and represent data (Scientific Reasoning Research Institute, 2012). Designed for students in grades 4-9, *TinkerPlots* allows students to analyze data by constructing and manipulating graphical representations of data. *TinkerPlots* provides students the ability to construct graphs to represent their data rather than just select them (Konold, 2002; MacKinnon, Lynch-Davis, & Driskell, 2009; Scientific Reasoning Research Institute, 2012). The *TinkerPlots* product website (http://www.keycurriculum.com/products/tinkerplots) claims that its drag and drop interface makes it easy for students to learn and is engaging for them to use as they explore data, probability, and graphs. Konold (2002) suggests that "because with TinkerPlots graphs are built up (or deconstructed) in stages, students are less likely to get disoriented by 'imposed' abstraction. They can work from the bottom up, building on the foundation of what they already understand" (p. 9).

Teachers are not limited to using hardware or software created for math instruction. Many math teachers are also integrating innovative hardware like the iPod, digital cameras, and Web 2.0 tools such as YouTube (http://www.youtube.com/) into math for viewing, analyzing, and creating digital videos that support the understanding of complex math operations (Niess & Walker, 2010).

Technology and Music

The National Association for Music Education (MENC) collaborated with the Partnership for 21st Century Skills (2009) to provide educators with classroom examples of 21st century skills in the arts curriculum. MENC (2010) actively supports the Partnership for 21st Century Skills (2009) in their promotion of what they call the four Cs (critical thinking and problem solving, communication, collaboration, and creativity and innovation) and their integration with the arts, specifically music education. The Technology Institute for Music Education's (TI:Me) mission is to assist music educators in using technology to improve teaching and learning in music. TI:ME hosts a yearly conference on technology in music education and their website (http://www.ti-me.org/) offers music teachers resources and articles about specific technology tools integrated into the music curriculum.

Digital technology has changed the way people perform, compose, share, and purchase music (Gall & Breeze, 2008; Savage, 2007). The Internet allows immediate access to music of all genres and styles and gives composers access to sophisticated musical tools that were previously only found in recording studios (Savage, 2007). However, changes in the music world do not always align with changes in the music classroom, which continues to remain technologically conservative (Savage, 2007). In fact, it is still uncommon to see music classrooms fully equipped with computers or other digital technologies (Gall & Breeze, 2008). However, one of the case study teachers in this study is a general music teacher in a K-5 school.

Savage (2007) suggests that a paradigm shift within music education needs to occur for music teachers to recognize the benefits of integrating technology in the music curriculum:

> Teachers too need to broaden their understanding of what constitutes musical compositional and performance activity in the light of the changing practices that ICT is bringing to music in its various genres. They will need to recognize that using ICT in music education has the potential to transform the nature of the subject itself as well as how it could be taught. (p. 74)

In his study of 18 music education schools, Savage (2007) found that interviews of teacher participants revealed some of the benefits of using music technology, including the following:

(1) Motivation for boys to be involved in music,

(2) Students exhibiting increased pride, enthusiasm, and motivation about their work in music class,

(3) Teachers changing the music curriculum to make it more stimulating and relevant,

(4) An increased ease at which students approached technology compared to traditional instruments,

(5) New approaches to music composition, and

(6) More accurate alignment of the music classroom and the music world.

In addition to the benefits of using music technology, the teacher participants also cited potential problems:

(1) Technical difficulties with the music technology,

(2) A noticeable loss of conventional musical skills in some cases,

(3) Students' decreased confidence in musical performances,

(4) An increase in computer isolation, and a decrease in peer interactions with the music,

(5) Difficulty in ensuring equal access to limited technology resources,

(6) Varying student interest in using music technology, particularly those traditionally trained in playing an instrument, and

(7) Students confusing quantity of work with quality work due to increased productivity from use of music technology. (Savage, 2007)

Digital technologies first developed for the entertainment industry are making their way into music classrooms. For example, the software program *eJay* (http://www.ejay-store.eu/) was originally aimed at the entertainment market, but is now being successfully integrated into music classrooms (Gall & Breeze, 2008). *Dance eJay* provides the user with a variety of short music samples they can organize to create their own longer music. In their study of two music teachers working with students ages 10-11on the development of composition skills through the use of *Dance eJay*, Gall and Breeze (2008) found that the teachers' use of *Dance eJay* encouraged collaboration and creativity among students as they negotiated ideas and arranged the music together. Despite the software program offering the same variety of music clips to each pair of students, the students composed very different pieces of music when using *Dance eJay*.

Despite the fact that digital technology has changed the way people perform, compose, share, and purchase music (Gall & Breeze, 2008; Savage, 2007), there continues to be a gap in the literature examining how music teachers, especially in elementary schools, use technology in their music classrooms. Perhaps there still needs to be a paradigm shift among music teachers and the way they think about technology (Savage, 2007), or maybe researchers are missing out on innovative practices in music classrooms today.

Technology and Science

The National Science Teachers Association (NSTA) recognizes the need to address 21st century skills, as defined by the Partnership for 21st Century Skills (2009), within the context of science education. NSTA (2011) suggests that there is a correlation between 21st century skills and the goals of science education and that exemplary science education can foster 21st century skills including critical thinking, problem solving, and information literacy. NSTA (2011) recommends that science educators use the Partnership for 21st Century Skills framework (2009) in the context of science education. Wofford (2008) argues that, within science, "new intellectual fields are emerging that include traditional disciplines, but also ignore boundaries" (p. 29), suggesting that the field of science is changing and so should science education. Edelson (2001) suggests that computers have changed the way scientists collect and analyze data in scientific research and that "an effort to engage students in authentic scientific practices should reflect this trend" (p. 356).

Current best practices in science education include inquiry-based education (Higgins & Spitulnik, 2008). Higgins and Spitulnik (2008) describe the inquiry approach to teaching science as one that "supports students in identifying problems, designing experiments, gathering evidence, constructing models, and forming arguments. It also requires students and teachers to think critically about information sources and claims, as well as to make informed decisions about scientific topics" (p. 512). Bransford et al. (2000) state that inquiry-based instruction fosters the growth of deep foundational knowledge in a content area and allows students to expand their own problem-solving abilities. Gerard, Varma, Corliss, and Linn (2011) suggest that

> new instructional technologies can support classroom inquiry by providing opportunities for students to experiment with dynamic simulations of scientific phenomena, engage in scientific modeling, and participate in scientific experimentation activities such as collecting data and conducting analyses using probeware and scientific databases. (p. 409-410)

Gerard et al. (2011) also cite students' learning gains in science as significantly greater when using technology tools to enhance inquiry versus using textbook materials alone. Guzey and Roehrig (2009) suggest that using technology in inquiry-based science classrooms encourages students to think and work like scientists:

> Educational technology tools such as computers, probeware, data collection and analysis software, digital microscopes, hypermedia/multimedia, student response systems, and interactive white boards can help students actively engage in the acquisition of scientific knowledge and development of the nature of science and inquiry. (p. 27)

In their study of laptops and science technology tools in middle school science classrooms, Yerrick and Johnson (2009) found that students spent more time in the science classroom outside of class hours working with the MacBooks, probeware, and iLife applications. Students in this study also reported having greater access to data with the collecting probes, digital microscopes, and web-based databases for data such as seismic activity (Yerrick & Johnson, 2009). In addition to collecting and analyzing data, the students also cited technology benefits in their science classes that included being able to repeat experiments, making concepts clear, collaboration, time saved, and ease of use (Yerrick & Johnson, 2009). Science teachers using the laptops and science equipment saw gains in student achievement from the pre-test to the post-test in all topics throughout the year, including gains in overall scores from the previous year, indicating that teaching science with the technology tools may have impacted student learning (Yerrick & Johnson, 2009).

Successfully integrating both technology and inquiry into science instruction requires that teachers have developed science content, pedagogical, and technological knowledge (Higgins & Spitulnik, 2008). Unfortunately, in traditional science classrooms, content and inquiry skills are often taught separately with the content delivered through lecture and inquiry skills encouraged through lab experiments (Edelson, 2001).

Computer technologies can also be used in science classrooms for:

(1) calculation,

(2) simulation, such as how a tornado forms, allowing students to ask questions and analyze behavior of complex systems,

(3) data collection through audio, images, text, voice, annotations, and numerical data,

(4) imaging to represent ideas through the use of scanners, cameras, and graphic programs,

(5) writing of scientific observations using word processing,

(6) accessing information, especially on the Internet,

(7) networking with other students and professional scientists,

(8) presentations of findings, and

(9) portability in data collection through the use of laptops or handheld devices (Woolsey & Bellamy, 1997).

Roschelle et al., (2000) argue that "computer-based applications using visualization, modeling, and simulation have been proven to be powerful tools for teaching scientific concepts" (p. 86). They go on to suggest that "technology using dynamic diagrams—that is, pictures that can move in response to a range of input –can help students visualize and understand the forces underlying various phenomena" (p. 86). The University of Colorado at Boulder, as one example, offers free interactive simulations for students in physics, chemistry, biology, and earth science on their PhET website (http://phet.colorado.edu/).

The Internet also provides access to real-time resources for students gathering data and information. For example, satellite imagery online allows students real-time access to changes in weather patterns, allowing them to collect data and make predictions just as a meteorologist might do (Mistler-Jackson & Songer, 2000). The Satellite Services Division of the National Environmental Satellite, Data, and Information Services (NESDIS) provides real-time access to satellite data for the public and the government (http://www.ssd.noaa.gov/). Students can also access satellite imagery through the National Weather Service (http://weather.gov/), and the United States Geological Survey (http://www.usgs.gov/) allows students to access maps, aerial photographs, satellite images, and other data (Yerrick & Johnson, 2009). In addition to being dynamic and current, unlike textbooks, Internet resources can provide authenticity in data collection. For example, scientists in the field being studied can be contacted and questioned by students through email or Skype giving the students a chance to ask questions and grapple with current issues in science (Mistler-Jackson & Songer, 2000).

In their case study of the Kids as Global Scientists eight-week atmospheric science network program, Mistler-Jackson and Songer (2000) found that the use of the Internet to study general weather topics collaboratively with other students and professional scientists across North America motivated students to work on the class project significantly longer than they had on previous projects not using the Internet for research and collaboration. Their inquiry-based project allowed for (1) telecollaboration in which students worked with other students across the nation sharing data, (2) study of authentic questions posed to scientists in the field, and (3) sufficient time for development of understandings due to the inquiry-based nature of the project (Mistler-Jackson & Songer, 2000). One of the benefits of the Kids as Global Scientists program was the relevance it provided students to science topics, in this case, the topic of weather (Songer, Lee, & Kam, 2002). The researchers cited this benefit as being most impactful to their African-American students who otherwise felt disconnected from the science material (Songer et al., 2002).

Technology and Social Studies

The National Council for the Social Studies (NCSS) addresses technology in both its national curriculum standards and its approach to teaching social studies. Focusing on teaching social studies, the NCSS (2006) believes that technology should be woven into the social studies curriculum and that technology should be thought of in terms of its effect on the teaching and learning of social studies. NCSS offers guidelines for social studies educators on the effective use of instructional technology modeled after ISTE's National Educational Standards (2008). These guidelines, as related to technology, include 1) technology operations and concepts, 2) planning and designing learning environments and experiences, 3) teaching, learning, and the curriculum, 4) assessment and evaluation, 5) social, ethical, legal, and human issues (see NCSS, 2006 for more information on these guidelines). The integration of technology in social studies encourages the use of various instructional methods that motivate students in a subject area they typically deem boring (Heafner, 2004).

Traditionally, social studies educators have been known for taking a familiar pedagogical approach to instruction in which “the teacher talks and the students listen” (Doolittle & Hicks, 2003). Heafner (2004) summarizes research on social studies education as saying students typically associate social studies as being boring and unimportant, qualities, she says, that tend to result from the teacher’s instructional methods. Tally (2007) says a gap exists between powerful uses of technology in social studies and how technology is actually being used in the content area. Journell (2009) says that social studies instruction is usually stereotyped as being “dull and lifeless with no relevance to students’ lives” (p.56), which is often depicted in popular movies such as *Ferris Bueller’s Day Off.* If it is true that many teachers use technology to maintain existing practices (Cuban, 2001; Swan & Hofer, 2008), then the traditional social studies lecture may not look much different with the use of technology. Doolittle and Hicks (2003) agree that traditional pedagogical uses of technology will not enhance social studies instruction:

> If integrating technology means nothing more than enhancing the traditional delivery system of social studies content, where laptops replace notebooks, where PowerPoint slides replace handwritten overheads, where e-textbooks replace hard copy textbooks, then we will be no closer to the NCSS vision of transformative, powerful social studies instruction. (p.75)

Instead, Doolittle and Hicks (2003) suggest that effective technology integration in social studies starts with a shift in pedagogical beliefs among social studies educators. They believe that a constructivist approach to instruction, where the teacher acts more as a facilitator of knowledge, rather than a giver of knowledge, would provide classroom environments conducive to technology integration:

> A key implication is that if interactive technologies are truly going to impact teaching and learning there needs to be a shift in social studies education that requires technology to be used as a resource stimulus for inquiry, perspective taking, and meaning making, and not as a conduit for the transmission of knowledge. (Doolittle & Hicks, 2003, p. 14)

Technology can encourage a constructivist learning environment "in which students construct their own interpretations of history" (Journell, 2009, p. 56). However, when integrating technology, teachers cannot just think about technology as a tool; decisions must be made regarding how to use the tool within the social studies curriculum because the tool itself does not guarantee learning (Doolittle & Hicks, 2003; Journell, 2009; O'Brien, 2008; Staley, 2000). To encourage effective technology integration within the social studies, Doolittle and Hicks (2003) offered teachers the following strategies:

1. Teachers and students should be prepared to implement technology as a tool for inquiry.
2. Teachers should use technology to create authenticity, which facilitates the process of student inquiry and action.
3. Teachers should use technology to foster local and global social interaction such that students attain multiple perspectives on people, issues, and events.
4. Teachers should facilitate student knowledge construction by using technology to build on students' prior knowledge and interest.
5. Teachers should enhance the viability of student knowledge by using technology to provide timely and meaningful feedback.

6. Teachers should cultivate students' academic independence by using technology to foster autonomous, creative, and intellectual thinking. (p. 14-18)

Staley (2000) believes that "technology in the classroom will be truly effective if it can aid in this process of discovery, active analysis, and historical thinking" (para. 16).

In the beginning of the 21^{st} century, the focus of digital technology integration in social studies was mainly on the use of Internet resources, since they provided sources that moved students beyond classroom textbooks and books (Doolittle & Hicks, 2003), although there was little research regarding technology integration in social studies instruction until after 2005 (Hofer & Swan, 2008). Friedman and Heafner (2007) agree that during the first part of the 21^{st} Century social studies educators advocated for the use of the Internet in social studies instruction because it surpassed geographical distance and political boundaries and allowed students to study differing perspectives. However, they found that Internet use in social studies classrooms tended to involve low-level tasks, despite the students' comfort level with the technology, which was often a result of teacher pedagogical beliefs about the use of technology (Friedman & Heafner, 2007).

In addition to being a way to gather information, Internet use in social studies classrooms is an effective way to give students access to primary sources (Friedman, 2006; Salinas, Bellows, & Liaw, 2011; Staley, 2000). Friedman (2006) says "digital primary historical sources allow students to analyze documents of the past and draw their own conclusions" (p. 315). The National Archives (http://www.archives.gov/) and the Library of Congress (http://www.loc.gov/) are just two examples of the many websites that offer free primary sources including photographs, original documents, and audio files that can be used in the classroom. However, despite their availability, Friedman (2006) found that teaching with digital primary sources was still viewed as something to do only if there was enough time because the teachers with whom he worked felt pressured by the state standardized tests. One teacher in Friedman's (2006) study felt like she did not have enough time to allow students to "surf around" the Internet looking at primary sources when important tested facts would not be on them (p. 319). Heafner (2004) also found that in high-stakes testing situations, student interest is sacrificed for content coverage, provided most often through lecture and discussion in social studies. Salinas et al. (2011) noted that, in order to use digital primary sources in the classroom and still prepare students for state tests, teachers need to recognize the ways in which technology can transform pedagogy. They examined pre-service teachers' ability to critically evaluate the use of digital primary sources in their own instruction. They found that "the way teachers determine the value, usefulness, and trustworthiness of websites with digitized primary sources is entwined with how they understand historical thinking" (p. 197), which supports the idea that knowledge of content, pedagogy and technology cannot be isolated when choosing instructional activities (Mishra & Koehler, 2006).

The use of primary sources in the social studies classrooms addresses the National Council for the Social Studies (NCSS) Theme known as Time, Continuity, and Change. According to NCSS, "Studying the past makes it possible for us to understand the human story across time" (http://www.socialstudies.org/standards/strands). Within this theme is the idea of encouraging students to think as an historian might think while examining and interpreting different historical artifacts and perspectives (Friedman, 2006). In fact, Swan and Hofer (2008) state that “the majority of research that examines technology in the social studies focuses on the impact of technology on historical thinking and the instructional uses of technology in history teaching” (p. 308). Salinas et al. (2011) suggest that in order to engage in historical thinking, such as with the use of digital primary sources, social studies teachers must be willing to allow for the construction of knowledge, rather than the traditional view that history is already constructed. Hofer and Swan (2008) used a movie-making tool, in their case Windows *MovieMaker*, to lead fifth graders in creating short, historical, documentary films that they called myth-busters because they challenged traditional stories that often are myths, such as that of Rosa Parks and the bus boycott. Although Hofer and Swan (2008) observed higher student engagement resulting in a deeper understanding of historical myths throughout time by examining primary documents and sharing their findings through *MovieMaker*, the fifth grade teacher participant in their study was not convinced that creating historical documentaries was the most effective way to reach her instructional goals. Instead of allowing the students to choose the myth, she felt like her instructional goals would be better met if they focused on the myth most closely aligned with the period in time they were studying, which suggests that she may have been more comfortable teaching social studies chronologically, like many social studies educators (Hofer and Swan, 2008).

Journell (2009) makes the point that technology use in social studies can transform the way students think about history. He suggests that “technology has the capability to develop historical empathy among students like no previous educational resource” (Journell, 2009, p. 57), which, given the teacher’s effective integration of technology, could allow students to understand more of the emotional aspects of history, rather than just the facts and dates. He cites simulations, such as those offered by the British Broadcasting Corporation (BBC) as offering students glimpses at what it might have been like living during a certain time period like the Holocaust in Auschwitz. Gaming through video games and computer games is not often thought of as an educational tool, but can also transport students to another time and place, encouraging them to make decisions as someone living during that time might, such as military commanders making decisions on the battlefield (Gaudelli & Taylor, 2011; Gee, 2007; Journell, 2009).

With state testing focusing on mathematics, reading, and science at the elementary level, social studies tends to be the first subject cut from the daily schedule. Field trips can be a way elementary teachers share history with their students.

> Field trips can provide students the opportunity to construct knowledge actively through interacting with historic places, experts, and artifacts. When integrated into the curriculum and not used as rewards, field trips can be among the most valuable and effective modes of history teaching, especially local historic sites. (Stoddard, 2009, p. 412)

While taking field trips might be the ideal way to encourage historical thinking, a lack of funds often prevents classes from taking field trips during the school year (Nespor, 2000; Tuthill & Klemm, 2002). To counteract this dilemma, virtual field trips (VFTs) offer students the ability to access historical sites and resources without leaving the school. Tuthill and Klemm (2002) suggest that “new technologies can help overcome geographic isolation, support an investigative study of local topics, and promote global understanding" (p. 455). Resources on the Internet encourage an "anytime, anywhere" approach to learning that connects students with places and people around the world (Tuthill & Klemm, 2002).

Virtual field trips can be achieved in different ways using various technologies. Many VFTs already exist through reputable locations such as George Washington's Mount Vernon Estate (http://www.mountvernon.org/) or the White House (http://www.whitehouse.gov/). Some websites offer webcams that allow students to observe what is happening 24/7, such as the San Diego Zoo (http://www.sandiegozoo.org/livecams/). Public museums, such as The United States Holocaust Memorial Museum in Washington, DC (http://www.ushmm.org/) offer invaluable online exhibits including artifacts and videos for classes that cannot visit the museum in person (Journell, 2009). VFTs can also be created by teachers. Websites such as TrackStar (http://trackstar.4teachers.org/trackstar/) provide a place for teachers to organize multiple hyperlinks leading students through a VFT. Currently, teachers are also creating VFTs using Google Earth (http://www.google.com/earth/index.html). Many VFTs are already created online and supported by virtual tours, webcams, audio clips, and images, and teachers can customize their own VFTs using the same instructional media. However, Tuthill and Klemm (2002) warn us that "many of the shortcomings of actual field trips have their electronic field trip counterpart" (p. 458). Therefore, it is important for teachers to keep instructional goals in mind when choosing VFTs because many pre-made trips address multiple concepts, grade levels, and interests (Stoddard, 2009). In my personal experience, VFTs work best when the teacher creates a Trip Guide for the students to follow that specifically states instructional goals and encourages higher-level thinking, while still allowing the students choice as they navigate the VFT.

Civic Ideals and Practices is another one of the ten NCSS Themes for the social studies curriculum. According to NCSS, “social studies programs should include experiences that provide for the study of the ideals, principles, and practices of citizenship in a democratic republic” (http://www.socialstudies.org/standards/strands). In elementary grades, students are introduced to the theme of Civic Ideals and Practices through activities such as helping to set classroom rules and expectations, participating in mock elections, and determining how to balance the needs of individuals and the group. VanFossen and Berson (2008) suggest that, when addressing this theme, elementary students also need “instruction on the application of skills for critical analysis and ethical decision making as citizens in a digital world” (p. 123). Berson and VanFossen (2008) view the use of digital technology in the social studies classroom as a chance to teach students about being a participatory citizen:

> In fact, social studies teachers have a critical role to play in establishing a strong foundation of skills for interaction in digital spaces that primes children as citizens who optimize the iterative functions of the Web for self-expression and participatory forms of citizenship. (p. 219)

O’Brien (2008) says educators need to be careful not to think of digital citizenship as being the same as citizenship in the face-to-face world:

> If the online environment is not considered as substantially different from the offline one, social studies educators run the risk of applying preconceived notions not only of citizenship, citizenship education, freedom of expression, and

> commercial and public space to the online environment, thus, limiting its potential and young people's preparation for it. (p.126)

Berson and VanFlossen (2008) affirm that all fifty states have promoted teaching students how to safely interact in online environments, yet this instruction is not typically aligned to content curriculum standards. Researchers suggest that cybersafety, digital citizenship, and the promotion of democratic engagement through online sources have a place in social studies education (Berson, Berson, Desai, Falls, & Fenaughty, 2008; Berson & VanFlossen, 2008; Doolittle & Hicks, 2003; O'Brien, 2008). O'Brien (2008) proposes a virtual laboratory of democracy to teach students to be digital citizens. This virtual laboratory of democracy would be open to K-12 students on an education site that would "serve as a democratic commons where young people might engage in discussion of school or local, national, or global concerns" (O'Brien, 2008, p. 143). iCivics (http://www.icivics.org/), a vision of Justice Sandra Day O'Connor, is designed similarly to O'Brien's (2008) virtual laboratory of democracy. The goal of iCivics is to teach students civics and to encourage them to be informed, active citizens. This is done through virtual simulations and games that allow students to take on the role of the President, make voting decisions during political debates, better the community, and have control of the federal government's budget. iCivics also offers teachers resources for teaching civics (http://www.icivics.org/teachers). The Internet also provides classrooms access to current events as they happen, as well as websites of politicians, allowing students to be connected to all that is happening in the world at a moment's notice (Journell, 2009).

Utilizing Technology in the Content Areas

Harris and Hofer (2011) suggest that "successful technology integration is rooted primarily in curriculum content and content-related learning processes, and secondarily in savvy use of educational technologies" (p. 211). Planning for the use of technology in the content areas previously mentioned should incorporate teacher knowledge of technology, pedagogy, and content (Mishra & Koehler, 2006). Although there are many innovative ways technology can be integrated into the curriculum, Tally (2007) reminds those who advocate for technology within content areas to remember to take a critical look at the way in which it is used. He cautions against using technology with restrictions, rather than fostering creativity, like when a product such as a PowerPoint presentation is assigned with a list of formatting and organizational directions. The decisions teachers make for the purposeful integration of technology in the content areas can determine its instructional effectiveness, and because of this, we must also examine how teachers make those decisions through lesson planning.

Technology and Diverse Learners

The use of technology is often promoted to meet the needs of diverse learners (Bray, Brown, & Green, 2004; Watson & Watson, 2011), which is important to address here because the students in the classrooms I will be studying are diverse in many ways. Bransford et al. (2000) suggest that "many technologies function as scaffolds and tools to help students solve problems" (p. 213). Watson and Watson (2011) cite "interactive content, giving immediate feedback, diagnosing student needs, providing effective remediation, assessing learning, and storing examples of student work (e.g., portfolios)" as critical elements in technology-enhanced, learner-centered instruction for diverse learners (p. 39). Bray et al. (2004) suggest that “technology can be quite effective in reducing or removing restrictions that hinder the performance of normal human activities” (p. 9). The use of technology can also challenge students beyond what traditional curriculum and instruction offers (Shaunessy, 2007; VanTassel-Baska & Stambaugh, 2006). Given this, it is important to recognize the ways in which teachers use technology to meet the various needs of their learners. Therefore, in this section, Universal Design for Learning (UDL) is discussed as a framework for integrating technology to meet diverse learning needs. Then, with the demographics of the study’s schools in mind, the following areas will be reviewed from the research on technology and diverse learners: (1) socioeconomic status and the digital divide, (2) English language learners, and (3) exceptional learners, specifically students with learning disabilities and gifted students.

Universal Design for Learning (UDL)

Universal design is a term common to designers of products, buildings, and environments (Rose & Gravel, 2010). Architects design buildings that are universally accessible to all users. For example, today’s buildings include elevators, ramps, automatic doors, and other features that eliminate barriers for the needs of diverse people (Rose & Gravel, 2010). A door that opens automatically may eliminate a barrier for someone in a wheelchair, a mother pushing a stroller, or even someone carrying too many items to open the door. In this case, the automatic door is universally designed for various users of the building.

Similar to the idea of universal design, Universal Design for Learning (UDL) "is the process by which we attempt to ensure that the means for learning, and their results, are equally accessible to all students" (Rose & Gravel, 2010, p. 2). UDL is based on three principles:

(1) providing multiple means of representation;

(2) providing multiple means of action and expression; and

(3) providing multiple means of engagement. (Male, 2003; Rose & Gravel, 2010; Rose & Meyer, 2002)

The principles of UDL address:

> three critical features of any teaching and learning environment: the means by which information is presented to the learner, the means by which the learner is required to express what they know, and the means by which students are engaged in learning. (Rose & Gravel, 2010, p. 3)

UDL is a framework for learning that encourages the use of curriculum materials that are universally accessible to all students because instructional supports are built-in to the materials (Rose & Meyer, 2002). The National Center on Universal Design for Learning (http://www.udlcenter.org/) offers more information on UDL, including videos, articles, and examples of UDL in the classroom. Offering multiple means of representation, action and expression, and engagement aligns with Shulman's (1986) suggestion that teachers should have a toolbox of multiple representations based on their knowledge of the content and how to best teach it.

One way to provide instruction that is universally accessible to students is through the integration of technology (Male, 2003; Rose & Meyer, 2002). Technology offers supports that may aid or challenge diverse learners. For example, electronic books (e-books) contain supportive elements that aid in decoding, pronunciation, fluency, and comprehension of the text (Rhodes & Milby, 2007; Zucker, Moody, & McKenna, 2009). Because these supports are built into the text, unlike in traditional print-based texts, e-books nicely align with UDL. When planning for technology integration, teachers should consider how the supportive elements that are already built in to the technology tool can enhance instruction and support the diverse learning needs of their students. UDL should also be considered a way of thinking about planning. Just as an architect may place a ramp or elevator in his initial building blueprints, a teacher should think of multiple representations of material and instructional supports within the initial stages of planning, rather than as a modification or afterthought to the planning process.

Socioeconomic Status and the Digital Divide

Students of low socioeconomic status (SES) can benefit from the use of technology in the classroom. However, research indicates that students and teachers in low-income areas often use computers for repetitive activities such as skill development and test preparation, whereas students and teachers in high-income areas use computers more often for inquiry-based activities and to promote higher-order thinking skills (Becker, 2000; Cummins, 2008; Mouza, 2011). Students in high-income families are also cited as having greater access to technology at home than their peers from low-income families (Becker, 2000; Cummins, 2008; Mouza, 2008). This disparity of access is called the digital divide (Becker, 2000; Hess & Leal, 1999). Schrum and Levin (2009) define the digital divide:

> The digital divide, much like the achievement gap, reveals inequities in access to technology between rural, urban, and suburban schools; large and small schools; and affluent and poor schools. Unequal access to technology is usually present in homes and neighborhoods that are poor, rural, and often urban compared to homes and neighborhoods that are more affluent or suburban. (p. 79)

However, the way we define the digital divide is changing. As access to technology at school and at home becomes ubiquitous, the quality of access continues to be divided (Crawford, 2011; Hertz, 2011). For example, many adults and teens have access to the Internet through Smartphones and regularly use their phones to check email and visit websites. Due to a lack of competition in the market of Internet providers, home wireless coverage is often more expensive, especially in rural areas, than cell phone data packages. Despite being connected, those who only access the Internet through a cell phone may struggle with tasks that are increasingly becoming digital, such as job applications (Crawford, 2011; Hertz, 2011).

Becker (2000) reminds us that schools are a place where we can bridge the digital divide when he says that “schools play a critical role in ensuring equal opportunity for less-advantaged children by providing access to a wide range of enriching experiences, including exposure to computer technology” (p. 45). In an increased awareness of the digital divide, many schools have allotted instructional funds or sought grants to purchase digital technologies (Gibbs et al., 2009). However, access to technology resources does not completely remove first- and second-order barriers for teachers (Ertmer et al., 1999; Gibbs et al., 2009). Bridging the digital divide requires more than just placing computers in classrooms (Becker, 2000; Gibbs et al., 2009). Gibbs et al. (2009) suggest that bridging the digital divide entails

> providing all students with reasonable access to technology, providing teachers with the professional development they need to access the resources, and providing an infrastructure within the school that supports not only the technology itself but also the incorporation of the technology in the curriculum. (p. 17)

In his study of 10 third and fifth grade classrooms in Louisiana, Page (2002) found that technology-enriched classrooms contribute to raising the self-esteem levels of low SES elementary students. In addition to enhanced self-esteem, Page (2002) stated that the low SES students in technology-enriched classrooms in his study scored significantly higher in mathematics achievement than the students in the non-technology enriched classrooms. Mouza (2011) suggests that the need to prepare economically disadvantaged students with the technological skills for participation in the global world is crucial to their success.

English Language Learners

There are also advantages for English language learners (ELLs) when integrating technology in the classroom (Lee, 2006), which is relevant because a large proportion of the learners in the teachers' classes that I am studying are English learners. Beckett et al. (2007) summarized the literature on ELLs and technology integration:

> According to research on English language learners, integration of technology into instruction can augment positive self-concepts, promote English and native

> language proficiency, enhance motivation, stimulate positive attitudes toward learning, improve academic achievement, and foster higher level thinking skills. (p. 26)

ELL technology use in cooperative groups also provides opportunities for collaboration among students (Beckett et al., 2007; Lee, 2006). Beckett et al. (2007) suggest that the integration of technology to support ELLs is best done when aligned with TESOL standards for intentional language teaching. An example of current WIDA (World Class Instructional Design and Assessment) standards for ELLs used by many teachers can be found on the organization's website (http://www.wida.us/standards/).

One example of an online program designed specifically for ELLs in math is the HELP with English Language Proficiency Program (HELP Math or HELP) (Freeman, 2012). HELP Math (http://www.helpprogram.net/public/) targets ELLs in grades 3 through 10. According to Freeman (2012), "language and vocabulary and the development of prerequisite knowledge and skills are fundamental cornerstones of the program" (p. 53). HELP Math applies UDL principles by

1) presenting concepts in multiple ways,

2) delivering content with both audio and video,

3) providing customizable learning activities with supports that can be turned on or off,

4) offering explanations for terms, and

5) providing interactive modeling and guided practice. (Freeman, 2012)

HELP Math offers teachers and students

> 1) over 300 hours of interactive standards-aligned math content,
>
> 2) a digital media library with virtual manipulatives,
>
> 3) diagnostic assessments,
>
> 4) a customizable learning environment based on the students' needs, and
>
> 5) continuous feedback and monitoring of student progress. (Freeman, 2012, p. 53)

In her study of secondary ELLs using HELP Math in a sheltered math class, Freeman (2012) examined the effect of the online program on students' math ability and perceived math self-efficacy. Freeman (2012) found a statistically significant relationship between providing a math intervention that was purposefully designed with specific embedded instructional supports and positive student learning outcomes. She suggests that there is a continued need for personalized digital technologies that target the needs of special populations (Freeman, 2012).

Exceptional Learners

Digital technologies offer supports to exceptional learners in the general education classroom setting (Bray et al., 2004; Hasselbring & Glaser, 2000; Lewis, 1998). Exceptional learners have varying characteristics and needs. For the purpose of this literature review, two categories of exceptional learners will be discussed: students with learning disabilities and students who are academically gifted because students with such varying skills and abilities are located in all the classrooms in this study. Students with learning disabilities constitute 50% of the children identified as exceptional (Bray et al., 2004). Students who are classified as having a learning disability have normal or above-normal intelligence, and may also be identified as gifted. Bray et al. (2004) describe learning disabilities:

> A learning disability negatively impacts a student's ability to use and/or acquire basic skills in listening, speaking, reading, writing, and/or mathematics. The most common types of learning disabilities focus on basic language and/or reading skills. (p. 27)

To be identified as having a learning disability prior to implementing RTI strategies for early intervention, most states use the following criteria:

- A severe discrepancy exists between the student's intellectual ability and academic achievement.
- The student's difficulties are not the result of another known condition that can create learning problems.
- A need for special education services exists. (Bray et al., 2004, p. 28)

Some common learning disabilities are (a) Dyslexia: a persistent deficit in basic reading skills and letter recognition; (b) Dysgraphia: difficulties in writing, including the physical aspects of writing, spelling, and putting thoughts on a paper; (c) Dyscalculia: difficulties in either counting and calculating or understanding math processes (Bray et al., 2004). Although there is no known "cure" for learning disabilities, instructional supports, such as technology, offer students ways to achieve academic success.

Gifted and talented students can also be referred to as exceptional learners (Bray et al., 2004). Bray et al. (2004), describe gifted and talented students as “students who excel in academic settings and therefore require unique instructional strategies to address their “accelerated” needs” (p. 9). Students may be considered gifted in terms of cognitive skill, visual or auditory skills, or physical skills (Bray et al., 2004). Generally, these characteristics distinguish gifted learners from their peers:

- The ability to learn at faster rates,
- The ability to find and solve problems more willingly, and
- The ability to manipulate abstract ideas and make connections more easily (VanTassel-Baska & Stambaugh, 2006).

It is important to remember, however, that gifted students’ characteristics and needs are not all alike (VanTassel-Baska & Stambaugh, 2006). Gallagher (1975) also points out that many teachers believe giving longer, more extensive assignments to gifted students than given to other students in the classroom is a way to effectively modify the curriculum. Instead, to make instruction more meaningful for a gifted student, the teacher can modify the content, the process by which the content is taught and/or the thinking processes expected of the students, and the learning environment (Gallagher, 1975; Maker & Schiever, 2005).

Assistive technologies and compensatory technologies. Assistive technology (AT) includes “both ‘low’ technologies and ‘high’-tech devices and it incorporates technologies designed specifically for people with disabilities as well as generic technologies developed for use by the general public" (Lewis, 1998, p.16). Lewis (1998) suggests that it is a mistake to think too narrowly about assistive technology because all digital technologies have possibilities for supporting and enhancing learning for students with special needs. Assistive technology has two major purposes: (1) to augment an individual's strengths so that his or her abilities counterbalance the effects of any disabilities, and (2) to provide and alternate mode of performing a task so that disabilities are compensated for or bypassed entirely (Lewis, 1998, p. 17). Bray et al. (2004) suggest that assistive technologies are generally used to help students access information necessary to understand a concept, rather than to actually teach the concept. Due to the amount of assistive technologies available for specific learning disabilities and given that this paper focuses on the general education classroom, this paper will focus more on what Bray et al. (2004) call compensatory technologies. Compensatory technologies "help a student perform a task more effectively and efficiently than they could on their own" (p. 10). An example of a compensatory technology is a word processing program. A word processing program allows students to engage in the writing process while freed from handwriting and letter formation, spelling (if using spell check), and recopying work during the editing process. In this paper, compensatory technologies that are used by all students in the general education classroom will be discussed.

Learning disabilities and technology. Students needing support in reading and writing often find it through the use of technology during literacy instruction (Bray et al., 2004; Jeffs, Behrmann, & Bannan-Ritland, 2006; Male, 2003). Jeffs et al. (2006) found that students struggling with literacy, as identified through Individualized Education

Plans (IEPs), created longer, more detailed stories using technologies such as Microsoft Word, the graphic organizer software Inspiration (http://www.inspiration.com/), PowerPoint, and Storybook Weaver Deluxe, a graphic-based word processing software, than when they used paper and pencil alone. An advantage of using word processing programs with students who struggle with literacy is that they allow students to edit their work more easily, reducing the consequences of making a mistake while writing (Bray et al., 2004; Hasselbring & Glaser, 2000; Lewis, 1998; Male, 2003). Electronic texts and electronic books (e-books) also provide supportive elements for struggling readers (Karchmer, 2001; Lewis, 1998; Rhodes & Milby, 2007; Zucker et al., 2009). E-books often incorporate many of the supportive principles of Universal Design for Learning (UDL) that promotes accessible text for all readers (Rose & Meyer, 2002). The principles of UDL were discussed earlier. Calculators are another example of a compensatory technology that alleviates struggles with simple calculations, allowing students to focus on more advanced math concepts (Bray et al., 2004).

Gifted learners and technology. Technology use with gifted students challenges them beyond what traditional curriculum and instructional practices offer including opportunities for abstract thinking, creativity, and critical thinking skills (Shaunessy, 2007; VanTassel-Baska & Stambaugh, 2006). VanTassel-Baska and Stambaugh (2006) state that the field of gifted education recognizes the following specific learning conditions for gifted students that can be supported by technology integration:

(1) a learner-centered focus,

(2) opportunities to explore complex and real-world problems,

(3) opportunities to pursue interests and abilities,

(4) flexibility in programming and learning options,

(5) creation of innovative products,

(6) opportunities to work at an appropriate pace,

(7) elimination of previously mastered material,

(8) higher-order thinking skills, and

(9) opportunities for independent study. (p. 291)

Research has cited simulation activities, Internet activities, virtual reality programs, multimedia applications and programs, acceleration in math, and distance learning as offering challenging opportunities for gifted students (Shaunessy, 2007).

The Internet offers real-time access to information to gifted students who process information quickly (Shaunessy, 2007), including the ability to consult professionals in the field they are studying (VanTassel-Baska & Stambaugh, 2006). When posed with challenging questions, gifted students can benefit from the ability to travel around the world virtually (VanTassel-Baska & Stambaugh, 2006). VanTassel-Baska and Stambaugh (2006) also cite WebQuests as appropriate activities for gifted learners on the Internet. Developed by Bernie Dodge in 1995, a WebQuest is "an inquiry-oriented lesson format in which most or all the information that learners work with comes from the web" (Dodge, 2007). More information on WebQuests can be found on Bernie Dodge's Webquest website (http://webquest.org/index.php). As in any activity accessed from the Internet, teachers need to consider the level of complexity of the WebQuest they are using with gifted students, as not all WebQuests that have been created are equally challenging (VanTassel-Baska & Stambaugh, 2006).

Virtual simulations that allow students to experience an authentic event, including the implications and consequences of making decisions within the event are a tool that may challenge gifted students (VanTassel-Baska & Stambaugh, 2006). One example of a program that offers virtual simulations is *SimCity* (http://www.ea.com/simcity-4-deluxe). In *SimCity*, students can take on the role of a particular member of the community, such as a building engineer or an historian reviewing a primary document. These simulations provide students with real-world problems as they negotiate the role of the community member (Journell, 2009; VanTassel-Baska & Stambaugh, 2006). Other examples of virtual simulations and a discussion of its benefits within social studies are discussed in the *Technology and Social Studies* section of this literature review.

Teacher Planning

When thinking about the way teachers plan for technology integration, it is important to consider prior research that examined teacher planning in general (without the inclusion of digital technology). Clark and Peterson's (1986) definition of teacher planning guides this section of the literature review:

> Teacher planning includes the thought processes that teachers engage in prior to classroom interaction but also includes the thought processes or reflections that they engage in after classroom interaction that then guide their thinking and projections for future classroom interaction. (p. 258)

Empirical research on teacher planning increased in the 1970s as researchers became interested in teachers' behavior during preactive teaching, a term used to describe what teachers did before and after school, as well as during recess and other times away from the students (Clark & Peterson, 1986; Yinger, 1979, 1980). The most essential component of this preactive teaching time is planning. According to Yinger (1979, 1980) and, according to Clark and Peterson (1986), "it was not until 1970 that researchers began to examine directly the planning processes in use by teachers and to compare what was being practiced with what was being prescribed" (p. 263). At the time, what was being prescribed was mostly modeled after Tyler's (1950) linear model of planning (Clark & Peterson, 1986). During this period Shavelson (1973) posited that the most important teaching skill was decision-making, as he wrote that "any teaching act is the result of a decision, either conscious or unconscious" (p. 144). He recommended that research on teaching should examine teachers' decisions (Shavelson, 1973). Researchers agreed that the thoughtful decisions made during teacher planning impacted instruction and student outcomes (Shavelson, 1973; Yinger, 1979, 1980; Zahorik, 1970), but empirical research only began focusing on teachers' decision-making in planning situations (Yinger, 1980) in the 1970s.

The commonly held belief about teacher planning during the mid-twentieth century was that "specific, thorough planning will give direction to teaching and result in worthwhile, efficient learning" (Zahorik, 1970, p. 143). In one of the first empirical studies of teacher planning, Zahorik (1970) questioned this belief as always being correct and decided to investigate whether a planned lesson was less sensitive to students than a lesson that was not planned. Zahorik (1970) defined sensitivity to the students as being verbal acts by the teacher that support student ideas, thoughts, and actions. In this study

Zahorik (1970) divided a group of fourth grade teachers into two groups: teachers who planned and teachers who did not plan. Both groups were given the same lesson on credit cards, a topic not previously taught, but one with which most teachers and students had personal experiences. The teachers who planned were given the lesson plan in advance and encouraged to add to it, while the teachers who did not plan had to wait until the lesson began to learn that they were teaching a lesson on credit cards. Zahorik (1970) found that the teachers who did not plan for the lesson tended to use more of the students' experiences and examples to guide the lesson than those who had previously planned for the lesson. Not planning for the lesson allowed the teachers to feel like they could encourage more student comments, rather than have teacher initiated discussions. While it may seem counter-intuitive, Zahorik (1970) suggested that planning did not discourage sensitivity to students, but that not planning seemed to encourage more sensitivity to student ideas. Based on these findings, Zahorik (1970) recommended that, in addition to planning for specific goals and objectives to be achieved during the lesson, teachers should also plan for specific student sensitive behaviors they would like to accomplish during the lesson, such as recognizing and expanding on student comments.

Yinger (1980) summarized the findings of multiple studies of teacher planning in the 1970s and found that teachers spent the largest amount of their planning time focusing on the content being taught, with planning time focused on instructional strategies and activities being second (Yinger,1980; Zahorik, 1975). A focus on objectives was given the least amount of planning time (Kagan & Tippins, 1992; Yinger, 1980). When examining the types of problem-solving and decision-making involved in a first/second grade teacher's planning, Yinger (1980) found that two themes emerged from the data on teacher planning: planning for instructional activities and the use of teaching routines. Teaching routines are defined as "established procedures whose main function is to control and coordinate specific sequences of behavior" (Yinger, 1979, p. 165). He found that instructional activities were the teacher's most important and most frequent planning concern, but that activities were not separate from subject matter, making this case study a little different than the previous studies summarized by Yinger. The teacher participant in Yinger's (1980) study also was sensitive to students' backgrounds, as well as objectives, both of which were neglected by teachers in Yinger's previous review of the research. Yinger (1980) suggests that this may be attributed to the definition of teacher planning changing over time to include the decisions teachers make on and off paper about instruction, rather than just the act of writing lesson plans and implementing them in the classroom.

Researchers during the 1980's found that teachers make decisions about instructional practices based on the content they are teaching (Shulman, 1986; Stodolsky, 1988). This declaration is also the driving force behind the current TPCK framework (Mishra & Koehler, 2006), which currently includes knowledge about the technology teachers are integrating. However, such decisions vary with individual teachers as content and pedagogical knowledge is not universal and is always changing (Stodolsky, 1988). Decision-making during planning was found to be influenced by teacher experience (Ball, Knobloch, & Hoop, 2007; Superfine, 2008). For example, novice teachers may have more difficulty predicting and adjusting to student responses during instruction than expert teachers (John, 2006). Research on teacher planning past the 1980s was sparse until more recently with the emergence of the TPCK framework. Some examples of teacher planning for technology integration are discussed later in this chapter.

Models of Lesson Planning

Although learning how to write lesson plan is a staple in teacher education methods courses, more recent research indicates that the way teachers plan is influenced by content, materials available, the school context, beliefs, and experience, despite what was learned in their teacher education programs (Ball et al., 2007; Kagan & Tippins, 1992; Reid, 2009). Reid (2009) agrees that the way teachers plan is influenced by more than just the written format they use: "Regardless of the approach used by teachers to plan lessons, their intentional and accidental additions, deletions, and personal style inevitably dictate the final form of the curriculum" (p. 419). Various written lesson plan templates remain a significant part of the learning process in teacher education programs, even though most of them have not been examined empirically in classrooms (Kagan & Tippins, 1992).

Traditionally, the lesson plan templates used in teacher education programs and schools are linear, beginning with objectives and goals for the lesson (Ball et al., 2007; Clark & Peterson, 1986; Kagan & Tippins, 1992). This linear model was first proposed by Ralph Tyler (1950). The linear model included four steps: (a) specify objectives; (b) select learning activities; (c) organize learning activities; and (d) specify evaluation procedures (Clark & Peterson, 1986; Tyler, 1950). Tyler's linear model of lesson planning is still currently supported by some teacher education programs and school systems (Ball et al., 2007).

Other lesson plan examples include components of Tyler's (1950) linear model, yet veer away from being linear. For example, Joyce, Weil, and Calhoun (2004) identify the inquiry model as a way to "involve students in a genuine problem of inquiry by confronting them with an area of investigation, helping them identify a conceptual or methodological problem within that area of investigation, and inviting them to design ways of overcoming that problem" (p. 111). Often used in science teaching, this model encourages students to think as to think like scientists or mathematicians (Joyce et al., 2004). In the inquiry model, components such as the identification of objectives are significant to the process of planning, but the formulation of a problem that supports the curriculum is of equal significance to the process of planning, as it guides the unit of study.

Another example of a different model of teaching that includes Tyler's (1950) linear components, yet reorders the approach, is backward design (Wiggins & McTighe,1998). Also known as backward planning, teachers begin to plan with instructional objectives in mind but also with student outcomes in mind, or beginning with the end in mind. According to Wiggins and McTighe (1998) many teachers begin planning with activities in mind. Backward design shifts the focus from activities to instructional goals. Once teachers know what they would like their students to know and accomplish by the end of the unit of study, and know how they will assess what students learn, they then go back and plan the activities that will provide those outcomes. This type of planning is designed to ensure that activities and methods of assessment are aligned with instructional goals (Wiggins & McTighe, 1998).

Novice teachers usually leave their undergraduate programs having learned how to write at least one type of lesson plan. However, research indicates that the way novice teachers plan is similar, regardless of the method they learned for writing lesson plans (Ball et al., 2007; Kagan & Tippins, 1992). In their study, Kagan and Tippins (1992) were interested in learning what lesson plan formats were most useful to novice teachers. Beginning with a general linear lesson plan format, the researchers allowed the novice teachers to adjust it to meet their needs, and the adjustments that were made varied for each teacher. They found that the elementary novice teachers mainly used their lesson plans to organize materials and thoughts, but rarely referred to the plans during instruction. As time progressed, the novice elementary teachers' lesson plans grew less detailed and often were replaced by plans taken/adapted from teachers' guides. Further, they found that most of the planning the novice teachers remained in their heads, rather than on paper (Kagan & Tippins, 1992). Kagan and Tippins (1992) suggest that teacher education programs not limit pre-service teachers to required linear models of lesson planning, but instead promote the lesson plan as a collection of major instructional procedures, which they suggest would, in turn deter novice teachers from using the lesson plan in an information-giving format.

In contrast to Zahorik's (1970) early research on teacher planning, more recent studies have found that student interests and needs do influence the decisions teachers make while planning for instruction (Ball et al., 2007). In fact, several factors influence the decisions teachers make while planning for instruction:

> The curriculum as published is transformed in the planning process by additions, deletions, changes in sequence and emphasis, teachers' interpretations, and misunderstandings. Other functions of teacher planning include instructional time allocated for subject matters and for individuals and groups of students, study and review of the content of instruction by teachers, organization of daily, weekly, and term schedules, meeting administrative accountability requirements, and communicating with substitute teachers. (Clark & Peterson, 1986, p. 267-268)

As research on teacher planning progressed through the late 20th century and early 21st century, emphasis on planning within specific subject areas began to emerge, suggesting that how teachers plan may be influenced by the content taught. Superfine (2008) posits that there is a need to examine how teachers plan within their current curricula, such as those that have been reformed:

> There is even less research that focuses explicitly on teachers' planning in the context of the reform mathematics curricula that provide much of the instructional design for teachers…. The challenges of planning lessons using such curricula may be somewhat different from the challenges of planning lessons with more conventional mathematics curricula. (Superfine, 2008, p. 11)

In addition to the recent focus of the research on teacher planning shifting to planning within a given content area, research about teacher planning for technology integration is growing, as indicated by searches for recent journal articles. For example, a search for teacher planning in the ERIC database of peer-reviewed, full text articles returned 113 matches, with 8 of the first 40 articles addressing planning for technology integration, despite not including technology in the search keywords. However, as access to technology has increased in schools, questions still remain about how it is being integrated into the curriculum (Jonassen, Howland, Marra, & Crismond, 2008; Kemker et al., 2007; Lim & Chai, 2008), which might explain the growing number of research articles addressing planning for technology integration.

Teacher Planning for Technology Integration

As more is learned about how teachers make instructional decisions during planning, new questions arise about the addition of instructional technology. Gaps in the literature still remain regarding how teachers plan for the integration of technology (Tubin & Edri, 2004). Angers and Machtmes (2005) suggest that “teacher planning is a key underlying context factor in determining the extent to which technology gets used” (p. 787), making teacher planning an important area to be examined as it relates to meaningful use of instructional technology (Jones & Moreland, 2004). Berg, Benz, Lasley II, & Raisch (1998) suggested that there was a need to identify exemplary uses of technology in the classroom, and how teachers plan for those uses. Yelland (2005) suggested that one of the main problems with technology use is that it is still considered an “add-on” to instructional planning instead of an integral part of the planning process. Kemker et al. (2007) agreed that planning is significant to the way technology is used in the classroom when they stated that, “simply providing access to computers and the Internet does not guarantee that students will use the computers for meaningful instructional tasks” (p. 306-307).

Sandholtz and Reilly (2004) found that teachers tended to integrate technology more frequently when the focus of the district’s implementation shifted from technical professional development to professional development on how the technology aligned with the curriculum. Weston and Bain (2010) argue that when technology is used in professions other than teaching, the focus is on the professional act, not on the technology. For example, when a surgeon uses a piece of technology to perform surgery, his content knowledge and pedagogical knowledge drive his actions. He does not solely rely on his knowledge of the technology he is using to perform the surgery. Weston and Bain (2010) suggest that administrators and teachers put too much focus on the technology, rather than on how the technology purposefully fits within teaching and learning the content of the curriculum, leading to failed attempts at effective technology integration.

Exemplary teachers do not necessarily integrate technology in meaningful ways because their beliefs about the value of technology affect its use (Pierson, 2001). However, in her collective case study of three technology using teachers, Pierson (2001) found that "teachers at the lower levels of either technology or teaching abilities altered their planning habits when planning for technology inclusion" (p. 420). Pierson (2001) described one teacher who was not comfortable with using technology as reverting to novice tendencies when planning, such as scripting the individual lesson, rather than thinking about long-range goals in instruction as she commonly did before trying to integrate technology. Lessons from the ACOT studies (Sandholtz et al., 1997) highlight adoption and proficiency when integrating technology occurring on a continuum, suggesting that teachers who revert to novice tendencies when planning for technology integration will, over time, become more comfortable and proficient in their planning. For example, Jones and Moreland (2004) used data gathered from their case studies of teachers in New Zealand to develop ways to move the teachers from thinking about technology as a series to tasks to thinking about technology through learning goals they had for their students. They presented the teachers with a planning format or template that modeled this way of thinking about planning. They found that over time, the use of the planning format prompted change in the way the teachers approached technology integration and that decisions about lessons using technology were made with learning goals in mind, rather than the completion of skill-based tasks.

In her collective case study of three elementary teachers using technology with low-performing students, Edmunds (2008) suggested that the teachers were effective in the way they planned for the use of technology because they used a continuous and balanced approach to technology integration. Edmunds (2008) defined continuous as “the roles and purposes for the technology use are consistent with their broader instructional practices” (p. 213). To be balanced, decisions about how to use technology were based on what was being taught and students’ needs. Technology in the classroom was used to both remediate and challenge the students. The technology was also used as both a teacher tool for instruction and a student tool for learning and creation.

The Influence of Knowledge and Beliefs on Planning for Technology Integration

This literature review provided examples of ways teachers integrate technology in the content areas and use it to address diverse learning needs, including discussions of teacher knowledge as represented by the TPCK framework (Mishra & Koehler, 2006). The literature review also discussed factors that impact teachers’ use of technology, including how teachers’ knowledge and beliefs influenced how teachers use technology in the classroom. As evidenced in the research cited, both teachers' knowledge of content, pedagogy, technology, and the way students learn, as well as their beliefs' about all of these (content, pedagogy, technology, how students learn) influence the decisions teachers make. Therefore, the conceptual framework guiding this study suggests that teachers' knowledge and beliefs work together to influence the decisions teachers make when planning for technology integration. Figure 4 provides an expanded visual image that represents how the elements of this literature review inform the conceptual framework.

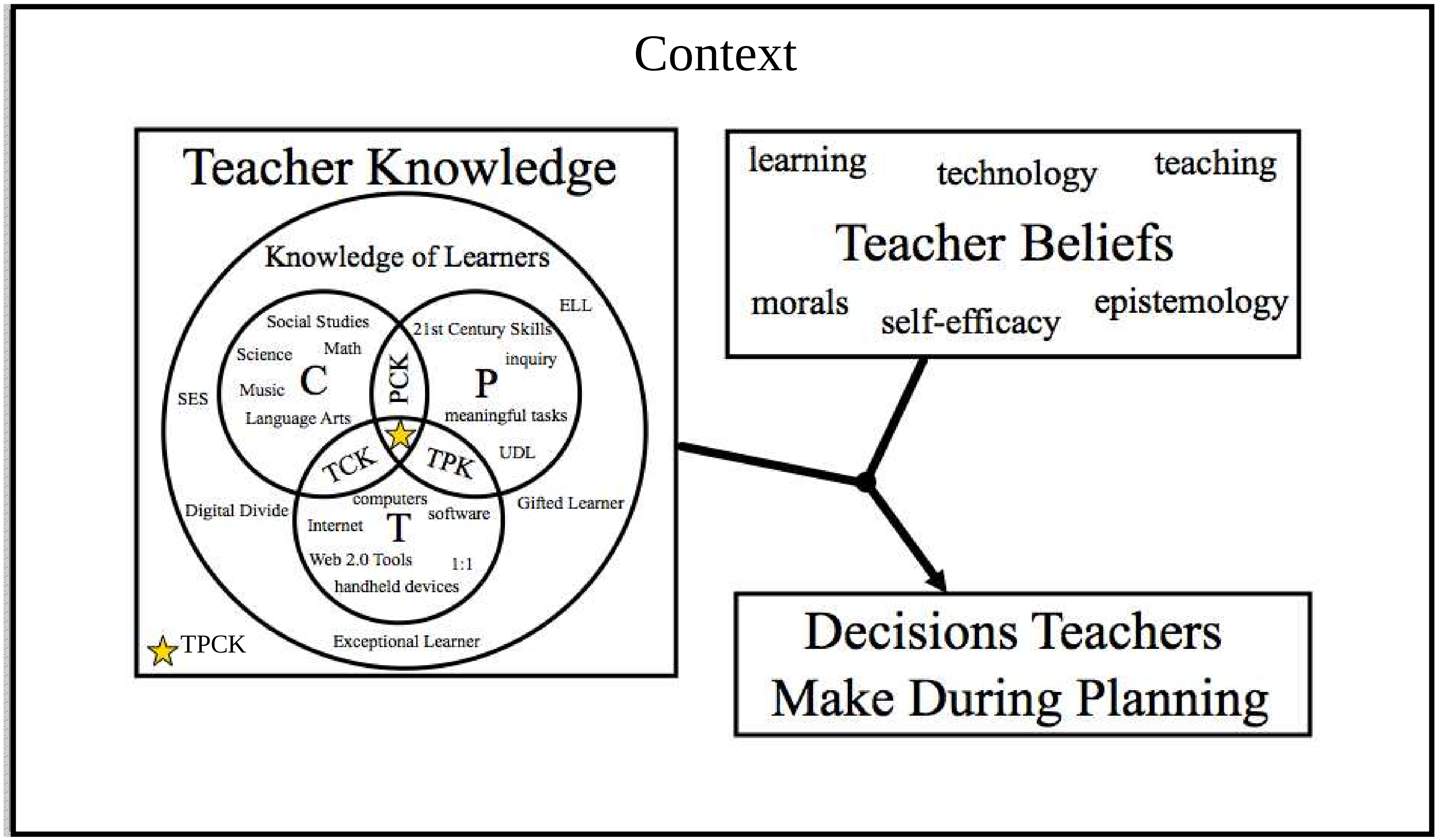
Sections of this literature review discussed teacher planning and the literature on teacher planning for technology integration. However, still missing from the literature are examples of teachers planning for the integration of technology that focus on the decisions teachers make to plan meaningful tasks using technology. Because teachers' knowledge and beliefs both play a role in the way teachers plan, it is important to acknowledge how they influence the decisions teachers make while providing examples of teachers planning within a technology-rich environment. However, research taking this perspective is quite limited (Harris & Hofer, 2011; Hofer & Swan, 2008). Hence, this study sought to contribute examples of teachers planning for technology integration when first-order barriers are not a concern (Ertmer et al., 1999), and how their knowledge and beliefs guided the decisions they made, to the literature on effective technology integration in the elementary classroom.

Summary

This literature review examined research on elements of teacher planning and technology integration, including 21st century skills, frameworks for technology integration, factors influencing technology integration, 1:1 initiatives, technology use in the content areas, and technology and diverse learners. Current literature in the field of instructional technology, cited throughout this literature review, offers us examples of technology use in the classroom. However, a gap in the literature on technology use in the classroom still exists about how teachers purposefully plan for the use of instructional technologies. Therefore, the purpose of this study is to understand the thought processes and decisions teachers make to integrate technology into their lessons and how their pedagogical beliefs about teaching, learning, and technology affect those processes.

Figure 4

Expanded View of the Conceptual Framework



CHAPTER III

METHODOLOGY

This chapter explains the research design and methods of data collection and analysis used in this study. First, the multiple case study design is described and justified as the best approach for answering the research questions in this study. Second, the data collection and analysis procedures used in the study are described. Third, a discussion of validity and reliability is provided, and possible ethical issues are addressed. Finally, the limitations of the study are explained.

Research Design

One way to examine how teachers are integrating technology is to observe the decisions they make when planning. Case studies of teachers planning for instruction within technology rich classrooms may paint the picture of what it looks like to make decisions about using technology in the classroom. In order to understand the thought processes and decisions teachers make to integrate technology into their lessons using the TPCK framework (Mishra & Koehler, 2006) for teacher knowledge and how their various beliefs about content, pedagogy, technology, and how children learn affect those processes, I conducted a multiple case study of three teachers to provide detailed, descriptive cases, as well as a cross-case analysis (Creswell, 2007; Yin, 2009).

Multiple Case Design

Case study research is the study of an issue through one or more cases within a bounded system (i.e., a setting or a context) (Creswell, 2007). Schramm (1971) highlights the essence of a case study by saying, “The essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result” (p.6). Yin (2009) also describes cases of “decisions” as one major focus of case studies. Individuals, organizations, processes, programs, or events could also be considered cases (Yin, 2009). In this study, a multiple case study was conducted with each teacher being a case. It is important for each teacher to be a case because the decisions a teacher makes are particular to her classroom’s makeup and setting, her instructional methods, and her beliefs. This multiple case study also sought to illuminate any common decisions that the three focal teachers made when planning for the integration of technology.

Case study methodology offers a detailed look into each teacher as a bounded case, investigating a contemporary phenomenon, which in this study is their planning for thoughtful technology integration (Stake, 1995; Yin, 2009). Using case study research methods to collect data, I was able to gain a deeper understanding of each teacher and their decision making processes of planning for technology integration within the TPCK framework (Mishra & Koehler, 2006), attempting to pull themes across the cases in a cross-case analysis (Creswell, 2007; Yin, 2009). In addition, case study methods are particularly useful when asking How? and Why? questions (Yin, 2009), which are the majority of my research questions for this study. A cross-case analysis treats each case study in the multiple case study as an separate study, but aggregating aggregates findings across the studies (Yin, 2009). Descriptive quotes from the teachers provided insight into each case (Stake, 1995), along with my own interpretation of these data as related to the literature and the TPCK framework (Yin, 2009). Yin calls this pattern matching.

Research Questions

The following research questions guided this study:

1. What does meaningful technology integration look like in a technology-rich elementary classroom?

2. What kinds of decisions does the teacher make when planning for technology integration?

2a. Why were those decisions made when planning for technology integration?

3. How do teacher beliefs influence planning for integration of technology in the classroom?

4. How does a teacher's knowledge about technology, pedagogy, content, and learners influence her planning of meaningful lessons that integrate technology?

Setting

The current study was conducted in three elementary classrooms in a mid-sized school system in North Carolina. The elementary school settings are described below.

Oak Tree Elementary School

Oak Tree Elementary School (pseudonym) is a Title-I PreK-5 elementary school in rural North Carolina. Oak Tree operates on a traditional academic calendar. At the time of the study, Oak Tree served 269 students. Approximately 59% of the students received free or reduced lunch, 2.56% were categorized as Academically Gifted, and 11% received Exceptional Children's (EC) services. Forty-one students were classified as English Language Learners (ELLs). Oak Tree has a wireless campus and all of the teachers received laptop computers during the 2008-2009 school year. The number of students per Internet-connected, instructional computer was 1.55 and 100% of the classrooms had Internet access.

Hillendale Elementary School

Hillendale Elementary School (pseudonym) is a PreK-5 elementary school in North Carolina. Hillendale operates on a traditional academic calendar. At the time of the study, 553 students attended Hillendale. Approximately 43% of the students received free or reduced lunch, 11% were categorized as Academically Gifted, and 8% received Exceptional Children's services. Eighty-nine students were classified as English Language Learners (ELLs). Hillendale has a wireless campus and all of the teachers received laptop computers during the 2007-2008 school year. The number of students per Internet-connected, instructional computer was 2.14 and 100% of the classrooms had Internet access.

Blue Ivy Elementary School

Blue Ivy Elementary School is a Title-I PreK-5 elementary school in North Carolina. Blue Ivy operates on a year-round academic calendar. At the time of the study, Blue Ivy served 380 students. Approximately 79% of the students received free or reduced lunch, 3.93% were categorized as Academically Gifted, and 14.2% received Exception Children's (EC) services. One hundred forty students were classified as

English Language Learners (ELLs). Blue Ivy has a wireless campus and all of the teachers received laptop computers during the 2008-2009 school year. The number of students per Internet-connected, instructional computer was 1.62 and 100% of the classrooms had Internet access.

Participants

The three elementary school teachers in this study were white females in their late 20s to early 60s with varying years of teaching experience. Each teacher applied for and received a $20,000 grant from the school system to purchase technology for the classroom. I chose the teacher participants as a purposeful sample (Creswell, 2007; Maxwell, 2005) because these teachers had technology-rich classrooms, therefore removing the barrier of access that typically confounds many studies of technology integration (Ertmer et al., 1999). Further, removing the barrier of access to technology made these cases rich models for how technology can be integrated by teachers when they do have all the resources they need. These classrooms were transformed through a grant focusing on technology integration in curriculum, making the teachers ideal candidates for discussing how they plan for technology integration. These particular grant recipients were chosen based on their willingness to participate and share their planning processes.

The teacher participants were recruited through email. Prior to data collection, I obtained approval from the principal of each school, the school system, and, finally, IRB approval. At the beginning of the initial interview, I explained to each of the participants the purpose of the study, their rights as participants, and the benefits and risks to participating in the study. Each participant indicated her willingness to participate in the study by signing my consent form. The grant and the participants are discussed in more detail below.

It is important to note that I had a relationship with the school system and the teacher participants prior to this study. Prior to pursuing my doctoral degree, I taught at an elementary school in this school system. When I met the three teachers in this study, I was working for the school system as the Lead Teacher of Elementary Technology. In this role, I worked with principals to purchase technology for the schools and with teachers to use technology in instruction. The three teachers were members of a technology teacher-leader group that I facilitated. Although I knew of their interest in integrating technology, I did not work for the school system when they were awarded the Innovation Grant. My prior relationship with the teacher participants is also discussed in the Ethical Issues section later in this chapter.

Innovation Grant

During the 2008-2009 school year, the school system offered all teachers K-12 the opportunity to apply for one of ten Innovation Grants that outfitted their room with $10,000 worth of technology. Then, during the 2009-2010 and 2010-2011 school years, five $20,000 grants were awarded to school system teachers. In the grant application, the teachers specified the technology they wanted for their rooms and the goals that would be achieved with its use, including an outline for their plan of action based on desired student outcomes. The three teachers participating in this study were each awarded a

$20,000 Innovation Grant during the 2009-2010 (1 teacher) and 2010-2011 (2 teachers) school years.

Hope Moore, Oak Tree Elementary School

Hope Moore, 27 years old at the time of the study, was in her 5th year teaching and her 5th year at Oak Tree Elementary School. She taught 2nd grade for 3 ½ years and was in her 2nd year of teaching 3rd grade. Hope is licensed in Elementary Education K-6 and is currently pursuing her M.Ed. in Instructional Technology. Prior to being awarded the school system's Innovation Grant, Hope had a mounted Smartboard with a teacher laptop loaded with Smart Notebook Software. Oak Tree Elementary School had a wireless campus. From the grant, Hope earned the following technology for her classroom:

- 25 student Netbooks with a charging station
- 10 iPads
- 3 digital cameras
- Wireless access point for the Netbooks

In addition to the technology acquired through the Innovation Grant, Hope stores the school's iPad cart with 20 iPads, a MacBook Pro laptop, and a syncing station in her room for teacher checkout. After receiving the grant, the school system provided all teachers at Oak Tree with a document camera.

Ella Rose, Hillendale Elementary School

Ella Rose, 46 years old at the time of the study, was in her 21st year teaching and her 9th year at Hillendale Elementary School. She had experience teaching preschool, 1st, 2nd, 3rd, and 5th grades and was currently in her 3rd year teaching 5th grade. Ella is licensed in Elementary Education K-6. Prior to being awarded the school system's Innovation Grant, Ella had a mounted Smartboard with a teacher laptop loaded with Smart Notebook Software and a Smart Wireless Slate. Hillendale Elementary School had a wireless campus. From the grant Ella earned the following technology for her classroom:

- 30 student Netbooks with a charging cart
- Wireless access point for the Netbooks
- 30 headphone/microphone sets
- 5 external DVD burners
- 5 digital cameras
- 5 Flip Video cameras
- 2 iPads
- Networked printer

After receiving the grant, the school system provided all the teachers at Hillendale with a document camera.

Jan Richards, Blue Ivy Elementary School

Jan Richards, 59 years old at the time of the study, was in her 35th year teaching and her 5th year at Blue Ivy Elementary School. Jan is licensed in Music Education K-12, has a M.Ed. in Curriculum and Instruction, and has Academically and Intellectually Gifted (AIG) certification. Jan is also a Nationally Board Certified Teacher (NBCT) who has recently completed her recertification. Prior to being awarded the school system's Innovation Grant, Jan had a mounted Smartboard with a teacher laptop loaded with Smart

Notebook Software, a Smart Wireless Slate, a digital piano, and an additional teacher laptop (MacBook Pro). Blue Ivy Elementary School had a wireless campus. From the grant, Jan earned the following technology for her classroom:

- Monitor for the digital piano
- 21 student Netbooks
- 4 digital cameras
- 5 Flip Video cameras
- 4 iPod Touches
- Copier/Scanner
- Student Teacher laptop
- Document Camera

After receiving the grant, the school system provided all the teachers in Blue Ivy Elementary School with a document camera.

Table 4

Participants in the Study

Teacher	**School**	**Grade/ Subject**	**Age**	**Teaching Degrees/ Certifications**	**Total Years of Experience**	**Years at the School**	**Years in this Grade**
Hope Moore	Oak Tree Elementary School	3rd grade	27	Elementary Education; Instructional Technology (M.Ed.- in progress)	5	5	2
Ella Rose	Hillendale Elementary School	5th grade	46	Elementary Education	21	9	3

Jan Richards	Blue Ivy Elementary School	K-5 Music	59	Music Education; Curriculum & Instruction (M.Ed.); NBCT; AIG	35	5	35

Table 5

Technology in the Classroom

Teacher	**Technology in the Classroom**
Hope Moore	Mounted Smartboard Document camera 25 Netbooks with charging cart 3 digital cameras 10 iPads Syncing station Wireless access point Teacher laptop- Lenovo PC Wireless campus 20 additional iPads for the school stored in room MacBook Pro with iPad cart
Ella Rose	Mounted Smartboard SmartSlate Document camera 30 Netbooks with charging cart 30 headphone/microphone sets 5 digital cameras 5 Flip Video cameras 5 external DVD burners 2 iPads Wireless access point Networked printer Teacher laptop- Lenovo PC Wireless campus
Jan Richards	Mounted Smartboard SmartSlate Document camera Digital piano Computer monitor for digital piano

	21 Netbooks with charging cart 4 digital cameras 5 Flip Video cameras 4 iPod Touches Copier/Scanner Teacher laptop- Lenovo PC Student teacher laptop- MacBook Pro Additional teacher laptop- MacBook Pro Wireless campus

The Pilot Case Study

In the fall of 2010, this study was piloted with one teacher who was awarded a $20,000 Innovation Grant from the same school system as the participants in this study (Beeson, 2011). Emma (pseudonym) was awarded the grant to purchase technology for her fifth grade classroom in the 2009-2010 school year. The pilot case study was conducted in a year-round, Title-I, low SES, elementary school. Emma was in her fourth year teaching and had taught at this school for her whole teaching career. She was not originally from the area in which the school system was located, but attended college and student taught in the community, which led to her staying in the area after graduation. Emma selected the technology purchased with the grant money, including:

- Netbooks and headphones with microphones for every student
- 11 iPod Touches,
- 6 digital cameras
- 6 Flip Video Cameras, and
- 5 flat screen monitors placed strategically around the classroom to which students could hook their Netbooks for collaborative use.

These grant technologies were in addition to the interactive whiteboard (Promethean Activ Board) and supporting tools (Activ Slate, Activ Votes, and Activ Expressions) already in use in her room. Emma also looped from fourth grade to fifth grade with her students for the 2010-2011 academic year, so she knew her students well and they were already familiar with how to use most of the technology during the time of the pilot study. Initial findings from this case suggested that Emma was in fact planning within the TPCK framework (Mishra & Koehler, 2006) even though she never articulated her plans using the TPCK language (see Beeson, 2011).

Research Procedures

The current research was conducted over 14 weeks during the fall of 2012. Observations averaged 1-2 times a week in each classroom. There were 13-15 total classes observed for each teacher. A total of 13.5-18 hours were spent observing in each classroom.

Table 6

Schedule of Observations

	Date	Math	Science
Hope Moore	September 13	X	X
	September 27	X	X
	October 5		X
	October 16	X	X
	October 31	X	
	November 27	X	X
	November 30	X	
	December 4	X	X
	December 7	X	X
	Date	Language Arts	Social Studies
Ella Rose	September 20	X	
	October 3	X	X

	October 18	X	X
	October 25	X	X
	November 14		X
	November 27	X	X
	November 28	X	X
	December 7	X	X
	December 11	X	X

	Date	K	1st	2nd	3rd	4th	5th	Intervention
Jan Richards	Sept 20	X				X		
	Sept 21						X	
	Sept 26					X		
	Oct 17		X				X	X
	Nov 30						X	
	Dec 4	X						
	Dec 6		X	X				
	Dec 13		X		X	X		
	Jan 11				X			

Formal interviews were conducted approximately one time for every two observations. These interview were recorded. Informal interviews occurred often through casual conversation or questions I asked in passing, so field notes were made following these contacts. Lesson plans were viewed and collected during formal interviews. Table 7 is a data-planning matrix (Maxwell, 2005, p. 100) describing how my research questions, data sources, and analysis methods align.

Table 7

Data-Planning Matrix

What do I need to know?	Why do I need to know this?	What kind of data will answer the questions?	What ways might I use to analyze my data?
What does technology integration look like in a technology-rich elementary classroom?	To share examples of how teachers plan for technology integration and to describe what this integration looks like in practice.	Field notes from classroom observations; Think-Aloud Interview transcripts; Lesson Plans	Coding (descriptive and interpretive), pattern coding
What kinds of decisions does the teacher make when planning for technology integration? Why were those decisions made?	To describe the decision making process that affects technology integration in the classroom.	Ongoing Interview transcripts; Contact Summary Sheets; Think-Aloud Interview transcripts; Lesson Plans	Coding (descriptive and interpretive), pattern coding
How do teacher beliefs influence planning for integration of technology in the classroom?	To assess and describe the influence that teacher beliefs have on integrating technology.	Initial and Ongoing Teacher Interview transcripts; Contact Summary sheets	Coding (descriptive and interpretive), pattern coding
How does a teacher's knowledge about technology, pedagogy, content, and learners influence her planning of meaningful lessons that integrate technology?	To understand and describe the role of TPCK and knowledge of learners in the development of meaningful lessons integrating technology.	Initial and Ongoing Teacher Interview transcripts; Contact Summary sheets; Planning Think-Aloud Interview transcripts; Lesson Plans	Coding (descriptive and interpretive), pattern coding

(adapted from Maxwell, 2005, p. 100)

Data Collection

Three types of data were collected during the fall of 2012. First, a pre-study interview was conducted prior to the start of classroom observations (see Appendix A). Throughout the study, interviews were conducted approximately one time for every two observations. Additionally, a think-aloud interview was conducted with each teacher two times. Second, classroom observations were conducted once or twice a week. Finally, lesson plans were viewed and collected during teacher interviews. This section describes the data sources and data collection methods used in this study.

Teacher Interviews

According to Yin (2009), the interview is one of the most important data sources in a case study. Three types of interviews were conducted in this study.

Initial interview. Prior to the start of the study, an initial interview was conducted with each teacher participant at her school. The purpose of this semi-structured interview (Shank, 2006) was to learn background information about the participant, to ask initial questions about the technology in the room and how the teacher plans, and to discuss procedures for observations and interviews (see Appendix A for the initial interview protocol). The initial interview lasted about an hour for each teacher and was audio-recorded and transcribed for analysis. A version of the initial interview was piloted with the pilot study teacher participant, Emma (Beeson, 2011).

Ongoing interviews. Throughout the study, formal (scheduled) and informal (unscheduled) teacher interviews occurred at least once per every two observations. Formal interviews were scheduled based on the teacher's availability before, during (planning time), or after school. These semi-structured interviews (Shank, 2006) lasted about 30 minutes and were audio-recorded and transcribed for analysis. The purpose of the scheduled interviews was to better understand how the teachers planned for the integration of technology, what role technology played in their planning, and how they decided what technologies were appropriate for the lesson. An interview protocol (see Appendix B) was used for the scheduled interviews. The interview protocol for the formal interviews was piloted with the pilot study teacher participant, Emma (Beeson, 2011). Based on my experiences with that study, some questions were added in order to gain a better understanding of how teachers plan for technology integration. Informal interviews occurred frequently in passing between the teachers and me and were based on immediate questions I had about the observations or immediate thoughts the teachers wanted to share about the lesson.

Think-aloud interview. For each teacher, two think-aloud interviews were also performed. The think-aloud method asks participants to think-aloud as they are completing a task, such as teacher planning (Peterson & Clark, 1978; Peterson & Comeaux, 1990; Peterson et al., 1978). Historically, the think-aloud method has also been used to study the decision-making process of bank trust officers, chess players, clinical psychologists, and physicians (Ericsson & Simon, 1980; Ericsson & Simon, 1998; Peterson et al., 1978).

During an interview at the beginning of data collection and an interview at the end of data collection, I asked each teacher to plan a lesson aloud. Because the think-aloud method was new for the teachers, I had each teacher complete a warm-up activity prior to planning aloud. Research suggests that a warm-up activity, such as talking through a simple math problem, helps the participant understand the process of the think-aloud without leading the participant to think-aloud in a particular way, such as if they watched a video or listened to an audio-recording of an example think-aloud (Ericsson & Simon, 1998). For this study, I had the teachers first view a short online video clip of a teacher teaching. While they viewed the clip, I asked the teachers to think-aloud or verbally express what they were thinking and seeing during the clip. Past studies have used the think-aloud method in this manner to examine the thoughts of expert and novice teachers as they viewed clips of classroom instruction (Berliner, 1986; Sabers, Cushing, & Berliner, 1991). The warm-up activity allowed the teachers to think-aloud before the planning activity and to ask me questions about what they were being asked to do. I chose to use the video think-aloud because talking about a teacher teaching was authentic to their roles as teachers, therefore possibly making the warm-up comfortable for the participants.

After the warm-up activity, I asked the teachers to plan aloud a lesson that integrated technology with me present. They were given no parameters other than including technology in the lesson. I prompted the teachers as I felt necessary when they were unsure of what to say next. For example, I asked the teachers questions such as (a) Can you tell me more?, (b) What objectives are you addressing?, and (c) How have you thought about the different learners in your class? (see Appendix D for the Think Aloud Protocol).

One limitation of using the think-aloud method to understand how teachers plan is that it can be unauthentic to the way the teachers normally plan (Peterson et al., 1978). Teachers often plan over time in smaller chunks, such as in the shower or while driving home from work and they may not be familiar with planning from start to finish in one sitting. To make the participants feel more comfortable, I explained that I knew they were not used to planning in this method, but that planning aloud would help me to better understand the decisions they make while planning. In closing, I asked the teachers to share their thoughts about the exercise and what they just planned. I used a think-aloud interview protocol (see Appendix D) to introduce the think-aloud activity and to offer prompts when needed. The think-aloud interview protocol was piloted with the pilot study teacher participant, Emma, and revised based on that experience.

Classroom Observations

Classroom observations were conducted at least once a week with each teacher (see the observation schedule in Table 6). The purpose of the observations was to observe the teachers' follow through with their planning for the integration of technology. Each observation was about one to two hours and I used an observation protocol (see Appendix E) to structure my field notes. The observation protocol had two columns that allowed me to script what was happening in the room during the lesson in one column and to record my own thoughts and questions about what was happening in the second column. Contact sheets were also completed after each observation (see Appendix C).

Lesson Plans

Lesson plans for scheduled, formal observations were viewed as an additional data source. The teachers' lesson plans provided another example of the ways in which the teachers were thinking about technology as they planned. In some instances, the lesson plans were discussed during the interview if the teachers wanted to highlight something in the plan for me or if I had any questions about the written lesson plans. The lesson plans were not collected on a regular basis because the teachers did not always write out their plans in a way that could be collected. In these situations, the lesson plan may have just been viewed and discussed at the school, with field notes taken by me.

Summary of Data Collection

Three types of data were collected from insert date to insert date. A pre-study interview was conducted at the beginning of the study to gain more information about the participants and the technology in their rooms. Ongoing formal and informal teacher interviews occurred at least once for every two observations to better understand how the teachers planned for the integration of technology, what role technology played in their planning, and how they decided what technologies were appropriate for the lesson. Two think-aloud interviews were also conducted with the teachers during the study to better understand how they planned for the integration of technology. Classroom observations occurred about once a week for 14 weeks to observe the teachers' follow-t hrough of their planning for technology integration. Finally, lesson plans were viewed and sometimes collected as an additional data source offering a glimpse into how the teachers planned for technology integration.

Table 8

Data Collected

	Total # of Classes Observed	Total # of Hours in Class (observations)	Think Aloud Interviews	Total # of Interviews
Hope Moore	15	18	2	5
Ella Rose	15	13 ½	2	5
Jan Richards	14	14	2	5

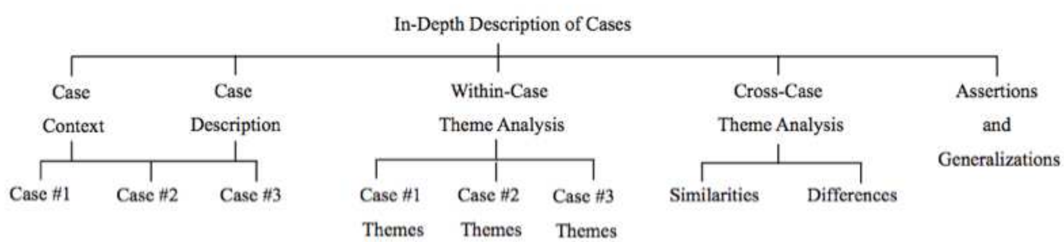
Data Analysis

This section describes the methods of data analysis used for this study. According to Stake (1995), “there is no particular moment when data analysis begins. Analysis is a matter of giving meaning to first impressions as well as to final compilations” (p. 71). In this study, data were analyzed during and after data collection in the fall and winter of 2012-2013. All audio-recorded data were transcribed for analysis. In a multiple case study, data can be analyzed both within the cases individually and across the cases collectively (Yin, 2009), and I did both with- and cross-case analyses of my data.

Initial data analysis included multiple readings of the interview transcripts, contact summary sheets, observation field notes, and notes I took on my review of the lesson plans. From these readings, I developed additional codes for data that contributed to a detailed description of each case. However, I started with codes based on my literature review and experience with my pilot study on one teacher, including the following: 1) codes addressing TPCK (Mishra & Koehler, 2006), 2) codes address beliefs, 3) codes addressing 21st Century skills, and 4) codes addressing meaningful learning and meaningful instructional tasks, but added additional codes as they emerged (see Table 9). Figure 5 (Creswell, 2007, p. 172) represents a template for initial data coding for the within-case and cross-case analysis. Using the computer program, NVivo, I created codes for each of the categories in Figure 5. For each case, I coded data that represented the case context and the case description. Higher-level codes were also developed for patterns in each case (within-case analysis). For the cross-case analysis, codes existed for similarities and differences found across cases. Finally, I coded assertions and generalizations made across cases. The analyses and codes are described in more detail below.

Figure 5

Data Coding for Within-Case and Cross-Case Analyses



(Creswell, 2007, p. 172)

Within-Case Analysis

In case study research, analysis includes making a detailed description of the case and its setting (Creswell, 2007) as well what occurred in that setting during the study. In order to create a detailed description of each case, I first used within-case analysis. For each case, I coded data that represented the case context and ways to describe the case. Then, I developed themes based on the codes that emerged from the data for each case and used these themes to organize the write-up for each case. In the pilot study, themes emerged from that data that represented thinking within the TPCK (Mishra & Koehler, 2006) framework. For the current study, I used the pilot study codes as start codes as well as additional codes derived from the literature after further reflection on the pilot study (see Table 9). As I read the interview transcripts, contact summary sheets, and field notes from observations and lesson plan reviews, I initially coded the data using the start codes. I then re-read the data allowing additional codes and, eventually, patterns of codes that became themes to emerge. Finally, I used the descriptions and themes for each case to write three descriptive case narratives.

Table 9

Start Codes for Within-Case Analysis

Codes derived from the pilot study	**Additional codes derived from the literature**
Evidence of Beliefs about Technology	Active Learning (Jonassen et al., 2008)
Evidence of Planning for Technology Use	Authentic Learning (Jonassen et al., 2008)
Evidence of Thinking about the Learner	Constructive Learning (Jonassen et al., 2008)
Evidence of Thinking about the Content	Cooperative Learning (Jonassen et al., 2008)
Evidence of Thinking about Pedagogy	Intentional Learning (Jonassen et al., 2008)
Evidence of Thinking about the Type of Technology	Deep and Connected Knowledge (Ertmer & Ottenbreit-Leftwich, 2010)
Evidence of TPK	Application to Real Situations (Ertmer & Ottenbreit-Leftwich, 2010)
Evidence of TCK	
Evidence of PCK	
Evidence of TPCK	
Evidence of Classroom Management with Technology	
Examples from the Classroom	
Evidence of Creativity and Innovation	
Evidence of Collaboration	
Evidence of Communication	
Evidence of Critical Thinking Skills	

Cross-Case Analysis

After writing the three descriptive case narratives, I looked for patterns across the three cases. Initially, I looked for patterns that were common to all three cases (see Table 10). I did this by placing case patterns in a Word table. I then re-read the cases noting patterns that were particular to one or two cases and not another case. For example, I noted patterns that were common to the two teachers in Title-I schools, but not common to the third teacher. From the analysis of the patterns, themes emerged across the cases. Finally, I made note of any assertions or generalizations I had about the data from the within-case and cross-case analyses.

Table 10

Example of Cross-Case Analysis

Case #1	Case #2	Case #3
Beliefs about engagement	Beliefs about engagement	Beliefs about engagement
Beliefs about 21st century skills (technical skills)	Beliefs about 21st century skills	Beliefs about 21st century skills (technical skills)
Beliefs about building background knowledge with technology	Beliefs about building background knowledge with technology	Beliefs about building background knowledge with technology
Technological knowledge	Technological knowledge	Technological knowledge

Summary of Data Analysis

Data was analyzed during and after data collection in the fall and winter of 2012-2013. Data analysis included multiple readings of each of the data sources, as well as coding of data that represented case descriptions, the case context, emerging patterns and themes within cases and across cases, and my assertions and generalizations. A descriptive narrative of each case (within-case analysis) and a cross-case analysis is provided in Chapter IV. Next, I discuss how I established the study's validity and reliability.

Validity and Reliability

In qualitative research, validation strategies test the validity of a study's conclusions and possible threats to those conclusions (Maxwell, 2005). Validation strategies increase the credibility of the study's conclusions by ruling out possible threats to validity. Yin (2009) suggests validation strategies, or tests, for judging the quality of case studies, including construct validity, external validity, and reliability. Each test is discussed below in regard to this study.

Construct Validity

Construct validity, or "identifying correct operational measures for the concepts being studied," is a challenge in case study research and is often not established (Yin, 2009, p. 40-41). In this study, construct validity was established through the use of multiple data sources (different kinds of teacher interviews, classroom observations, and lesson plan review), providing multiple measures of the decisions made when planning for technology integration. The use of multiple data sources allowed me to better corroborate, or triangulate, my findings (Creswell, 2007; Yin, 2009). A chain of evidence was maintained from initial research questions to conclusions, supporting construct validity (Yin, 2009). Construct validity was also established through the use of member checking (Creswell, 2007; Maxwell, 2005; Yin, 2009). After the case narratives, or within-case analyses, were written, the participants were asked to read and provide feedback about their individual cases to improve accuracy. This is known as member checking (Yin, 2009). Finally, extensive time was spent with the participants conducting formal and informal interviews and observing classroom instruction.

External Validity

In case study research, external validity refers to analytic generalizations, which "generalize a particular set of results to some broader theory" (Yin, 2009, p. 43). In other words, external validity refers to whether a study's findings are generalizable beyond the current study, in terms of theory rather than populations, as in statistical generalizations. In this study, external validity is established through the analysis of multiple cases. Multiple cases provide for replication or comparison (Maxwell, 2005; Yin, 2009) and, in this study, a literal replication (predicting similar results) is represented by three cases of teachers planning for the integration of technology. However, the purpose of this multiple case study was not to generalize the findings to other teachers, but to present three descriptive cases of teachers planning for technology integration and my interpretation of common patterns and themes found across those cases. Finally, rich description of each case allows for transferability because the readers of this can determine whether the findings are transferable to other settings due to familiarity with similar characteristics (Creswell, 2007).

Reliability

Reliability is achieved when the research procedures of a study can be repeated with the same results, minimizing the errors and biases of the study (Yin, 2009). To ensure reliability, interview and observation protocols were used (see Appendices A-E) consistently with each case. The protocols were also piloted during the pilot case study.

Reliability was also established through the use of a peer review to check for possible inaccuracies or biases, allowing for inter-rater reliability (Creswell, 2007).

Ethical Issues

An ethical issue present in this study is the relationship between the participants and me. Although I do not work with them now, at one time I interacted with them as the Lead Teacher for Elementary Technology in the school system where they teach. In this role, I helped to place some of the older technology they have in their rooms, including the establishment of the wireless campus for two of the participants, and I served as a coach as they learned to use it. This role did not place me as their superior so I do not think it affected their current relationships with me as a researcher. To clarify my relationship with the participants as a researcher, I explained in the initial interview that I was there to learn from them about the ways teachers plan for technology integration, and in no way was I there to evaluate them.

Researcher Role and Potential Bias

Due to my past relationships with the teacher participants when I worked in the school system, I chose to be a non-participant observer in their classrooms. I did not want my presence in the classroom to influence the way the participants taught. For example, it was important for me to not have conversations with the participants that could have interfered with their instructional time. I explained to them that in order to prevent distractions, it was best for me to remain on the sidelines as an observer throughout the study.

It is also important to recognize any potential biases I bring to the study. One potential bias that needs to be considered is my knowledge of technology integration. I have experience integrating technology into my fifth grade classroom, as well as experience leading classes and professional development on technology integration. By bracketing my experiences with instructional technology, I sought to set aside those experiences to take a fresh perspective during data collection (Creswell, 2007; Schram, 1971). I also used member checking (Creswell, 2007) to make sure that my view of the data collected was not altered by my prior experiences with technology integration.

Summary

This chapter described the research methods used for this multiple case study. The research questions, participants, data collection procedures, and data analysis procedures were discussed. A consideration for ethical issues and the trustworthiness of the study were also discussed. Chapter IV examines and discusses the findings of the study.

CHAPTER IV

FINDINGS

This chapter discusses the findings of this study. First, three detailed teacher cases are presented with a discussion of factors that influenced technology integration during planning. Then, a cross case analysis of the findings from each teacher, guided by the study's research questions, is discussed.

The Case of Hope Moore

A low rumble of voices is heard around the room, just loud enough to know instruction is occurring. Ms. Moore bends closer to a student as she observes him creating a place value chart in his math journal. Other students at her kidney table are busy creating their own charts. In another group across the room, a student excitedly blurts out an answer while Ms. Smith, the classroom assistant, turns to write on the whiteboard easel. At a group of desks in the middle of the room, two students sit, heads together, sharing a Netbook. Sprinkled across the floor, more students sit, recline, and kneel around center buckets, iPads, markers, and large paper. Lost in their own thoughts, the students move fluidly between the iPads and Netbooks and the markers and paper. From outside looking in, the view is seamless- newer digital technology complements the markers and paper; teachers and students are working together. Neither one person, nor one resource stands out. Instead, they all fit together.

Hope Moore (pseudonym), a soft-spoken, yet vibrant young 3rd grade teacher was finishing her 4th year of teaching at the beginning of the study. With a sweet, calm demeanor, Hope ran a structured, yet loving classroom, where she never seemed to raise her voice. Hope had high expectations for her students and often spent extra time with concepts she was teaching until her students met her expectations. Through high expectations, Hope's goal was to empower her students to know that they could achieve:

> The main thing that I want to do in my classroom is inspire my students. I want them to know that they are all able to learn and achieve in life. They don't have to be the best reader or the best mathematician, but they are great at something and as long as they have the desire to work hard and try I will be pleased with their effort.

Hope is licensed in Elementary Education and, at the time of the study, was working toward a M.Ed. in Instructional Technology. Hope taught a two-hour math and science block to the other 3rd grade class in the morning and to her homeroom class after lunch. The other 3rd grade teacher taught language arts and social studies to both classes and Hope often collaborated with her to achieve shared goals in the classroom. Hired in the middle of a school year at Oak Tree, a Title I PreK-5 Elementary School, Hope quickly became a technology leader in the school, joining the district's technology leadership group by the next fall upon the recommendation of her principal. As a member of this leadership group, Hope provided professional development at the school and district level on various topics related to technology integration. Hope also developed strong relationships with her colleagues, often collaborating with Oak Tree Elementary's Media Specialist on projects and working closely with her classroom assistant to identify student needs. Classroom observations and interviews indicated that Hope knew her students well, which was the foundation of her lesson planning.

Hope's 3rd Grade Classroom

Upon entering Hope's classroom, visitors were immediately greeted by two teacher-created displays that captured Hope's vision of her third grade class. The first display on the classroom door said, "When you enter this classroom, you are scientists, you are mathematicians, you are respected, you are explorers, you are authors, you are 21st century learners, you are artists, you are important, you are the reason we are here!" Around the corner from the door, another inspirational display covered a closet door: "In our classroom, we are a team, we create, we respect each other, we learn from our mistakes, we try our best, and we celebrate each other's successes." With only 14 students, Hope's classroom appeared large, leaving plenty of room for the students to spread out. In fact, students were often observed intently working on iPads spread out all over the room, at tables, on carpets, and on pillows. Through the Innovation Grant, Hope received 10 iPads that she consistently used for previewing concepts in math. In addition to her 10 iPads, Hope was in charge of the school's iPad charging/syncing cart that housed 20 iPads. The cart stayed in her classroom, which meant that her students often used additional iPads.

Groups of student desks faced a mounted Smartboard. On one side of the Smartboard, Hope had a table for small group instruction, her primary method of math instruction. A Netbook charging cart containing 25 Netbooks sat on the other side of the Smartboard. Another table for small groups sat in the back of the room and was used by Hope's assistant during math. Carpets and pillows decorated a reading center full of books, which was a go-to area for the students when working on centers, projects, or individual work. In sum, Hope's classroom technology received before and from the Innovation Grant included the following:

- Mounted Smartboard
- Document camera
- 25 Netbooks with charging cart
- 3 digital cameras
- 10 iPads
- Syncing station
- Wireless access point
- Teacher laptop- Lenovo PC
- 20 additional iPads for the school stored in room
- MacBook Pro with iPad cart

Hope's Beliefs about Technology in the Elementary Classroom

When asked why she applied for the Innovation Grant to receive the above technology, Hope explained that she wanted her students to have access to technology on a daily basis, which she believed was not happening at home for most of her students. She included these key points in her plan for use of the grant technology:

- Provide students daily access to technologies that will be used as a tool for learning.
- Provide students with background experiences via technology.

- Develop an awareness of learning itself and how to learn using technology as a tool.
- Develop relevant, applicable lessons that use technology and current curriculum.
- Create a learning environment where students can apply their learning to their own environment.

Hope believed that technology had the power to engage and motivate her students to learn, if they were given the opportunity to access it every day. She described the role of technology in her room:

> I think it is to get the kids engaged in the learning. I don’t think the technology does the teaching for you, it just needs to be a way to get them engaged and motivated to learn and the teacher has to play a part and gear them in the right direction for that, but I think they’ve become more interested in school and learning when they get to use the technology.

In order to engage the students, Hope believed that the technology in her room played a supporting role to her instruction and she mainly used technology for previewing concepts to build background knowledge or as a method to check for student understanding and assess a concept. She said, “I think the technology is a support tool that helps get them engaged, but you have to teach them before they can use that support tool and allow them to create things.”

In addition to engaging the students, Hope believed that the technology in her classroom would serve a vehicle for building the background knowledge her students lacked in math and science as well teach them how to use technology. In the Innovation

Grant application, Hope wrote that "technology has the power to motivate and engage students," but that "academic inequity occurs between those who have and those who don't." At the time of the application, Hope explained that 52% of her class did not have access to computers or the Internet at home. She wrote, "This Innovation Grant would allow my students to have access every day to a computer and the Internet for learning." In the Needs section of the grant application, Hope described her students as coming to school with "no background knowledge and exposure to academic and technological things," which "impacts their success in the academic setting."

Planning in a Technology-Rich Elementary Classroom

Hope participated in Think Aloud interviews with me on October 31, 2012 and December 7, 2012. During the Think Aloud interview, Hope verbally expressed everything she was thinking while planning a lesson. In addition to the Think Aloud interviews, the way Hope planned her lessons was discussed during scheduled interviews and informal interactions during the study. Hope tended to use the technology in her room to either preview a concept and provide background knowledge or to assess student understanding and create a product. When asked how she decided to use technology in a lesson, she explained that it largely depended on what she wanted the end result to be. She said, "I think you have to think what the end result is because there are times where, if I'm teaching how to draw out a math problem, I'm not going to have them use the computers, so it really depends on what you're teaching and what you want them to get out of the lesson." To determine what she wanted the end result to be, Hope used student assessment data to inform her planning.

Considering assessment data and student growth when planning. Hope approached the way she planned for math differently than how she planned for science, but in both content areas, the students' level of mastery guided her planning. Hope used small group instruction for the math portion of her teaching block, having the students rotate through her table, her assistant's table, and several center groups every day. Hope began her math week on Wednesdays because she believed she could see what the students were losing being away from school on the weekends if the weekend was in the middle of the unit of study instead of at the end. On Wednesdays, the students took a quiz on the material they learned during the previous week. Then, they grabbed an iPad and a spot around the room to preview the math concept for the upcoming week by watching a video Hope created. These previewing videos modeled a concept for the students and asked them to try an activity related to the concept. Hope always used Wednesdays as her assessment and previewing day and math content was taught in small groups beginning Thursday and ending Tuesday of the next calendar week. To plan for this model of instruction, Hope used Wednesday afternoons to grade and review the students' quizzes, recreate math groups, and plan for each group. Math groups were always changing because Hope arranged the students based on their level of mastery. She explained,

> This year I'm really focused on the students mastering the level before they move on…. Last year I was more focused on the "ok we've got to keep going keep going keep going." Yes, my class was picking up the skills they needed, but a lot of them weren't and sometimes it was too late before you realized you really don't have this skill and if we go back now it's kind of pointless at this point in the year. So this way I'm making sure they get what they need.

Hope's first Think Aloud interview was on a Wednesday so I was able to observe the students take their respective quizzes and preview concepts on the iPads during math. Then, after school, I observed Hope plan for the next week of math. To begin the Think Aloud interview, Hope graded the students' quizzes paying attention to items they missed in order to guide her planning. Because the math groups are always changing based on the students' needs, there were several different quizzes to grade. Hope used the assessment data to reorganize the math groups based on where she felt the students needed to be for the upcoming week. She then planned what the students would do when they visited her table during the math rotation. Hope believed that this approach to planning and implementing math allowed her to focus on her students' needs. She said, "I feel like I'm really trying to make sure they get it and I'm changing different ways of teaching - like when I was getting a lot of kids stuck on story problems I had to come up with a new approach."

Rather than switching concepts every week as she did in math, Hope planned science through conceptual units, but still used formative assessment data to inform her planning. Near the end of the study, Hope's students were studying the states of matter and she planned an inquiry-based unit that had them learning about the states of matter through a science experiment. The students were broken into small groups, assigned a different experiment to learn, and asked to use the iPads to video record themselves performing the experiment. Hope planned to have her students watch each video to learn about the experiment and the concept it was teaching. By the end of the unit, the students would have taught each other about the states of matter through their video-recorded experiments. However, it was immediately evident to Hope that her students did not understand their assigned concepts well enough to model and teach them through the video. The students could do the experiment, but did not understand *why* they were getting their results. During an observed lesson, Hope explained to me that she recognized the need to go through each experiment with each group until they understood the results of the experiment. She proceeded to work individually with each group over the next couple days until they were ready to perform in front of the camera.

Hope admitted that much of her planning and instruction in both math and science was based on student pace, which often left her behind the district-issued pacing guide. However, Hope was willing to fall a little bit behind schedule because she believed that, by the end of the year, the students would be better able to more efficiently build upon their strong foundation in math and science as they learned new concepts, than if she stuck strictly to the pacing guide. Hope believed that the technology in her room helped her restructure her lessons and instruction to meet the needs of her students. To support this belief, Hope described how she used technology to adapt her instruction when her students were having difficulties in reading class.

> Last year my [students] had a difficult time focusing for whole group reading with [the] literacy process we do [in the district]. I decided to use my subscription to Reading A-Z (http://www.readinga-z.com) and I used Smart Recorder (the screen recorder in Smart Notebook software) and I recorded the books [creating video files that I put] onto the computers… so when it came time for whole group reading they had to spread around the room and put their headphones on and they paid attention to the lesson that was on the computer. I didn't have any interfering with kids that just wouldn't behave because they were just all doing their work in a separate location. They were getting the same information and they still had to answer questions for me about the book. They had a Word document they had to type their answers in and they had a couple vocabulary pages they had to

> complete so they're getting everything in there [that the district literacy process requires], but it was just a different format. It helped them to be calmer during the time because otherwise they just couldn't handle the hour-long whole group literacy block together. So [using the videos] was a way to gear their attention to reading but in a different way.

Technology supported Hope's efforts to adapt her instruction to meet the needs of her students. In addition to adapting instruction, when planning, Hope considered the use of technology to build background knowledge prior to teaching a concept because she believed it made the students more confident and allowed her to dig deeper in the content.

Building background knowledge through technology. Hope often referred to the technology in her room as another teacher and she planned with that belief in mind. As described above, on Wednesdays Hope had her students use the iPad to preview the math concept through a video she created. She explained that the students enjoyed viewing the videos because they could replay parts for clarification, especially as they were doing the assigned activity, which built their background knowledge on the concept prior to visiting her during math rotations. Hope also used teacher-created videos with examples to explain the math centers.

> I think the technology is my helping hand. It's played a big part with putting the weekly videos out there. Kids will come to my group and they will have some of the experience before I teach it to them because they've watched the video and they've done work with it so they know what to expect when they come into my first group for that lesson. Some of the kids watch the video and don't get to that step until 3 weeks later, but they at least have the exposure to it before they come to me. It's really having another teacher in the room. Like center directions- I have not had to explain to the kids how to make a bar graph. It's all in the video. So what I'm hoping happens is when we get to this bar graph unit that comes up, they will already know how to make one. They may not know exactly why each thing is where it needs to be, but that's what I can teach. I can teach the why and

> they can know the how before they come to me and that way it all comes together in the end.

As she explained in her grant application, Hope believed her students lacked the background knowledge in the content areas and in technology use. Therefore, part of her planning time was devoted to creating ways to expose her students to uses of technology while exposing them to the concepts she was going to teach. To do this, however, Hope also had to consider logistical issues stemming from the use of technology in her lessons.

Considering technology during planning. During scheduled interviews and informal interactions, Hope explained that she often had to consider issues that arose from integrating technology when planning. She said,

> [Technology] plays a big part in my planning because I have to think of how I can, instead of just notebooks, paper, and pencil, adapt what I am doing into technology… Also I have to be flexible because every new school year my kids are not familiar with daily use of the computers so I have to reteach everything, logging in and going to Smart Notebook. I have to be flexible and push back some other lessons so that I give them more time to explore, so that later on in the year when I need them to create, they can create.

For example, at the beginning of the study, the students spent three weeks learning about the solar system by researching an assigned planet, creating a brochure about the planet using Microsoft Publisher, and recording an audio version of the brochure using the video camera on the iPad. Hope explained that, when planning large science units, she had to consider the way she was going to integrate technology.

> I have to start by thinking what is the end product that I want, and can we get it there? And when do I have to teach [the content] and when do I have to teach the computer skills? When do I let them explore and just work? If I'm giving them a

> project I have to specify days when we're going to accomplish a [particular] goal, but I really I'm looking at the end goal in the final project. So when we're doing the solar system I know what my angle is and I just need to get them there.

Hope also had to consider logistical issues during planning. During an informal interaction one day, Hope shared that technical issues often guided the way she planned centers. Because the Netbooks took a while to boot-up, she planned centers that involved their use, like Study Island (http://www.studyisland.com/web/index/) or the algebra blog on the classroom website to occur consecutively so the students did not have to shut down their computers.

Factors Influencing Technology Integration

Two main factors influenced the way Hope planned for technology integration.

1) Hope's vision of an end goal and knowledge of where her students were on the path to achieving that goal
2) Hope's beliefs about the role of technology in her room

Student assessment and reaching that end goal. In both Think Aloud interviews, Hope referred to formative assessments of her students to make decisions about instruction. When deciding how to integrate technology in her lessons, Hope considered how the technology would help her students reach an end goal. For example, iPads were used in math to help the students build background knowledge on a concept prior to Hope teaching the concept. Hope believed that when the students came to her with background knowledge, she was able to build upon it and move her students toward a level of mastery. In science, technology often became the end goal, demonstrating the students' understanding of the concept and growth over the unit. This was observed with both the planet video brochures and the jigsaw video experiments described earlier.

Beliefs about technology. Hope's beliefs about the role of technology in her classroom also influenced the way she planned. Hope believed that technology engaged the students and served as an additional teacher in the classroom. Because she believed that technology could engage her students like an additional teacher, she consistently planned for its use in math to preview concepts and to explain math centers. She also believed that it was important for students to have daily access to technology and used her classroom as a way to lessen the digital divide most of her students experienced at home. Guided by this belief, Hope explained that, when planning, she tried to find a way to always integrate technology, even if it is just in one content area. She said, "I use it every day, but it's not necessarily for the same area. So I might use it one day for math and one day for reading in the past…. It really depends on what we're doing." Hope believed putting technology in the hands of students was something every teacher should do.

> I think that in an elementary classroom, students should be utilizing the technology. There are a lot of basic skills that a teacher needs to teach them to begin with, but once they get used to utilizing the technology and programs available to them, they can easily explore and learn new tricks that help them complete tasks in a quicker more efficient manner. I think the elementary teacher needs to foster the students' needs to explore their own learning. The teacher needs to lay the foundation for [the students'] learning and then guide them from there on. I think the instruction should be designed to be kid friendly, interesting, for your students. It is the job of the teacher to ignite the spark in the learning that will then allow the students to create the large fire that allows their learning to grow larger and larger every day.

Summary

Hope Moore believes that technology has a place in the elementary classroom to engage students, build background knowledge, serve as an additional teacher, and showcase student learning in final products. Hope is a teacher who plans lessons while considering ways technology can preview concepts and show student understanding.

The Case of Ella Rose

The classroom is quiet except for the monotonous hum of computers and a projector and the muffled sounds of Ms. Rose helping a few students. Heads are bowed over computers and papers capturing tidbits of information that will later be transformed into an eye-catching presentation. Quietly, one student asks, “Can you show me how to do a PowerPoint?” to a student nearby. Without hesitation, the students begin working together as one learns to navigate a new tool. Ms. Rose walks by the table silently approving the partnership and moves across the room to check on another student. “How do I add a picture to this slide?,” a student softly asks at a table in the back of the room. “Let me show you,” says another student at the table. They push their seats together and get back to work. Later, at the end of class, Ms. Rose asks the students to share their feelings about the class on a sticky note before leaving for recess. One sticky note read:

> Dear Ms. Rose,
> I never knew how to do a PowerPoint, but my dear friend Sam (pseudonym) helped me and got me steady. Now, I feel really confident and would like to know how to do a Prezi and PhotoStory.
> Love, Mary (pseudonym)

Ella Rose (pseudonym), a bright, energetic, 5th grade teacher always seemed to walk with a bounce in her step. Ella loved her students as if they were her own and consistently had high expectations for them in the classroom. During the initial interview she said, “I’m strict and they know I mean business, but they know in their hearts I care and love them. They already know that and it’s the second week of school.” Ella often joked that she was strict and that her students probably disliked her, but that was far from the truth. The “tough love” approach worked for Ella. During classroom observations, I often overhead snippets of personal stories the students excitedly shared with Ella as they walked out the door to recess and witnessed the hugs the students often sought from Ella “just because.” Ella’s students appeared to thrive in her highly structured, yet loving classroom environment.

Ella, 46 years old at the time of the study, was in her 21st year teaching. Licensed in Elementary Education K-6, Ella had experience teaching preschool, 1st, 2nd, 3rd, and 5th grades and was currently in her 3rd year teaching 5th grade. Over her career, Ella participated in various leadership groups, including the district’s technology leadership group. At the time of the study, Ella had stepped back from most of her additional responsibilities to focus on teaching, being a mom to two high school boys, and planning her upcoming wedding. To Ella, the most important place she could be was in her classroom, so when additional responsibilities began to jeopardize time spent planning, Ella decided to reexamine her priorities. At the time of the study, Ella taught two blocks of language arts and social studies. Originally, the blocks were organized by homeroom class, but near the end of the study, Ella and the teacher partnered with her for math and science used assessment data to reorganize the students based on need.

Ella's 5th Grade Classroom

From the beginning of the study to the end, Ella's classroom seemed to transform. Although colorful, during my first visit to Ella's classroom in August 2012, I noticed mostly bare walls. By the time I said goodbye in December 2012, Ella's walls were covered floor to (almost) ceiling with teacher- and student-created anchor charts, a staple of Ella's lessons. Ella allowed the students to build their own classroom by showcasing their learning. The functional posters were often referenced during instruction and I observed the students using them when working individually. The anchor chart associated with the current lesson was always hanging on the whiteboard with a magnet, usually under the Learning Targets of the day. Located on both the front and back whiteboards, Ella referred to the day's Learning Targets, student objectives created from the Common Core Standards, several times throughout her lessons, making them a central piece of the classroom.

Mounted to the left of the Learning Targets was Ella's Smartboard, which hung over a lime green carpet where the students often sat during instruction. On one side of the Smartboard, Ella had a workstation for her laptop and document camera and on the other side she had a charging cart with student Netbooks. In all, Ella's classroom technology before and from the Innovation Grant, included:

- Mounted Smartboard
- SmartSlate

- Document camera
- 30 Netbooks with charging cart
- 30 headphone/microphone sets
- 5 digital cameras
- 5 Flip Video cameras
- 5 external DVD burners
- 2 iPads
- Wireless access point
- Networked printer
- Teacher laptop- Lenovo PC

When asked why she applied for the Innovation Grant to receive this technology Ella said,

> I just saw such a need for it and I wanted to have my own classroom set I could use. I mean that was the top priority because we had one [laptop] cart we were all fighting over and half of the computers never worked. I just wanted another piece of technology in the classroom besides the Smartboard.

Ella's Beliefs about Technology in the Elementary Classroom

Ella believed that integrating technology into her lessons was a way to engage her students in the content she was teaching. When asked what role technology played in her lessons, she said,

> To engage them; hopefully to teach skills in a purposeful way, and to connect to others outside of the classroom because I feel like kids are not exposed like you

> and I growing up so they really wouldn't get to write about going to a place that they've ever been. It's hard for them to do that, to make a connection to it.

After most observed lessons, Ella had the students share their level of engagement with her. A chart hung by the door titled "How engaged were you?" On the chart, three footballs were evenly spaced; the bottom football said out of bounds, the middle football said 50-yard line, and the top football said touchdown. At the end of the lesson, before the students left for recess, Ella had them answer a question about the lesson on a sticky note. Sometimes the questions demonstrated understanding and sometimes the questions had the students assess the lesson. For example, one time Ella asked the students what they liked about a project they had just completed on Native American tribes. One student's sticky note explained that she enjoyed the project, but that she did not like having to do a peer-assessment of her group members. After filling out their sticky notes, Ella asked the students to put their names on the back and attach them to the football that best represented their level of engagement. After one class period spent researching monuments in Washington, DC, some sticky notes said,

> I am [touchdown] because I like to use the computer and explore.
>
> I'm at the 50-yard line because I was kinda confused because I wanted to do a Prezi, but I did not know how.
>
> Dear Ms. Rose, I never knew how to do a PowerPoint, but my dear friend [student name] helped me and got me steady. Now, I feel really confident and would like to know how to do a Prezi and PhotoStory.

Ella explained that she used these sticky notes to inform her planning because they gave her insight into areas in which the students were still struggling, as well as how engaged the students felt they were during the lesson. She was excited to read the feedback from the Washington, DC lesson. She said, “The feedback I received through my tickets out the door from students is positive! All love choice, creating and sharing amongst their peers. I love to see their excitement for learning!”

Ella believed that one way to engage her students in the content she was teaching was to make the content relevant to the students through the use of technology. Because of this belief, Ella often devoted some of her planning time to finding video clips to introduce or clarify a concept. Through experiences in the classroom, Ella found that short video clips related to the concept they were studying helped her students make connections between the concept and the real world. Making content relevant to the students’ world was important to Ella. In fact, she explained that every elementary classroom should be incorporating 21st century skills into instruction in order to encourage students to be connected and collaborative. She said,

> In my opinion, a classroom should be practicing the 4 Cs: communication, collaboration, creativity, and critical thinking. Students should be producing content, not just consuming it passively. Though technology isn't synonymous with the 21st century learning, it is an integral part of it, and it's often the set of tools that makes this new approach to teaching and learning possible. The purpose of technology, in my opinion, should be to connect students with their world and enable them to learn from others and to share their own ideas.

Planning in a Technology-Rich Elementary Classroom

Ella participated in Think Aloud interviews with me on November 6, 2012 and December 14, 2012. During the Think Aloud interviews, Ella verbally expressed everything she was thinking while planning a lesson during her designated planning time.

In addition to the Think Aloud interviews, the way Ella planned her lessons was discussed during scheduled interviews and informal interactions during the study. Ella spent much of her free time planning and was known to spend evenings and weekends at school. She also admitted that she spent a lot of time reflecting on lessons she taught, considering ways to reteach or extend the content the next day: “I go home every night and I evaluate and I’m like, they really didn’t get that today and I really need to reteach it tomorrow, even if just for like 5 minutes.”

Ella described her planning as spontaneous, yet organized. She regularly sat down to plan lessons start to finish, but continued to think of ideas at other moments in the day, such as during her drive home from work or while taking a shower. “I swear my brain goes a mile a minute,” Ella said when discussing how she planned. Ella planned using a guide associated with the Common Core Standards that the district gave her. She called this the Anatomy of a Lesson and often referred to its components while planning. Within this lesson framework, there was a place for whole group instruction, small group or paired collaboration, and individual practice.

Concurrent thoughts on technology, content, and pedagogy. During both Think Aloud interviews, Ella began her planning by reviewing the Common Core objectives on the district pacing guide. In a follow-up interview, Ella explained that she always starts her planning with the objectives or Learning Targets she wants to address and then moves into how she is going to teach the content, which is what I observed in the Think Aloud interviews. For Ella, consideration of technology was concurrent with her thoughts about the content. In fact, as she planned in both Think Aloud interviews, Ella created a Smart Notebook file that organized her lesson. She then used this file as part of her instructional presentation during the lesson.

> I use the Smartboard for every lesson because, within the Anatomy of a Lesson, I feel like that's a great way to get the "me." Sometimes I can't find a read aloud book so I will find [text] for the Smartboard that I can at least put a paragraph or something in there…. I might even pull [text] out of something I find online that's just a short story or whatever…. Then it's easy for me to incorporate the "me" and then the "we" where [the students] come up and they [manipulate] what we talk about together [on the Smartboard].

After the objectives, the first slide Ella created in the interviews held a link to a short video clip related to the content. Ella later explained that she always started her planning by finding a clip for the students to view.

> I always think about the technology. I plan around the technology believe it or not I mean that's the first thing I'm always thinking of. Like I said a video- that's probably the first thing I do. I find something that relates to [the content] like maybe something audio. We did point of view with *The Three Little Pigs* and I had audio of that. Then, they had to compare it to *The True Story of the Three Little Pigs*. Then I used the document camera just to show a few pages of the story… so I'm always thinking about using technology.

During the first Think Aloud interview, Ella searched for a video that would introduce point of view to the students for a lesson prior to the *Three Little Pigs* lesson she described above. While she was planning she said,

> I always like to incorporate a teaching video. I did see that there was a Brain Pop (http://www.brainpop.com) video and I viewed that one and it got too involved with first, second, and third, and we're only going to do the two (first and third). I did find one on TeacherTube (http://teachertube.com). I use that a lot because I

> feel that kids really really relate because they watch T.V. a lot so they can see something visual, maybe something that kind of catches their eye.

Because she always viewed instructional videos before she taught with them, Ella spent about 6-8 minutes of her planning time searching for and previewing a video on point of view.

In addition to using video clips to activate and build background knowledge, Ella considered other ways to integrate technology as she moved through the "Anatomy of a Lesson." In the first Think Aloud interview, Ella decided to use an online comic strip creator (http://www.readwritethink.org/files/resources/interactives/comic/) to assess the students' knowledge on point of view. Ella believed that the comic strip was a medium that would be relatable to the students. Ella explained that the online comic strip allowed her to "incorporate writing" because the students "will have to create a story and be the narrator… they can use dialogue [representing first or third person point of view]." Therefore, as she was planning how to assess her students, Ella was thinking about the technology she wanted to integrate.

21st century skills. Ella also considered the integration of 21st century skills while planning. As she stated earlier, she believed that the integration of technology was one way to promote 21st century skills. As part of the "Anatomy of a Lesson," Ella included opportunities for students to work together to accomplish a task. For example, to prepare for a field trip to Washington, DC, Ella had the students individually research different memorials and monuments that they would see on their trip. The students were then responsible for sharing the information using a jigsaw approach with a small group of students. Although this project seemed like a typical elementary research project, Ella added a component of collaboration and communication often missing from elementary research projects. Since there were at least two people working on each monument, Ella had the students first work individually and then conference with those sharing the same monument. During the conference, the students communicated the information they had discovered about the monument, as well as their thoughts on their peers' presentations. Then, they collaborated on ways to improve their individual presentations, including new information they did not originally discover. Taking the new information, the students revised their individual presentations before they were split into jigsaw groups to teach other students about their monuments. In a follow-up interview, Ella explained why she wanted the students to collaborate during this project. She said,

> I feel as though students need practice communicating, working together, teaching one another and exploring within a group or partner situation. I feel students feel less threatened when having to complete an assignment especially when they do not understand a concept and can hopefully learn through their peers.

In all, Ella planned this project to include 21st century skills including communication, collaboration, and creativity as the student designed a PowerPoint, Prezi, or PhotoStory presentation and shared it with their peers.

Considering the technology during planning. As Ella was simultaneously thinking about technology and the content she wanted to teach, she also had to consider logistical issues that arose from the technology she wanted to integrate. Ella described herself as strict and had high expectations for her students and her lessons. She ran a structured classroom and was conscientious about procedures during lessons. Because of this, Ella spent a lot of time at the beginning of the year teaching her students how to use the technology in the room.

In addition to procedural issues with using technology, Ella found it difficult to integrate some of the grant technology that was not 1:1. For example, she only had 2 iPads, which limited the ways she could use them during instruction. She said,

> You know I'm always thinking of using something with technology during my lessons. I was thinking about that this morning. I don't use the iPads that much because I only have two of them and one is mine. I do use [the iPads] in word study because that's the only time that I can use [them in small groups]. I don't feel like it's something [I can use consistently] unless I have a class set that's why I feel so blessed to have a class set of Netbooks.

Although she had a classroom full of technology, Ella understood the frustrations teachers have with a lack of access to 1:1 technology.

> I did a workshop yesterday with my student teacher on using Google Forms to do their pre-assessment and you know the question [from other teachers] was "how do you allow all your students to take their pre-assessment?" Well, I have the advantage because I have computers for everyone and I feel like not every teacher can use technology in that way.

An access barrier also existed with the parents of Ella's students. Although many had access to technology at home, they did not always have the programs Ella was using in school. For example, Ella explained that she was limited in what file formats she could put on her classroom website because the parents had to be able to open it on their computers at home. As an example, Ella described a project she wanted to do in PhotoStory (http://www.microsoft.com/en-us/download/details.aspx?id=11132) as having limitations because many of the parents did not have PhotoStory on their home computers.

> I'm going to use PhotoStory and use the audio this time and let them record themselves reading their poetry, but then I always feel like what could I do with [the final products] after that because I can't put them all on my website. [Parents and students] can't always access it because they don't have PhotoStory on their computer at home so there's some disadvantages to using it.

Factors Influencing Technology Integration

Two main factors influenced the way Ella planned for technology integration in her 5th grade classroom.

1) Ella's beliefs about the role of technology in the classroom
2) Ella's ability to think about the technology while considering content and pedagogy

Beliefs about technology in the elementary classroom. Ella believed that technology engaged her students and made content relevant to them. She especially found that visuals were engaging to her students because they were used to watching television at home. Because of this belief, Ella routinely included visuals, such as short video clips, at the beginning of her lessons to build background knowledge about the concept she was teaching. Ella also believed that the use of technology was one way to promote 21st century skills in the classroom. She often included technology products in her lessons, such as the online comic strip, or the Washington, DC presentations, to encourage communication, collaboration, and creativity.

Planning with technology, content, and pedagogy in mind. Ella began lesson planning with content objectives and an overall goal in mind. However, she joked that the lesson planning between the objectives and the end goal was "all over the place." Ella felt this way because she appeared to jump around from thoughts about the content, thoughts about the delivery of the content, and thoughts about technology when she was planning. Although she thought this was somewhat chaotic and often said that other teachers did not understand how she planned, I believe that she was simultaneously considering technology, content, and pedagogy as she planned because she did not view them as separate entities. Planning with technology, content, and pedagogy in mind will be discussed more in the cross case analysis.

Summary

Ella believed that technology engaged her students by promoting 21st century skills of communication, collaboration, critical thinking, and creativity. Ella planned lessons while simultaneously thinking about technology, content, and pedagogy and found ways to use technology in multiple parts of her lessons to introduce, to practice, and to assess concepts.

The Case of Jan Richards

The kindergarten students in Ms. Richard's music classroom sat down to take a breath after singing an interactive version of *Feliz Navidad* where hands and bodies were moving. "I'm going to show you something very cool," said Ms. Richards excitedly. She told them that the song in the video clip she was about to show them was the same song they just sang, but that the musicians in the video were taking a different approach to the song. Laughter erupted as the students watched *Feliz Navidad* come to life with unique instruments: iPhones, iPods, and iPads. Ms. Richards paused the video to point out someone playing the drums on the iPad and then again to point out someone playing the piano on the iPad. "You mean like a keyboard?!," said a student in amazement. The camera zoomed in on a pianist playing the iPad. "Oh he is!," exclaimed a student from the back of the room. Another student chimed in, "Let's hear it again!" As the class watched the North Points iBand play *Feliz Navidad* (http://www.youtube.com/watch?v=DcexJQM-8W0), wonder, and then excitement, filled the room. "I wish we could see them play *Dreidel Dreidel* [another song in the students winter program]," a student muttered from the side of the room as Ms. Richards turned off the video.

Jan Richards (pseudonym) is a wife, mother, and grandmother with a passion for music education that would inspire anyone to be a music teacher. With a work ethic to match her passion, Jan is a teacher leader at Blue Ivy, a PreK-5 Title I Elementary School, where she serves as a mentor to beginning teachers, provides school-wide professional development in writing through a position on a district-level writing team, and leads professional development on various topics relating to technology integration at the school and district levels. Jan also directs the school's music programs, an extra-curricular student music group, and co-leads the televised morning announcements.

Jan is known in the school as the person to visit if you want to borrow the Netbook cart, troubleshoot a technical issue, or just to get in the school building on the weekends, because she is always going to be there working. Most importantly, Jan loves her students and they love her, which is reflected on their faces as they enter her room for music class. This could be because, most of the time, Jan's melodic voice greets them in song as they enter the room and it is the last thing they hear as she sings them out the door.

Jan is licensed in Music Education K-12, has a M.Ed. in Curriculum and Instruction, and is certified to teach gifted learners. Jan is also a Nationally Board Certified Teacher (NBCT) who has recently completed her recertification. With experience teaching in four states over 35 years, Jan has been in her current school system for 13 years. Music textbook publishers often solicit Jan to review or contribute to publications and she has written chapters for an elementary music textbook. In fact, Jan is often asked to participate in, lead, or organize events, groups, or professional development. Near the end of the study, Jan expressed a desire to step back a little bit from her responsibilities in order to focus her energy more on the classroom because that is truly where her heart is. However, she added that she would not give up her position in the school district's technology leadership group, highlighting the fact that technology played a large role in her beliefs about music education.

Jan's Music Classroom

Located on the back of the school's stage, Jan fought for her own space for music class by closing the stage curtains and creating a makeshift wall along the curtains out of bookcases. Although it did invite some criticism, the wall ensured that the back of the stage was her classroom instead of a walkway to the gym. When imagining a classroom in the back of a stage, one would probably think it to be drab or sparse, void of that welcoming feeling normally felt when entering an elementary classroom. However, only the glimpse of stage curtains to one side of the room or the occasional sound of balls bouncing in the gym hinted at Jan's room being anything but a musical oasis for the students.

When asked why she applied for the school system's Innovation Grant, Jan immediately exclaimed, "To get stuff!" In Jan's initial interview, she joked that her husband fondly told her not to worry when she first transferred to Blue Ivy Elementary and acquired a music classroom lacking technology because she was "good at getting stuff." Jan's husband was right because her classroom was full of "stuff." A small classroom given the location, Jan was able to effectively use her limited space to accommodate instructional materials, technology, and collaborative space for her students. Instead of having desks, two large, colorful carpets covered the center of the room for students to sit facing either the Smartboard that was mounted on the wall or the digital piano. The students often changed positions on the carpet during the lesson to face the board or the piano, both being vital parts of Jan's lessons. Jan explained,

> I never teach a lesson without technology anymore. Not every piece of equipment every day, every lesson, but there is something [in every lesson]. I mean Smart Notebook (the software associated with the Smartboard) now is a part of my life. I used to say I can't teach without the digital piano because it's an amazing tool because it is a computer that looks like a piano, but the Smartboard now is that piece, as well. Pull up a file for a lesson and it's just there, I mean with the videos embedded.

Next to the Smartboard, Jan had a cart equipped with a Lenovo (Windows) laptop given to her when the district provided laptops for all the teachers in her school, a MacBook Pro purchased by Jan's principal for special projects she was asked to do by administration, and a document camera acquired through the Innovation Grant. Jan also had an additional laptop for her student teacher that she got through the grant. When describing items she received through the Innovation Grant, Jan included the student teacher laptop as being one of the most significant additions to her room because she consistently was asked to supervise music education student teachers from the local university. She said,

> The three most powerful [items received from the grant] would have to be the Flips (video cameras), and having an army of Flips and the [digital] cameras, I'm going to lump those together, that would be one. But another one was I got an extra laptop for my student teacher.... that has been such a huge blessing. So for my student teachers ever since then they have a laptop that they use and I have a laptop. And then of course the [Netbook] cart.

Due to space limitations, Jan's cart of 21 Netbooks was stored in the school's library across the hallway. This location also allowed other teachers to borrow Jan's netbooks, which she encouraged, as long as they followed her strict usage rules. Jan proudly explained that she "preached" to students and teachers about proper care of technology because it was important to her for others to share a sense of ownership with the school's technology.

Jan described the arrival of the grant technology in her room as larger than life. She said, "You know, until you see them walking in with $20,000 worth of stuff, you really have no clue." In summary, Jan's classroom technology, acquired before and from the grant, consisted of the following items:

- Mounted Smartboard
- SmartSlate (wireless slate for Smartboard)
- Lenovo (Windows) teacher laptop

- MacBook Pro teacher laptop
- Digital piano
- Computer monitor for the digital piano
- 21 student Netbooks
- 4 digital cameras
- 5 Flip Video cameras
- 4 iPod Touches
- Copier/Scanner
- Student Teacher laptop
- Document Camera

Of the preceding items, only the copier/scanner was not available for Jan's use because, after purchasing the copier, the school system moved to a networked copier system at Blue Ivy Elementary School. In addition to technology, Jan's colorful music room was lined with teacher- and student-created posters, also referred to as anchor charts, that she often visited during lessons, such as the music staff next to the Smartboard labeled with acronyms to help the students remember line and space notes. Books and musical instruments filled the bookshelves and bins lined around the room.

Jan's Beliefs about Technology in the Music Classroom

With 35 years of teaching experience, Jan felt that she always had a passion for learning about technology in the classroom. She said,

> I have always been passionate about the technology piece and that got started in [a previous school/state] when they said, "Alright if you want to, sign up and take a

> class on the Mac" and everyone was like, "I don't know," because everyone was in the same boat when it started. So even the college kids coming out weren't really knowledgeable about [technology integration] because we were all really starting, unlike today.

In fact, Jan had a passion for enhancing her instruction in general. Although Jan attributed the choice of a M.Ed. in Curriculum and Instruction rather than Music Education to the convenience of the location and time of the program, consideration of her achievements and time spent with her reflect a teacher who has a bigger vision of the elementary music classroom. In her initial interview, Jan admitted, "I'm definitely a big picture person…. The interesting thing is that I am right-brained/left-brained. That helps, too. A lot of musicians are going to be strictly right-brained and can't see anything else." Jan's ability to see the big picture was evident in her degrees, certifications, and involvement in professional learning communities, such as a writing team that provided professional development to schools in the district.

Exposure to content through technology in the music classroom. Jan believed that the role of technology in her elementary music classroom was to enhance student learning by building the background knowledge from life experiences that her students typically lacked. In her initial interview she said,

> And in a school like this, what's going to increase their exposure, because they're not bringing the piece of we went to Disney World or we've been to the beach or we've been to the [local city] Symphony concert for the pop concert or we saw the Nutcracker Ballet. None of my kids bring that piece.

In an interview near the end of the study, when asked to give an example of the use of technology for exposure, Jan said, "Exposure can be the virtual fieldtrip knowing that my kids don't go to the symphony. Exposure through the YouTube video brings that to them." In the same interview, Jan elaborated on her beliefs about exposure by saying,

> My goal is so that when my kids are in a room with kids from [district school] and [district school] and [district school] and [district school] that somebody isn't able to say there's a poverty kid, there's a poverty kid, that's a poverty kid, because [the children] are like looking with their eyes open and don't really know what's going on. I want them to be able to compete. I want them to be able to break the poverty cycle even though all the research says they won't be able to easily do that. I want them to know that they can, if that means getting this stuff in their hands.

Jan also believed that integrating technology in her lessons exposed her students to specific music content beyond what she had available in her music classroom. During an interview immediately following the kindergarten *Feliz Navidad* lesson described above, Jan explained that she did some research on the North Points iBand in order to access the same applications they used to create music. She said,

> I went in and did some reading on that…. those programs they listed, I found in some writing…. so actually, on the four Pods that I've got, those programs are on there…. For one of my classes, I had four iPods and I divided the kids into four groups and then…. one of the iPods was Bebot (http://www.normalware.com) and one group had the tambourine, I can't remember the rest, but in my lesson we did the singing of the song, we watched the video and then we [composed and played the song on the iPods].

Jan used her iPod Touches to put music instruments in the hands of her students, having them create and play a song together.

Exposure *to* technology *through* technology in the music classroom. Jan had a larger goal in mind when applying for the grant- she believed that her music classroom was a powerful place in which all of the students at Blue Ivy Elementary School could have access to innovative technology tools. An excerpt from Jan's Innovation Grant application describes her desire to put technology in the hands of every student in the school. She wrote,

> Some may question the value of making a Music classroom a 21st century classroom, but two of the most positive outcomes of the Music room having a Smartboard as part of the [district technology leadership program] in the 2008-2009 school year was (1) *EVERY CHILD* at [Blue Ivy Elementary School] learned how to use the Smartboard, and (2) it excited other teachers to desire a Smartboard in their classrooms.

In another section of Jan's Innovation Grant application, she further described the impact her existing technology was already having on the students of her school:

> Last year we had a Smartboard in the music classroom for the entire year, and were able to see the students fully engaged and excited when using the Smartboard. They begged to know, "Why don't we have one in our classroom?" When using technology they get excited and are gaining knowledge without even realizing it because they are having so much fun! Technology is constantly changing; we want to stay on the cutting edge of it, allowing our students equal opportunities. This year we also added a digital piano, so students are exposed and experiencing the creation and performance of music created digitally. This will definitely be a part of our 21st century classroom!

Therefore, although Jan joked that her goal in applying for the grant was to "get stuff," the idea of getting stuff was surrounded by the larger goal of putting that "stuff" in the hands of students as a method of exposure.

Teaching in a transient school, Jan believed that one of her responsibilities was to prepare her students to be successful in other schools in the district. She believed that a digital divide existed between her students and students at other schools in the district and, therefore, it was necessary that teachers at Blue Ivy integrate technology into their lessons to expose students to technology tools.

> I do, I want them to have [21st century] skills, I think its critical. And the way the kids move now, for the kid who leaves here and goes to [other school in district], he'll stand out if we haven't exposed him to as much as we can.

To Jan, integrating technology into lessons was not an option: "If we don't do it [at Blue Ivy], that gap just gets bigger and bigger."

To encourage the students to become more proficient with the technology in her room, Jan often modeled *how* to use the technology while she was teaching with it. For example, during an observed 2nd grade lesson, Jan taught the students how to use the cloning feature in the Smart Notebook Software on the Smartboard as they illustrated and sang *The 12 Days of Christmas*. By the 12th day of Christmas, student participants were able to illustrate the song lyric, clone their illustration, and arrange the picture neatly to complement the typed lyric. One drummer drumming turned to 12 with a few quick touches and little guidance from Jan, as the students had almost mastered the Smartboard feature. As each student finished illustrating a lyric, the class stood up and sang the song while Jan clicked through the Smart Notebook pages revealing the lyrics and illustrations in time with the music. Although learning and using the cloning feature during the lesson did take time away from the music content, Jan believed this was necessary to providing the students with exposure to technology. In an interview after this lesson, Jan explained why she spent time with the cloning feature.

> I like to talk when I am at the Smartboard. I want them to know [how to use it] and like I said most of the kids even in the upper grades don't get to use the Smartboard and I wish I had longer lengths of time with them because I would love for them to have more hands on time with the Smartboard. So to me that's exposure, too, teaching them the tricks and hoping they get some kind of opportunity in the [general] classroom to show that they know the trick.

Jan also encouraged the students to share their knowledge or "tricks" with their general classroom teachers in order to 1) encourage the teachers to let the students touch the Smartboard more often, and 2) teach the teachers how to do the tricks if they did not already know how. Jan's beliefs about technology in her music classroom as a method of exposure to music content and technological knowledge influenced the way she planned her lessons, which will be discussed further in the next section.

Planning in a Technology-Rich Music Classroom

Jan participated in Think Aloud interviews with me on October 31, 2012 and January 11, 2013. Due to December being a busy time with music programs and other school events, the second Think Aloud interview was moved to after Jan's winter break. During the Think Aloud interview, Jan verbally expressed everything she was thinking while planning a lesson during her designated planning period. In addition to the Think Aloud interviews, the way Jan planned her lessons was discussed during scheduled interviews and informal interactions during the study. At Blue Ivy, teachers were required to keep their lessons plans in a red binder visible on their desks for the principal to review if she visited the classroom. Jan used a district-issued lesson plan template that she tweaked to meet her personal preferences to plan her lessons. She also kept the district-issued pacing guide for elementary music in her red binder. She referred to the binder, specifically for the pacing guide, during her Think Aloud interviews.

Big picture planning: goals, content, and technology. Jan called herself a "big picture person" and her method of planning reflected that description. In both of her Think Aloud interviews, Jan began with a big goal in mind and used the planning session to outline how she would move toward that goal through multiple days of lessons. At the time of the study, Blue Ivy was on a five-day schedule rotation with an occasional "zero day" added for special events. Therefore, Jan only saw her classes every five to six days, which meant that planning for big goals included lessons that covered several weeks at a time, rather than a few consecutive days like typical lessons in a general elementary classroom. For example, in her first Think Aloud interview, Jan began the planning session by saying that she would be planning for several weeks of lessons that would achieve the bigger goal of preparing her fourth and fifth grade students for the upcoming [state] Symphony concert for local elementary schools. Jan concluded the first Think Aloud interview by saying, "Well, that kind of gives you an idea of how I plan. I don't look at it as one lesson. I can't because otherwise I think then it becomes too much of an activity and not a whole piece."

In her second Think Aloud interview, Jan began the planning session similarly by saying that she would be planning for several weeks of lessons that would achieve the larger goal of preparing her second and third grade students for the upcoming spring music program. During a follow-up interview to the first Think Aloud session, Jan suggested that her role as a music teacher afforded her the flexibility to plan with larger goals in mind. She said,

> I'm guessing that my planning would look very different from a classroom teacher planning because theirs is so laid out in a pacing guide. Mine is a more generic pacing guide. I saw one this week for, I think it was ELA, and I was like "that's a daily guide." You can't really stray from that…. I know they also have some play in it a little bit, but I think that my planning would look very different from what they do because I have the leeway to decide what we are going to do and when we are going to do it kind of. I'm a firm believer that I can make almost anything that I want to do fit into [the content objectives] because it's just "what am I going to highlight?"

In both Think Aloud interviews, Jan moved from a larger goal to more specific content objectives, spending considerable time planning the delivery of the music content. In this progression, she considered the technology she wanted to integrate as she was thinking about the content objectives. When considering technology during planning, Jan explained, "I am always looking for something that will enrich or add to [the content]."

During one interview, Jan described how she thought about technology and content while she planned for the larger goal of having the students compose an original piece of music. Composing original music brings a level of difficulty to the elementary music classroom that causes many music teachers to skip the objective altogether, especially given the limited amount of time elementary music teachers see their students. According to Jan, interactive whiteboards, such as the Smartboard, have given music teachers a better platform for modeling the composition of music because of the ability to easily manipulate music notes on the staff in front of the students. She said,

> The two hardest parts [of the music standards] are to compose and to improvise. The invention of the whiteboards and the Smartboard has helped that…. And the neat thing is that the Smartboard is there and we can just throw [music] up and move it around. It's really made composition easier…. I want them to use the whiteboard and the manipulation of notes and then, what does that feel like with the recorder?…. Last year I even did something where each person was responsible for two measures and then I put them in groups of four and they were actually physically saying, "Well would it sound better…" That is where that is eventually going, but that will be later in the year. I'm a chunk planner so that is my vision for the end, but how do I get them there?

In both Think Aloud interviews, Jan's approach to technology within the content objectives was to enhance the content and move it beyond the walls of her classroom. This idea of exposure beyond the classroom walls is described further in the next section as a reflection of how Jan's beliefs about the role of technology influenced her planning.

An intersection of beliefs and planning. As previously discussed, Jan believed that exposure to content was an integral part of her instruction because her students were lacking the background knowledge from life experiences needed to make connections to the content she was teaching. This idea of providing exposure to the content was also observed during Jan's Think Aloud interviews. For example, during the first Think Aloud interview, Jan predicted that most of her students would not be familiar with the Symphony so she spent about 20 minutes out of 36 total minutes searching for and previewing video clips of the Symphony and of examples of music the students would hear the Symphony play. While she searched for video clips she said, "I find that when I'm planning my lessons, if I can use a short clip, it engages the kids. It gives us a starting point for discussion." She also readily admitted, "I spend probably too much time looking for this kind of stuff."

Jan used the video clips as a way to build background knowledge for the students before beginning the discussion of the Symphony. She also used the video clips to encourage the students to make connections between what they watched and discussed in class and what they experienced at the actual concert. During her Think Aloud interview, she tediously searched for and previewed clips that provided close up footage of the Symphony so the students could see the musicians playing their instruments because she knew that their seats for the upcoming concert were not close to the stage. During the follow-up interview, Jan explained why she spent so much of her planning time looking for clips with close-up shots of the musicians:

> You know we go to the concert, but [the musicians] are way up there on the stage and if we happen to be assigned to sit in the back…. seeing them play that Wagner piece [on the video clip] with the violinist right there, to me that's really important, that's critical because they won't get that [at the concert].

During another interview, Jan again mentioned the importance of using the technology in her room to build the students' background knowledge before they attended a performance because, in most cases, their field trip would be the first time the students attended such an event. Jan believed that music field trips were more powerful to the students when they were able to make connections between content in class and the field trip experience. She explained that she spends a lot of her planning time considering how she can provide meaningful exposure to the content, knowing that her students often bring no prior experiences with the content. Now, when she visits places or attends performances, Jan brings a digital camera and/or Flip Video camera so she can capture images and video that will expose her students to the same kinds of experiences in the classroom. For example, she said,

> I had taken pictures at the Nutcracker. They let me go backstage, and they let me take all these pictures. I put them on the laptop and when we got the Smartboard it was so wonderful to see them big. So I create all that stuff and then I use it. So that's a lot of the lesson planning.

When integrating technology to achieve big goals and provide exposure to content for her students, Jan also recognized the logistical issues that arose from technology use.

Considering classroom management during planning. During both Think Aloud interviews, Jan considered logistical, management-type issues that integrating technology brought to her lessons. The idea of managing the use of the technology in the room also emerged several times during the study in scheduled interviews and informal interactions with Jan. When describing how she plans, Jan suggested that having an array of technology in the room sometimes made her stop and think specifically about the tools during planning. She said,

> Sometimes I have to say ok I've got these Touches, or I've got this, how can I use that? And in some ways it is hard because it is only 4 Touches so how are you going to use that and keeping track of which kid has touched the Touch. But on the flip of that, everything I do is technology based whether that's with the piano or the Smartboard or the cameras or if we are going to assess with the Flips so it is still all there, but sometimes when you do have so much you really have to also think how am I going to use this?

Jan also discussed classroom management issues that arose when she planned a lesson using applications on her four iPod Touches to create music like the North Points iBand played *Feliz Navidad*. She said, "You can't put one kid on an iPod or four kids on an iPod and the rest of them- too bad so sad. So then it is a whole management thing in your lesson." Although Jan had various technology available for use everyday in her classroom, she still sometimes struggled with how to integrate hardware tools that were not 1:1.

Factors Influencing Technology Integration

Two main factors influenced how Jan planned for the integration of technology in her music classroom.

1) Jan's beliefs about the role of technology in her classroom at Blue Ivy
2) Jan's Technological Content Knowledge (TCK)

Beliefs. Jan believed one significant role of technology in her music classroom was to provide exposure to the content for the students because she felt that they sometimes lacked the background knowledge from life experiences to make connections to the content she was teaching. When planning during the Think Aloud interviews, Jan specifically thought about adding technology to her lesson in a way that would increase exposure to the content for her students. Jan also believed that her music classroom was a place to bridge the digital divide her students experienced because every student in the school saw her at least once a week. This belief encouraged her to integrate technology as much as possible, knowing that she was providing exposure to technology to those students lacking it at home on in their general classroom.

Technological Content Knowledge (TCK). Given her position as a music teacher, Jan had deep content knowledge of her discipline. Jan also had strong technological knowledge and felt comfortable exploring new ways to use technology in her classroom. However, Jan's greatest strength was her ability to identify the technology that would best address learning within the content of music. This combined knowledge of how technology influences content and vice versa is called Technological Content Knowledge (TCK) (Mishra & Koehler, 2006). Jan's Technological Content Knowledge influenced the way she planned her lessons, even changing the way she approached content objectives that were traditionally difficult to teach. For example, Jan's knowledge of the use of the Smartboard to teach music composition made it so that the content was accessible to the students.

Summary

Jan's knowledge of music, her knowledge of technology, and her knowledge of how the two influence each other influenced the way she approached lesson planning. Jan believed the use of technology in her music classroom provided student exposure to both content and technology. When planning lessons, Jan considered ways she could build background knowledge through the use of technology, such as video clips. Jan also considered ways she could expose her students to deeper technological knowledge, such as through detailed explanations of tools on the Smartboard.

Cross-Case Analysis

A discussion of the findings across the three cases as related to the research questions follows.

What does Meaningful Technology Integration Look Like in a Technology-Rich Elementary Classroom?

The three technology-rich classrooms integrated technology in active, constructive, intentional, authentic, and cooperative ways as defined by Jonassen et al.

(2008).

Active. In all three teachers' classrooms, technology integration promoted active learning. Hope's students manipulated numbers using applications on the iPad during math. In Ella's classroom, the students often discovered and evaluated information on topics in social studies using the Internet. Jan's students manipulated music notes on the Smartboard and played instruments on the iPod Touches. In each classroom, the students actively participated in their learning and the observations were void of large amounts of teacher-directed instruction.

Constructive. Technology also supported the students in constructing outputs that showcased knowledge beyond information the teacher presented. In Hope's classroom, the students taught each other concepts related to the states of matter through video-recorded experiments. Ella's students created products about Washington, DC, and point of view using tools such as Prezi, PhotoStory, PowerPoint, and a comic creator. For Constitution Day, Jan's students created videos accompanied by patriotic songs of patriotic symbols around the school.

Intentional. When planning, all three teachers were intentional in the way they integrated technology. Hope, Ella, and Jan integrated technology with instructional goals in mind, rather than planning around what tool they wanted to use. All three teachers used video clips intentionally to build or activate background knowledge for a new concept. Hope had the students video-record science experiments in order to teach their classmates about the states of matter. Ella had her students use an online comic strip creator to showcase different points of view through writing. Jan used the Smartboard to support the manipulation of music notes during music composition. Common to all the teachers was the use of technology to accomplish a specific instructional goal rather than to just use technology because it was available to them.

Authentic. All three teachers believed that it was important to integrate technology because it is authentic to 21st century living. Ella explained that integrating technology makes the content relevant to her learners because they are used to watching television at home and respond well to content presented visually. She also used the Netbooks for research projects so that they students could learn to access information and evaluate sources digitally, a skill that she thought was authentic to the way adults access information at home and in the workplace. Hope and Jan believed that, because the use of technology is authentic, it was their jobs to integrate it in their classrooms in order to expose their students to technology. Both teachers included the students' lack of access to technology at home as a reason for wanting the Innovation Grant. Jan specifically stated that she wanted her students to be able to compete globally, and especially with other students in the district. She believed that exposing her students to technical skills, such as tools for creation on the Smartboard, was one way she could set them up for success after elementary school.

All three teachers had their students use technology to create. Jan used technology for music composition, such as on the Smartboard or through the iPod Touches like the North Points iBand. Hope had her students create digital brochures and experiment vodcasts. Ella's students used presentation software to create a presentation and teach classmates and comic strip creators to write. In each case, the students were using technology in ways authentic to the way it is used in the workplace globally.

Cooperative. Classroom observations indicated that technology use in all three classrooms was cooperative. Technology is often thought of as an isolator (Ching, Wang, Shih, & Kedem, 2006), but that was not the case in the three classrooms. Each teacher built in elements of lessons that encouraged communication and collaboration among the students when using technology. Hope's students normally used the iPad to preview videos independently unless they had to share an iPad, but the activities associated with the videos were often done in pairs. Hope wanted the students to view the video independently so that they could rewatch parts for clarification, but she encouraged the students to help each other as they navigated through the activity. In science, the students worked together to create their technology products, supporting each other in both the science content and the use of technology.

Ella's technology products always included time for the students to communicate ideas and collaborate on ways to enhance their projects. A central component to Ella's Washington, DC project was the collaboration time the students had during the creation phase of the presentation. Jan's students worked together to compose music, both with the Smartboard and the iPod Touches. Jan also uniquely encouraged her students to work with their general classroom teachers to teach them technical skills they learned in music class. Rarely was a student observed sitting alone with a piece of technology for an extended period of time in any of the classrooms.

What Kinds of Decisions Does the Teacher Make (and Why) When Planning for Technology Integration?

The content and the end result. In different ways, each teacher stated that they decided how they were going to integrate technology in their lessons based on what they were teaching and what they wanted the end result of their lessons to be. Hope specifically said that she planned with end goals in mind and used assessment data to consider how she was going to move her students to the end goal. For Hope, technology took on different roles in math and science. In math, she used technology, such as the iPad videos she created for previewing new concepts, to support her students as they moved to her end goal. In science, Hope often used technology as the end goal, such as for the planet brochures and experiment videos they produced. The concept she was teaching also sometimes influenced Hope not to use technology, such as when she wanted the students to practice adding three digit numbers on paper to focus on regrouping instead of using an application on the iPad.

Ella began her Think Aloud planning sessions discussing the objectives and the end product. Ella often used technology as a product to assess student understanding and to integrate 21st century skills, such as the Washington, DC projects and the point of view comic strips. Jan described herself as a “big picture person” and planned with big goals in mind. For example, in the first Think Aloud interview, Jan’s big goal was to prepare the students for a trip to see the state symphony perform. Jan used technology to support this preparation by building the students’ background knowledge about the symphony and exposing them to elements of the symphony that they would not experience from where they would be seated during the performance. Jan also used technology to help the students create the end result. When her big goal was to have the students play their original music on the recorder, Jan had them manipulate notes on the staff using the Smartboard during the music composition.

The learners. All three teachers made decisions based on the learners in their classrooms when planning for technology integration. Hope and Jan described their students as lacking background knowledge from life experiences in both the content areas they taught, and also in technological knowledge. Because of this, Hope and Jan planned for technology use to build background knowledge for their students. To build background knowledge in the content area, Hope and Jan used video clips. During planning, Ella also looked for video clips. She used video clips to activate prior knowledge because she believed her students could relate to the content better when presented visually. All three teachers stated that they considered ways to use technology in their lessons because it was interesting to the students and motivated them within the content area.

Planning based on available technology. All three teachers consistently had to make logistical decisions about technology use during lesson planning. Although the barrier of access was removed for the teachers, they still struggled with integrating the technology that was not 1:1. Jan explained that, during planning, she often considered the ratio of technology tools to students. With only 4 iPod Touches, not every student could use one, which affected the way she integrated them into her lessons. Ella also had this problem with her iPads; she shared that it was difficult to plan lessons using the iPads because she only had 2 of them.

In addition to the amount of technology hardware available, planning *when* to use the technology was an issue for the teachers. Hope explained that she had to plan centers strategically so that the students did not have to waste time waiting for the Netbooks to slowly boot-up. Jan also regularly experienced difficulties planning for the use of her Netbooks. With only about 35 minutes of instruction time per class, Jan could not afford to lose time booting-up and shutting down Netbooks. Therefore, when planning, Jan had to decide if she wanted several classes in a row to use the Netbooks so that she could have the students leave them on, which meant she had to plan for the Netbooks to be used by different grade levels studying different music content.

The students' technical skills also affected the way the teachers planned. Hope explained that her students did not have experience working with Netbooks and iPads on a daily basis at the beginning of the school year so she had to plan for technical instruction for much of the first grading period. Jan said that her students often claimed to know how to use technology, such as iPod Touches, but did not navigate the technology proficiently enough during class. Therefore, Jan had to allot time for technical instruction when she was planning. Ella also had to consider her students' parents when using technology. When deciding if she wants to use technology as a student product, Ella explained that she had to think about what she could put on her classroom website that parents could access at home.

How do Teacher Beliefs Influence Planning for Integration of Technology in the Classroom?

In all three cases, it was evident that the teachers' beliefs about the role of technology in the classroom influenced decisions they made during planning.

Engagement. Two out of three of the teachers specifically stated that that technology engaged their learners. Ella said that integrating technology made the content more relatable to her students because they were used to being immersed in visuals through television and video games. Hope believed that integrating technology made lessons more interesting to the students, which, in turn, motivated them to learn.

Exposure to content through technology. Although articulated differently, all three teachers believed that technology gave them the ability to expose their students to content in order to build background knowledge. Interestingly, all three teachers did this through the use of video clips. Ella and Jan spent some of their Think Aloud interview time searching for videos that would help to introduce a concept and expose the students to examples of the concept beyond the classroom walls. Although not during the Think Aloud interviews, Hope said that she used some of her planning time to create math videos that preview a concept. Hope's students watched those videos on Wednesdays to gain background knowledge about the concept prior to visiting her during math rotations.

Exposure to 21st century skills through technology. All three teachers also believed that it was important to integrate technology in order to expose the students to 21st century skills. Out of the three, Ella specifically stated that the use of technology was one way she promoted 21st century skills in the classroom. She called these skills the "4

Cs: communication, collaboration, critical thinking, and creativity." When planning, Ella attempted to use technology products, such as the Washington, DC presentations, that encouraged the 4 Cs.

Hope and Jan explained that a digital divide existed between their students and other students in the district. They believed that exposure to technology in their classrooms would enable their students to be more successful in academic settings beyond their classrooms. Hope said that her students needed to use technology daily in school because they lacked access to it at home. Jan strongly believed that, because she taught every student in the school, it was her responsibility to expose them to technology. Jan wanted her students to be confident when using technology so that they could compete with other students in the district despite the existing digital divide. Because of this belief, Jan often spent some of her music class teaching technical skills, like how to clone items on the Smartboard, to her students. Although sometimes spontaneous, Jan considered these technical interactions with her students when planning because she believed they were significant to the role of technology in her room.

How does a Teacher's Knowledge about Technology, Pedagogy, Content, and Learners Influence her Planning of Meaningful Lessons that Integrate Technology?

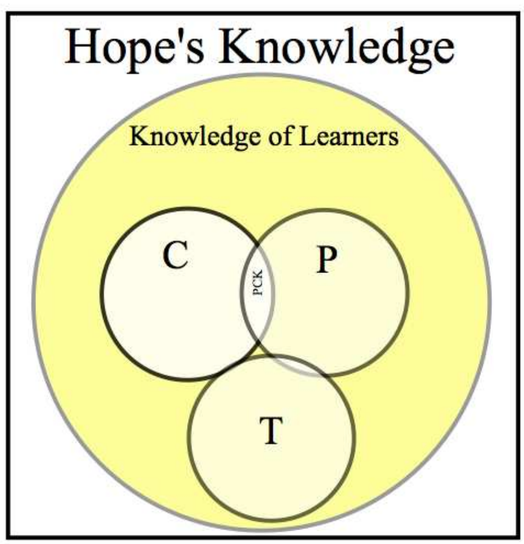
The teachers' knowledge about technology, pedagogy, content, and learners influenced the way they integrated technology in their lessons during planning, which will be discussed and represented visually for each teacher.

Hope. Central to Hope's planning was her knowledge of her students. Hope planned based on student needs, often rearranging math groups and re-teaching concepts.

Hope used iPads and videos as a previewing method to build background knowledge because she knew her students lacked foundational knowledge of certain math concepts, such as story problems. Hope also considered her learners when planning for science, reflecting on lessons and reteaching when necessary. Hope's pedagogical content knowledge in math appeared to be strong, as she was able to represent the math content in multiple ways, adapting it to meet her learners' needs. However, technology was rarely used during math instruction for anything other than previewing concepts on the iPad so Hope's technological pedagogical content knowledge was still developing, which influenced the ways she planned for technology integration. The following graphic could represent the way Hope's knowledge influences her planning:

Figure 6

Hope's Knowledge

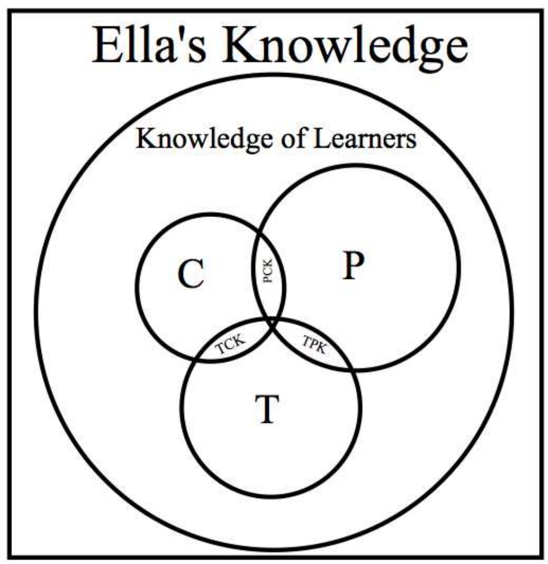


In this graphic, Hope's knowledge of learners is highlighted to represent her focus on learners during planning. Content knowledge, pedagogical knowledge, and technological knowledge are smaller because her knowledge of learners was a bigger focus during her planning. Hope's pedagogical content knowledge (PCK) represents her knowledge of multiple representations of the content, especially in math. Technological knowledge sits on the edge of content knowledge and overlaps pedagogical knowledge a little bit to show Ella's developing knowledge of how technology influences content and pedagogy and vice versa.

Ella. Ella often joked that her planning time was all over the place because her mind was going in so many different directions. Ella always began planning with learning objectives in mind, but then immediately started thinking about the content she was teaching, how she wanted to represent it, and the technology she planned to use. During the Think Aloud interviews, Ella was simultaneously considering content, pedagogy, and technology as she planned. For example, during the first Think Aloud interview, Ella discussed the different points of view she needed to teach as she was searching for video clips to activate prior knowledge, while explaining that the video clips would make the content relevant to the learners in her classroom. As an observer of her planning session, I did not see a separation between the technology, content, and pedagogy. However, although Ella considered technology, pedagogy, and content concurrently, only occasionally did it appear that she recognized the ways the three types of knowledge influenced each other. When considering what she knew about the learners in her classroom during planning, Ella acknowledged learning needs by differentiating product requirements and providing student choice through the use of technology. The following graphic could represent the way Ella's knowledge influences her planning:

Figure 7

Ella's Knowledge



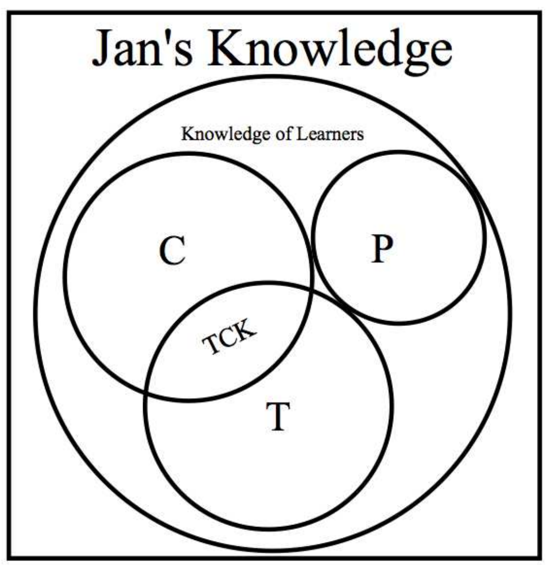
In this graphic, Ella's pedagogical knowledge is represented as being larger than technological knowledge and content knowledge. Ella often focused on multiple representations of the concept she was teaching above anything else during planning, including representing the content through technology. During planning, Ella considered content, pedagogy, and technology simultaneously, but did not always consider the relationships between the three. In the graphic, Technological Pedagogical Content Knowledge is very small, showing that Ella's TPCK was still developing.

Jan. Specializing in teaching music, it is not surprising that Jan's depth of content knowledge influenced her planning. Because she taught kindergarten through 5th grade, Jan had a strong understanding of the scope and sequence of elementary music content. She was responsible for the students' foundational music knowledge and she progressively built that foundation each school year. During Jan's Think Aloud interviews, she focused on the content being taught, including choosing the music for the lesson(s). Jan's Think Aloud interviews began with large content-based goals, and activities during instruction were addressed last. In addition to content knowledge, Jan appeared to have strong technological knowledge. She was comfortable with new technology, could troubleshoot problems effectively, and participated in a district leadership group that led professional development on technology integration. Because of her technological knowledge, Jan was not intimidated by integrating new technology into her lessons and she was always able to predict technical issues that could arise, which in turn influenced how she planned to use the technology.

Out of the three teachers, Jan uniquely had strong Technological Content Knowledge (TCK) (Mishra & Koehler, 2006). While planning, Jan considered how the technology she had in her room impacted, or even changed, the content she was teaching and vice versa. For example, Jan, like other elementary music teachers, struggled with teaching music composition to her students, but as she learned how to use her Smartboard, she recognized how the interactive features of the board could support music composition in a way that made it accessible to her students. Although Jan also thought about the learners in her classroom when planning, her knowledge of content and technology seemed to stand out during planning. Jan spent most of her time thinking about the content and the technology, leaving less time, if any, for consideration of representing the content during instruction. When considering what she knew about the learners in her classroom, Jan mainly focused on needs that she felt existed because of a digital divide, including the need to build background knowledge and expose the students to technical skills. The following graphic could represent the way Jan's knowledge influences her planning:

Figure 8

Jan's Knowledge



In the graphic, Jan's content and technological knowledge, as well as her Technological Content Knowledge (TCK) are represented as being larger than her pedagogical knowledge because Jan's planning was highly driven by what she knew about the content, what she knew about technology and how the use of technology enhanced, or even changed, the content.

Summary of the Cross-Case Analysis

The three teacher participants led technology-rich classrooms that were active, constructive, intentional, authentic, and cooperative. When planning, all three teachers made decisions about the content they were teaching and their desired end result, the learners in the classroom, and the technology available. The teachers' beliefs influenced the way they planned and these mainly included 1) beliefs about engagement, 2) beliefs about exposure to content through technology, and 3) beliefs about exposure to 21st century skills through technology. The teachers' knowledge also influenced the way they planned. However, the influence of teacher knowledge was different for each participant. Hope's knowledge of her learners mostly guided her planning. When Ella planned, she pulled from her knowledge of content, pedagogy, and technology concurrently. Finally, Jan's content knowledge heavily influenced her planning. A discussion of the findings as related to the literature is in Chapter V.

CHAPTER V

DISCUSSION AND IMPLICATIONS

This study examined the decisions three elementary teachers made while planning for technology integration in technology-rich classrooms. The influence of the teachers' knowledge and beliefs on the decisions they made during planning was also studied. This chapter presents a discussion of the findings and implications of the study. First, a discussion of the findings is presented as related to the research questions. Second, implications for teacher educators, teachers, and administrators are discussed. Finally, the limitations of the study are acknowledged and possible future research is discussed.

Discussion of the Findings

The findings of the study are shared and interpreted as related to the research questions below.

Meaningful Technology Integration in Technology-Rich Classrooms

My first research question asked: What does meaningful technology integration look like in a technology-rich elementary classroom? Jonassen et al. (2008) define meaningful learning as students being involved in instructional tasks that are active, constructive, intentional, authentic, and cooperative. In the three study classrooms, I observed the students engaged in instructional tasks using technology that had one or several of the attributes of meaningful learning as defined by Jonassen et al (2008). For example, each room technology promoted cooperative learning rather than isolating the students, a commonly held belief about technology in the classroom (Ching et al., 2006). Examples of cooperative learning include products that encouraged collaboration about Washington, DC, the states of matter, and patriotic symbols. Other examples of meaningful learning with technology are shared in Chapter IV.

Although each classroom exhibited all of the characteristics of meaningful learning as defined by Jonassen et al. (2008) in many of their lessons (but not in every lesson), the students engaged in using the technology the same way every time they used it. In Ella's classroom, the students always started the lesson with a Smart Notebook file to guide the lesson and often ended the lesson with a technology product to assess their learning. The students were actively engaged in intentional and constructive learning with technology, but it was not always authentic. In Hope's classroom, the students always used the iPads to preview a concept in math and created a technology product to demonstrate understanding in science. In this classroom the students engagement with technology was intentional but not usually active, constructive, or authentic. Jan's use of the technology varied a little bit more, perhaps because she taught kindergarten through fifth grade. Her use of technology was always active and intentional, and certainly constructive and authentic when the students were writing music on the interactive whiteboard. The teachers were thoughtful in their approach to technology integration, considering the content, the learners, and the technology, which I discuss below, but their use of the technology was predictable. I attribute this to their developing technological content knowledge (TCK) and technological pedagogical knowledge (TPK). As the teachers better understand the pedagogical affordances and limitations of different technology, I believe that they will continue to lead classrooms that are active, constructive, intentional, authentic, and cooperative, but the students will be using technology in innovative ways that are more constructive and authentic. Teacher support for developing TCK and TPK is discussed further in this chapter.

Decisions Made During Planning for Technology Integration

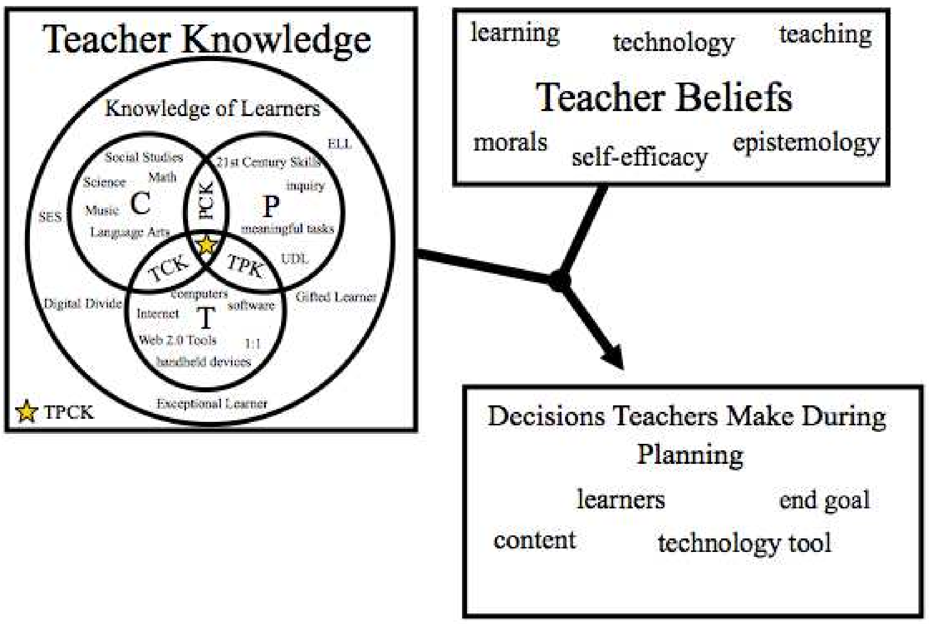
My second research question asked: What kinds of decisions does the teacher make when planning for technology integration and why were those decisions made when planning for technology integration? The Think Aloud interviews gave me a glimpse into the process of planning for each teacher. Common across the three cases was that the teachers did not begin their planning sessions thinking about technology. All three teachers began their planning with larger instructional goals in mind, with two teachers then moving to content objectives and the third teacher moving to use assessment data to guide her planning. Consideration of technology began at different points in the planning process for each teacher. In fact, all of the teachers stated that the technology tools were not the most important factor to consider when planning a lesson.

When considering technology integration during planning, all three teachers made decisions that were influenced by a) the content and a desired end result, b) the learners, and c) the technology tool. My original conceptual framework suggested that teachers' knowledge and beliefs influenced the decisions they made during planning. Figure 9 revisits the conceptual framework, highlighting *what* decisions the teachers made during planning. Although articulated in different ways, each teacher stated that the content and anticipated student outcomes affected decisions made about technology integration.

Often, technology was used as the product representing student understanding of the concept, such as Ella’s point of view comic strips and Washington, DC projects and Hope’s science experiment videos. The teachers also made decisions about the learners when planning for technology integration, considering their background knowledge of the content and experience working with the technology. Logistical issues such as time spent waiting for the Netbooks to start or the amount of available technology also arose during planning and the teachers had to decide what technology was most appropriate to use given possible issues during instruction. Logistical issues are often first-order barriers (Ertmer et al., 1999) that cause teachers to avoid using technology during instruction (Cuban, 2001; Grimes & Warschauer, 2008; Ertmer et al., 1999). However, because the three teachers had strong technological knowledge, they planned for ways to alleviate logistical issues, such as using the Netbooks with consecutive classes to avoid turning them off, rather than allowing the issues to deter them from using the technology.

Figure 9

Decisions Made During Planning



The decisions the teachers made during planning for technology integration were influenced by their beliefs about technology and their varying levels of knowledge of content, pedagogy, and technology. Understanding why the teachers made decisions about the content and the end goal, the learners, and the technology can only be done through consideration of how the teachers' knowledge and beliefs influenced the decisions they made during planning. Therefore, the following research questions are significant to understanding why, for example, when making decisions about the learners, the teachers mainly focused on building background knowledge for the class as a whole instead of considering how the technology could address specific learning needs.

The Influence of Teacher Beliefs on Planning for Technology Integration

My third research question asked: How do teacher beliefs influence planning for integration of technology in the classroom? All of the teachers strongly believed that technology had a place in daily instruction in elementary classrooms and I found technology present in some way in all of the observed lessons. Three main beliefs emerged from the three teachers I studied:

- Technology engages students in the content and motivates them to learn the content,
- Technology helps to build background knowledge by exposing students to content beyond the classroom walls, and
- Technology exposes students to 21st century skills vital to success beyond elementary school.

Beliefs about technology influenced the way each of the teachers planned for technology integration. For example, all three teachers regularly used video clips to expose their students to the content they were teaching as a method of building background knowledge prior to teaching the content. Ella specifically explained that, in addition to building background knowledge, she used video clips at the beginning of her lessons to engage her students in the lesson because video clips were similar to television and video games, popular among her students. To integrate 21st century skills into instruction, Ella included products to assess student learning that encouraged collaboration and communication, such as when her students researched, discussed, and presented information on monuments and memorials in Washington, DC. Hope and Jan planned for technology integration daily in an attempt to bridge the digital divide they believed their students experienced. Jan specifically planned for moments of technical instruction, such as learning features of the Smartboard, during her lessons to expose her students to the technological knowledge she felt they needed in order to compete with students from other schools beyond elementary school.

Research in the field of technology integration states that teachers' beliefs about technology influence the way technology is used in the classroom (Angers & Machtmes, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Hermans et al., 2008; Pajares, 1992; Penuel, 2006; Sandholtz et al., 1997; Windschitl & Sahl, 2002). I found this to be the case with the three teachers in this study. Teachers who believe that technology has value in the classroom and have mastered using it are at least at the appropriation stage of technology integration (Sandholtz & Reilly, 2004; Sandholtz et al., 1997). Reaching the appropriation stage allows teachers to experiment with ways the technology influences content and pedagogy, as they progress into the invention stage (Sandholtz & Reilly, 2004; Sandholtz et al., 1997). Therefore, in order for teachers to develop their knowledge of content, pedagogy, and technology, they need to believe in the use of technology in their instruction (Sandholtz et al., 1997). For the teachers in this study, beliefs influenced the way that they planned because they believed technology had a role in their daily lessons, specifically to build background knowledge and expose students to technical skills. As the teachers continue to develop their technological content knowledge (TCK) and technological pedagogical knowledge (TPK) and move into the invention stage (Sandholtz & Reilly, 2004; Sandholtz et al., 1997), their beliefs about technology may also develop and deepen. For example, instead of focusing on using technology primarily as a method of exposure to the content and 21st century skills, these teachers may see the value of technology for differentiating the content, providing multiple methods of representation of the content, and addressing specific learning needs, which, in turn, would influence the decisions the teachers made about integrating technology during instruction. However, as I will address later, professional development for content-specific uses of technology may be needed to help teachers become more knowledgeable about other ways to use technology than those ways they currently believe are important.

The Influence of Teacher Knowledge about Technology, Pedagogy, Content, and Learners on Planning for Technology Integration

My fourth research question asked: How does a teacher's knowledge about technology, pedagogy, content, and learners influence her planning of meaningful lessons that integrate technology? Ertmer and Ottenbreit-Leftwich (2010) recommend that teachers integrating technology have knowledge that allows them to (1) align technologies to specific learning goals; (2) choose technologies for various phases of the learning process; and (3) select appropriate technologies to address issues and needs. The teachers in this study exhibited knowledge of aligning technology to learning goals, choosing technology for different phases of the learning process, and selecting technologies to address those needs. However, in taking a closer look at teacher knowledge in this study, I discuss teacher knowledge as it is represented as an interaction between teachers' Technological Pedagogical Content Knowledge (TPCK) framework (Mishra & Koehler, 2006) and teachers' knowledge of their learners. When teachers are thinking within the TPCK framework, their considerations of technology, pedagogy, and content are interconnected as they are making decisions about instruction. Although the authors of the TPCK framework locate knowledge of learners under pedagogical knowledge, I believe that teachers' knowledge of content, pedagogy, and technology, as well as the relationships between the three types of knowledge, all operate within the context of teachers' knowledge of learners (see Figure 1 in Chapter 1). I assumed teachers are constantly thinking about what they know about their students as they are considering what they know about content, pedagogy, and technology and I found this to be true to some degree with the three teacher participants, which I discuss in more detail below.

Knowledge of technology and technology integration. Although the teachers did not begin lesson planning with technology in mind, their knowledge of technology was evident in how they planned for technology integration. I did not give the teachers a survey to determine their comfort levels with technology because I was mainly concerned with their planning; however, it is interesting to note that each teacher exhibited confidence in using various technologies during instruction, which I believe influenced how often they considered integrating it during planning. Technological knowledge is always changing because technology available to schools and teachers is always changing (Ertmer & Ottenbreit-Leftwich, 2010; Harris, Mishra, & Koehler, 2009). Therefore, it is common for teachers to be intimidated by the use of technology in the classroom because it makes them feel like novice teachers again (Ertmer & Ottenbreit-Leftwich, 2010) due to a lack of confidence in their ability to integrate technology and a feeling of not being prepared to use it in the classroom (Moore-Hayes, 2011). However, this was not the case for the three teachers in this study.

Related to technological knowledge is a teacher’s self-efficacy beliefs about being able to use technology successfully. Teachers who feel confident in their ability to integrate technology tend to spend more time using it in the classroom, which in turn helps them develop their knowledge of how different technologies work and improves their trouble-shooting capabilities (Ertmer & Ottenbreit-Leftwich, 2010; Moore-Hayes, 2011). Although the teachers in this study did not specifically articulate their confidence in using the technology in the room, they also did not suggest or display any lack of confidence in using the technology. In fact, all three teachers spoke decidedly about the technology they wanted to integrate, only wavering when considering logistical issues that may arise during the lesson. Based on my interpretation of how they planned, being able to predict the logistical issues was another indicator of the teachers’ technological knowledge stemming from experience with technology. For example, during the Think Aloud interviews and in other interviews, all of the teachers discussed logistical issues that centered on the technology. These issues, such as the slow boot-up of the Netbooks or only having two iPod Touches, caused the teachers to either rethink the direction they were going with the lesson or to plan accordingly in order to alleviate the issues. One example of this was planning Netbook activities consecutively to avoid having to shut down and restart the computers.

Knowledge of pedagogy and technology integration. Harris et al. (2009) describe technological pedagogical knowledge (TPK):

> Technological pedagogical knowledge is an understanding of how teaching and learning change when particular technologies are used. This includes knowing the pedagogical affordances and constraints of a range of technological tools and resources as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies. (p.398)

All three teachers stated that one of the reasons they chose to use technology was to engage and motivate their learners because they thought technology made the content more relevant to their students. In this case, they were thinking about using technology as one way to represent the content that their learners needed. Ella consistently represented the content in multiple ways, usually through children's literature and technology. All teachers used technology as a strategy for building background knowledge. Jan specifically considered how the Smartboard supported the manipulation of notes for the students during music composition. Therefore, in several ways, the teachers were considering how the technology related to both the content to be learned and the instructional strategies to teach the content. However, I believe the teachers were operating on the surface level of TPK, and when they begin to more purposefully consider using technology to afford specific strategies targeting specific learners in the classroom, they will move deeper within TPK.

Knowledge of content and technology integration. "Technological content knowledge (TCK) includes an understanding of the manner in which technology and content influence and constrain one another" (Harris et al., 2009, p. 399). Based on this definition, thinking about content and technology simultaneously may just be the surface level of TCK. When thinking about the content they wanted to teach, all three teachers also began thinking about the technology in their rooms. Most often, they thought about using the technology to build or activate background knowledge of the concept. Only Jan appeared to consider how the technology could influence the content with one example being how the use of the Smartboard changes music composition for her students. I believe this is probably because Jan's TCK was deeper because she specialized in music content, whereas Hope and Ella were elementary generalists teaching several subjects. Although Jan had a better idea of the interactions and relationship between content and technology, I believe TCK for all of the teachers was developing. They did not see content and technology as separate entities, but they also did not always consider how content and technology influence or constrain each other.

Knowledge of learners and technology integration. For all three teachers, knowledge of their learners influenced the way they planned for technology integration. Themes of building background knowledge, addressing the digital divide, and developing technical skills for their students' future emerged across the cases as these things were related to their knowledge of their learners.

Building background knowledge. Common to all the teachers was the idea that technology exposes students to content and therefore using technology is one way to build background knowledge for learners. All three teachers believed that using technology to build background knowledge allowed them to expose the students to elements of the content that they a) would not see in a textbook, and b) may not experience out of school. For example, all three teachers used video clips to build background knowledge either prior to teaching the concept or at the beginning of the lesson. Although using video for building background knowledge is universal across content areas, Doolittle and Hicks (2003) specifically site the use of technology to build background knowledge as an effective strategy for technology integration in social studies.

Digital divide. Two out of three of the teachers referenced a digital divide between the students at their schools and students at other schools in the district due to a lack of technology at home and in other classrooms for the children at their schools. Although all of the schools in the study, and in the district, provided some access to technology for all of the teachers in the school, such as computer labs, laptop carts, and mobile interactive whiteboards for check-out, the quantity and quality of access to technology was still uneven, a theme also present in the literature (Crawford, 2011; Hertz, 2011). Jan, the music teacher, especially considered herself an advocate for using technology to reduce the digital divide for all the students in the school because she saw every student at least once a week.

Developing technical skills. Providing economically disadvantaged students access to technology is vital to their success in and beyond elementary school (Mouza, 2011; Page, 2002). All three teachers explicitly recognized the need to provide exposure to technology in the classroom to both enhance the content and integrate technical skills. Two out of three of the teachers expressed concern for their students not being able to compete with other students in the district if they moved schools, due to the transient nature of the school population, and therefore, consciously integrated technical skills into instruction. For example, Jan allowed for time to teach the students how to navigate the Smartboard tools during class hoping that they would transfer the knowledge to other technology applications and share the knowledge with their general classroom teachers. Hope spent a considerable amount of class time teaching her students how to edit work in Microsoft Publisher, again with the idea that the knowledge would transfer to similar applications in their future.

Putting it all together. The ideas of building background knowledge, addressing the digital divide, and developing technical skills influenced the decisions the teachers made when planning. Because the teachers believed a digital divide existed between their students and other students in the district due to a lack of technology at home and in other classrooms, they assumed that this limited their students' exposure to videos, games, websites, and other technology that might help to build background knowledge and technical skills. Therefore, the teachers believed it was their responsibility to provide the exposure to technology in the classroom that the students lacked at home and in previous grade levels. Using video clips to the build background knowledge was a common practice to accomplish this goal for all three teachers. Through the integration of technology to expose the students to content and technical skills, the teachers hoped to reduce the digital divide that existed for their students. However, when thinking about the learners during planning there were some missed opportunities for individualized instruction.

Addressing specific learning needs. All three teachers tended to discuss the use of technology to benefit their students as a whole class rather than how they could use technology to differentiate the content for individual needs. During one Think Aloud interview, Ella described how she planned to use the online comic strip creator to differentiate product requirements for her students when teaching point of view. She explained that the gifted students, who also received gifted pull-out services, would complete multiple panels, whereas the students still struggling with point of view would complete one panel. Although Ella was specifically differentiating for groups of students, she was focused on the product and assessment of the students rather than how the technology could meet the needs of those learners. Hope consistently considered the needs of her students when planning; however, she did not discuss ways she could target individual needs of the students using the technology beyond using the iPad videos to build background knowledge for all of the students. As the technological content knowledge (TCK) and technological pedagogical knowledge (TPK) of these teachers continues to develop, they will better understand how technology can support or change the way they can differentiate the content to be learned, the learning process, and the products of learning to address specific student learning needs in their classrooms.

Using TPCK and the Lessons from the ACOT Studies as a Framework for the Influence of Teacher Knowledge on Planning for Technology Integration

Each of the teachers strongly believed in the use of technology in the elementary classroom, and although they did not consider it as the starting point for their planning, they always considered integrating technology at some point in their lesson planning. To me, this indicates that they believe that technology is an integral part of their lessons, just like the content they are teaching and the ways they represent the content during instruction. The teachers did not choose a technology tool to plan around; instead, they appeared to be thinking about content, pedagogy, and technology concurrently. However, based on my interactions with and observations of the teachers, I do not believe that they were all operating consistently within the center of the TPCK framework. In my opinion, these teachers' technological content knowledge (TCK) and technological pedagogical knowledge (TPK) are still developing.

Developing TCK and TPK

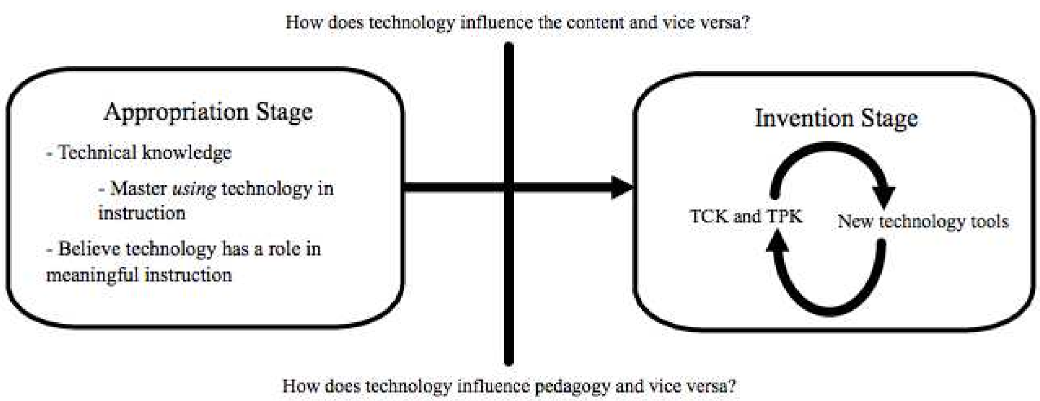
How can the teachers in this study have strong technological knowledge and still be developing their TCK and TPK? Knowledge about the technology they are using is more than just having strong technical knowledge. Teachers need both more complex understanding of technology, but also of content and pedagogy. After studying the Apple Classrooms of Tomorrow (ACOT) Project for 10 years, Sandholtz et al., 1997 found that teachers moved along a continuum, that they called The Stages of Instructional Evolution, when learning to integrate technology. The stages are described in more detail in the Apple Classrooms of Tomorrow section of Chapter II, but in summary, a) in the entry stage, teachers are still learning the basics of technology integration, b) in the adoption stage, teachers are successfully using technology on a basic level consistent with existing instructional practices, c) in the adaptation stage, teachers use technology more frequently and purposefully, d) in the appropriation stage, teachers use technology effortlessly to accomplish instructional and management goals, and e) in the invention stage, teachers use technology in new ways to promote 21st century skills and customize learning to meet student needs (Sandholtz & Reilly, 2004; Sandholtz et al., 1997).

I consider all of the teachers in this study to be in the appropriation stage but working toward the invention stage of technology integration as they continue to develop their technological content knowledge (TCK) and technological pedagogical knowledge (TPK). In the appropriation stage, teachers have mastered *using* technology in the classroom and recognize the benefits of integrating technology for teachers and students. All three teachers in this study have strong technological knowledge and believe in the value of using technology in the classroom. In the invention stage, teachers display mastery of using technology to experiment in new ways to enhance the content and meet diverse student learning needs. The teachers in this study are at the stage of using technology in new ways to support the content and learners, however, because technology is always changing, the invention stage is an ever-evolving process of learning. Further, I believe that getting to the invention stage may require deeper content knowledge. With the exception of the music teacher, Jan, who had deep knowledge of her specific content, the other teachers were still developing deep content knowledge of the subjects they taught, as well as how to teach them, and how to integrate technology in content-specific versus more generic ways.

Reaching the invention stage. How could the teachers in this study move in to the invention stage? At the invention stage, teachers are experimenting with new ways to use technology in the classroom with an understanding of how the technology influences teaching and learning. To move from the appropriation stage to the invention stage, teachers need to begin to recognize how technology influences content and pedagogy and vice versa, also known as technological content knowledge (TCK) and technological pedagogical knowledge (TPK) (Mishra & Koehler, 2006). As teachers begin to use this knowledge to make decisions about technology integration during planning, they move in to the invention stage. However, I believe that the invention stage is a cyclical stage instead of a final stage in the process of instructional evolution. As teachers learn about new technology tools to integrate in the classroom, they are challenged to use their TCK, TPK, and knowledge of learners to determine the affordances and limitations of using the technology to effectively teach the content. Figure 10 represents how I now see the progression of knowledge between the appropriation stage and the invention stage. It is important to note that the arrow from appropriation to invention only flows in one direction.

Figure 10

Reaching the Invention Stage



I believe that once teachers begin to develop their TCK and TPK, they do not move back into the appropriation stage because they are learning to consider content and pedagogy, rather than just their technological knowledge when integrating new technology tools. As the teachers encounter new technology tools, TCK and TPK continue to develop. The teachers in this study are beginning to consider how technology influences content and pedagogy so I would place them on the arrow moving toward the invention stage. Out of all of the teachers, Jan, the music teacher, is closest to entering the invention stage due to the deep content knowledge that she references as she is planning for technology integration. When thinking about her use of technology to make music composition comprehensible and accessible to her students, Jan was operating within the invention stage. However, overall, all three teachers need to continue to develop their TCK and TPK to move past the appropriation stage. With deep technological knowledge and strong beliefs about the value of technology in the classroom, the teachers are at the right stage for supports that would help them to start thinking within the TPCK framework.

Supporting TCK and TPK at the invention stage through curriculum-focused technology professional development. One way to help support and move teachers into the invention stage is to provide teachers with technology professional development focused on specific content and pedagogical content knowledge goals (Sandholtz & Reilly, 2004; Sandholtz et al., 1997). Currently, most professional development for inservice teachers tends to focus on *how* to *use* the technology tool, leaving curriculum-based decisions about how, why, and when to integrate technology into particular content areas up to the teachers (Harris, 2005; Harris & Hofer, 2011). As mentioned earlier, new technology can make teachers feel like novices when they are unsure how to integrate the technology into instruction (Ertmer & Ottenbreit-Leftwich, 2010). Therefore, teachers often leave technology professional development knowing the basics of how to use a tool, but not how to make decisions about when it is appropriate to integrate the tool into instruction. Findings from the ACOT studies also indicated that professional development was more successful when the focus was on the curriculum content rather than on the technology (Sandholtz & Reilly, 2004; Sandholtz et al., 1997).

Curriculum-focused technology professional development may influence the technology that teachers choose to integrate, and support teachers in reaching the invention stage of technology integration by having them experiment with new ways to integrate technology to meet the needs of students trying to learn specific content (e.g, math or reading or science). The teachers in this study tended to use universal technology tools, such as technology hardware (iPads or Netbooks or video), word processing tools like Microsoft Word, and presentation tools such as PowerPoint and Prezi. However, displaying her deeper content knowledge, Jan demonstrated knowledge of music composition software available for music teachers. However, she did not use it in her classroom, perhaps because she used the Smartboard for music composition. Overall, what was missing in this study, that would be evidence of teachers who have already reached the invention stage, was the inclusion of specialized content area technology tools. For example, when studying Native American tribes in social studies, perhaps Ella could have located a primary document online from the National Archives for the students to examine (http://www.archives.gov/research/native-americans/), or as part of the students research time on monuments and memorials in Washington DC, they could have taken a virtual tour, such as the National Parks Service's virtual tour of the Lincoln Memorial (http://www.nps.gov/featurecontent/ncr/linc/interactive/deploy/index.htm#/introduction).

When Hope had her students create bar graphs during center time from her iPad video, but they could have also visited the National Library of Virtual Manipulatives (http://nlvm.usu.edu/en/nav/vlibrary.html) as another way to explore bar graphs before creating their own. The Technology and the Content Areas section of Chapter II provides multiple ways technology can be used specifically within content areas, but I did not observe many of those tools being used in these three classrooms. Perhaps this is because, as the ACOT studies (Sandholtz & Reilly, 2004; Sandholtz et al., 1997) showed, this takes at least 3-5 years and these teachers had only been teaching in technology-rich settings for less than three when this study took place.

Swan and Hofer (2011) suggest there is a place in instruction for both universal and specialized technology tools. Each technology tool offers affordances and constraints to content and pedagogy. It is up to the teacher to understand those affordances and constraints and make appropriate decisions about when and how to use the technology (Swan & Hofer, 2011). One factor influencing the types of tools teachers tend to integrate is curriculum-focused rather than tool-focused professional development. With a more curriculum-focused approach to technology professional development, teachers may be more aware of specialized content area tools available to them. Because all three teachers were comfortable with technology and valued its place in their classrooms, I believe they would benefit from professional development focusing on specialized content area tools and developing their technological content knowledge (TCK), allowing them to move into the invention stage of technology integration. These findings have implications for teacher educators, teachers, and administrators and are discussed below with recommendations for future steps.

Implications of the Study

The findings from this study have implications for teacher educators, teachers, and school and district leaders and are discussed in greater detail below.

Teacher Educators

Due to increasing accessibility to technology in schools today (Gray et al., 2010), it is important for teacher educators to understand the decisions teachers make when integrating technology in order to guide preservice teachers to learn to make good decisions while planning. In preservice teacher preparation programs, elementary content methods courses provide a logical environment for considering content, pedagogy, technology, and learners when integrating technology into instruction. This study offers three detailed cases of factors influencing technology integration during planning that can be used as examples for preservice teachers. Perhaps preservice teachers could use these cases to begin to first understand their own beliefs about technology and knowledge of content, pedagogy, and technology, and then to begin to understand how their beliefs and knowledge influence the decisions they make when planning lessons. Armed with this knowledge, preservice teachers may see the importance of developing their content knowledge and finding content-focused technologies that will help their students develop deeper knowledge of content. With this information, maybe preservice teachers will be more purposeful in planning ways to integrate technology, and seek out professional development in areas where they find themselves using generic rather than content-specific technology in their teaching. However, this requires that methods teachers know about and model the use of content-specific technology for preservice teachers, and make explicit the benefits of using content-specific technology versus generic technology for teaching their subject matter.

Preservice Teachers' Beliefs about Technology Integration. Understanding how preservice beliefs about technology and learning and knowledge of content, pedagogy, technology, and learners influence technology integration is significant to the success of teaching technology integration in the content methods course. Preservice teachers often hold beliefs about teaching stemming from experiences they had as students.

> Teachers enter the profession with deeply held notions about how to conduct school –they teach as they were taught…. If beliefs govern behavior, the process of replacing old beliefs with new becomes critically important in changing educational practice in schools. (Sandholtz et al., 1997, p. 36)

If teachers' beliefs about integrating technology can be changed (Levin & Wadmany, 2006; Staples, Pugach, & Himes, 2005; Sandholtz et al., 1997), then methods courses seem to be the place to start to initiate changes in the way preservice teachers think about using technology in the classroom.

In order for beliefs about technology to change, preservice teachers need to experience integrating technology into instruction. Beginning methods courses with a survey of the preservice teachers' beliefs about technology integration and comfort levels with using technology may help to identify where preservice teachers fall on the stages of instructional evolution continuum (Sandholtz & Reilly, 2004; Sandholtz et al., 1997). Integrating technology into methods courses as examples for preservice teachers, and providing them with assignments, such as planning and teaching practice lessons, that encourage the integration of technology would give preservice teachers more opportunities to experience technology integration and encourage them to move along the continuum. As preservice teachers more along the stages of instructional evolution continuum and begin to integrate technology in more innovative and purposeful ways, their beliefs about technology may also shift as they recognize the benefits of technology use for students (Sandholtz et al., 1997). Because most of today's preservice teachers are members of the Millennial generation (Schrum & Levin, 2009), they may enter methods courses at the adoption or adaptation stages, knowing how to use technology at a basic level, but still teaching as they were taught, rather than understanding how the use of technology can change teaching and learning (Sandholtz et al., 1997). Therefore, in addition to changing preservice teachers' beliefs about technology through real classroom experiences with technology integration, teacher educators should also work with preservice teachers to develop their technological pedagogical content knowledge (TPCK) (Mishra & Koehler, 2006).

Preservice Teachers' TPCK. Although the majority of preservice teachers are part of the Millennial generation (Schrum & Levin, 2009) with greater exposure to technology growing up, teacher educators should not assume that preservice teachers understand the relationships between content, pedagogy, and technology. However, because current preservice teachers may have background knowledge in using technology, such as word processing, gaming, and social media, learning to use technology in the elementary classroom may develop quickly, given the right technical and instructional support (Sandholtz & Reilly, 2004). In this case, preservice teachers could be at the adoption or adaptation stages when beginning methods courses because they know how to use basic technology in the classroom, but they do not necessarily understand how it changes teaching and learning. Teacher educators should capitalize on the technological knowledge preservice teachers have by explicitly discussing how technology influences content and pedagogy and vice versa. For example, when teaching music composition, how does being able to manipulate the notes on the Smartboard change the way the students perceive and access the idea of composing music? When considering technology integration in the methods course, time should be left for discussions of the pedagogical affordances and limitations of using the technology to teach the desired content.

The following are recommendations for teacher educators:

- Be aware of the preservice teachers' beliefs about technology and learning. In this study, beliefs about technology influenced the way the teachers planned for technology integration. Begin methods courses with a survey addressing beliefs about technology and comfort level with using technology.
- Model technology integration in methods courses addressing concerns preservice teachers may have about integrating technology. Teachers' beliefs about technology can change given the right support (Levin & Wadmany, 2006; Sandholtz & Reilly, 2004; Sandholtz et al., 1997; Staples et al., 2005).
- Capitalize on the strong technological knowledge most preservice teachers have. Help them transfer this knowledge to technology used in elementary classrooms

by integrating it into your own lessons as examples. In this study, the teachers' strong technological knowledge contributed to their confidence in integrating technology. This knowledge allowed the teachers to recognize and plan for possible barriers to integrating technology into particular lessons, which contributed to the successful use of technology in the classroom.

- Offer multiple opportunities for preservice teachers to practice integrating technology, such as through lesson plan creation or requiring practice lessons. Beliefs about using technology can change as preservice teachers recognize the benefits of using technology in instruction (Sandholtz et al., 1997). Success with technology integration occurs on a continuum, such as the Stages of Instructional Evolution model, but preservice teachers can move along this continuum faster with targeted technical and instructional support in methods courses (Sandholtz & Reilly, 2004; Sandholtz et al., 1997).
- Develop your own technological content knowledge (TCK) by seeking professional development, webinars, or publications that highlight technology use in specific content areas. Also, find examples of both universal and specialized content area technology tools being used in the elementary classroom.
- Develop your technological pedagogical knowledge (TPK) by seeking professional development, webinars, or publications that focus on how technology changes teaching and learning.
- Explicitly consider the pedagogical affordances and constraints of integrating particular technology into lessons (Harris et al., 2009).

- Seek professional development that addresses using technology to specifically support different learning needs and model and discuss this integration for preservice teachers in your own courses.
- Integrate universal and specialized content area technology tools into your lessons as examples for preservice teachers. Discuss these examples highlighting how the technology influences content and pedagogy.

To begin considering these recommendations, teacher educators should model asking the following questions during planning:

- What technology tool(s) am I going use in my lesson?
- Did I consider the content I was teaching when I chose the technology?
- Is the technology tool specific to the content area or universal to all content areas?
- Does the technology change or influence *how* I am going to teach the content?
- Did I specifically think about different learners in my class and how the technology might meet their needs?
- Are all of my students going to be doing the same thing with the technology? Is this appropriate given the needs of my students?

Teachers

Beliefs about technology and knowledge of technology and how it interacts with content and pedagogy were factors that influenced the way the teachers in this study planned for technology integration. These findings have implications for teachers. As schools gain greater access to technology (Gray et al., 2010), teachers need to recognize how technology changes teaching, and the learning of content. Successful technology integration requires some degree of change in how teachers do their planning and deliver instruction (Ertmer & Ottenbreit-Leftwich, 2010; Roschelle et al., 2000; Windschitl & Sahl, 2002). Successful technology integration also requires knowledge of the relationship between the content they are teaching, the best practices for teaching that content, and the most appropriate technology tools that could be used to integrated to teach the content, also known as Technological Pedagogical Content Knowledge (TPCK) (Mishra & Koehler, 2006).

The teachers in this study had strong technological knowledge, which gave them confidence when integrating technology despite any possible first-order barriers, such as time constraints, technical issues, and technology that was not 1:1 (Ertmer et al., 1999; Sandholtz et al., 1997). However, in addition to technological knowledge, they also had developing technological content knowledge (TCK) and technological pedagogical knowledge (TPK), which allowed them to begin to understand how technology influences content and pedagogy. With additional time spent developing TCK and TPK, the teachers in this study could be thinking within the heart of the TPCK framework, consciously considering the relationship between technology, pedagogy, and content. To do this, even when first-order barriers of access to technology are removed, teachers need to participate in technology professional development that addresses content and pedagogical goals, rather than just explaining *how* to use a technology tool. Findings from the ACOT studies suggest that technology professional development that focused on curriculum rather than technical skills was more successful at encouraging teachers to integrate technology into instruction, but this took three to five years on average (Sandholtz & Reilly, 2004; Sandholtz et al., 1997).

The following are recommendations for teachers:

- Develop your technological content knowledge (TCK) by seeking professional development, webinars, or publications that highlight technology use in specific content areas. Also, find examples of both universal and specialized content area technology tools being used in other elementary classrooms.
- Develop your technological pedagogical knowledge (TPK) by seeking professional development, webinars, or publications that focus on how technology changes teaching and learning. Consider the pedagogical affordances and constraints of integrating particular technology into lessons (Harris et al., 2009).
- Seek professional development that addresses using technology to specifically support different learning needs of your students in order to use technology as a tool for differentiating content, process, and products.
- Integrate specialized content area technology tools into your lessons. Choose the tool most appropriate for addressing content and pedagogical goals.
- Collaborate with other technology-using teachers at your school and in your district, especially if you are at the invention stage, ready to experiment with new ways to use technology (Sandholtz et al., 1997).

To begin to consider these recommendations, teachers should ask themselves the following questions when planning:

- What technology tool(s) am I going use in my lesson?

- Did I consider the content I was teaching when I chose the technology?
- Is the technology tool specific to the content area or universal to all content areas?
- Does the technology change or influence *how* I am going to teach the content?
- Did I specifically think about different learners in my class and how the technology might meet their needs?
- Are all of my students going to be doing the same thing with the technology? Is this appropriate given the needs of my students?

School and District Leaders

Finally, this study also has implications for school and district leaders. Because they are in a position to support teachers as they integrate technology, school and district leaders need to understand the how teachers' beliefs and knowledge influence the way they plan. The teachers in this study had strong technological knowledge, but were still developing their technological content knowledge (TCK) and technological pedagogical knowledge (TPK). Therefore, they would benefit from professional development that specifically addresses how technology influences teaching and learning in specific content areas. A teacher lacking technological knowledge would also benefit from technology professional development that focuses on curriculum. Although the addition of technology often makes teachers feel like novices again (Ertmer & Ottenbreit-Leftwich, 2010), technology professional development that focuses on curriculum capitalizes on teachers' strengths (Sandholtz & Reilly, 2004), ultimately making them feel more confident using technology in the classroom. School and district leaders do not have to be technology experts, but should positively support its use during instruction

(Davis, 2009), which can be done through providing technology professional development that focuses on content and pedagogy rather than on just the newest tools. In addition to providing professional development for teachers, school and district leaders should continue to develop their own TCK and TPK to understand the affordances and constraints technology offers to content and pedagogy.

The following are recommendations for school and district leaders:

- Offer professional development that focuses on best practices for using technology in specific content areas, even for elementary school teachers.
- Compare the benefits and drawbacks of universal and specialized content area technology tools appropriate for the elementary curriculum.
- Provide technical *and* curriculum support to teachers integrating technology.
- Collaborate with local universities for technical and curriculum technology support for teachers.
- Encourage exemplary, technology-using teachers to be teacher leaders by leading technology professional development, teaching model lessons that integrate technology, and mentoring other teachers as they plan for technology integration (Sandholtz et al., 1997).
- Develop your technological content knowledge (TCK) by seeking professional development, webinars, or publications that highlight technology use in specific content areas. Also, find examples of both universal and specialized content area technology tools being used in the elementary classroom to share with teachers.

- Develop your technological pedagogical knowledge (TPK) by seeking professional development, webinars, or publications that focus on how technology changes teaching and learning in specific content areas. Consider the pedagogical affordances and constraints of integrating particular technology into lessons (Harris et al., 2009).
- Seek professional development opportunities for yourself and teachers that addresses using technology to specifically support different learning needs of students.

When observing teachers using technology, school leaders should consider the following questions:

- What technology tool(s) is the teacher using? What technology tool(s) are the students using?
- Is the technology specific to the content area?
- Is the technology appropriate given the content area?
- Does the technology change or influence the way the teacher teaches the content or the way the students access the content? Is this appropriate?
- Are all the students always doing the same thing with the technology or is the technology use/tool differentiated based on need?

Limitations

A limitation of this study is that the three focal teachers are extreme cases. These cases are unique in that the limitation of first-order barriers regarding access to technology was not applicable in their cases (Ertmer et al., 1999). Although technology is becoming more affordable and accessible to schools (Penuel, 2006; Warschauer, 2006; Windschitl & Sahl, 2002), most teachers currently do not have access to as much technology on a daily basis as the three participants in the study (Gray et al., 2010). Therefore, findings from this study should be considered as they relate to the varying amounts of technology in teachers' classrooms. However, it is important to remember that the focus of the study is on how the teachers plan for technology integration given a technology-rich classroom, rather than on what tools they have in their classrooms. Another limitation to this study is that each participant was awarded a school system specific technology grant. Although Google searches show that nationwide technology grants and contests are available through organizations such as Digital Wish (http://digitalwish.com/dw/digitalwish/home) and companies such as Smart Technologies (http://smarttech.com/), $20,000 grants awarded through school systems may not be common. The grant awarded to the teacher participants, therefore, makes these cases unique.

This study only focused on inservice teachers in technology-rich classrooms to examine how teachers plan for technology integration. Missing from the study are the voices of the administrators whose leadership also might influence the way the teachers integrate technology in their lessons. Also missing from the study are considerations for how preservice teachers are currently being taught to plan for technology integration. These additional voices can be examined through future research on planning for technology integration.

It is important to also consider the context of the study as a possible limitation. Situated within the same district, two out of three of the schools were designated Title-I, serving similar populations. Therefore, the decisions the teacher participants made during planning, particularly to build the background knowledge the students lacked, may not be to the same as decisions other teachers would make during planning for technology integration. The timing of the study as related to the new Common Core State Standards initiative is also a possible limitation to the study. Data were collected during the first semester of implementation of Common Core State Standards for all three teachers. Because the Common Core State Standards were only adopted in Math and Language Arts for the 2012-2013 school year, only two of three of the teachers were directly affected. However, the Music teacher planned with general classroom teachers, taught remediation in several content areas, and led professional development in writing so she was also experiencing the transition to the Common Core State Standards as well. Although the teachers did not explicitly say that the Common Core State Standards influenced the decisions they made during planning for technology integration, it is important to consider this transition period is a possible limitation to the study.

In addition to limitations concerning these participants and the context, data collection was limited to one academic semester and only three cases. Although having three teacher participants allowed me to spend more time with the teachers, the findings from this study are not generalizable to other teachers. However, the purpose of this multiple case study was never to generalize the findings to other teachers, but rather to present three descriptive cases of teachers planning for technology integration and my interpretation of common patterns and themes found across those cases. If I were to replicate this study, I would extend the time spent with the teachers to include more than two Think Aloud interviews and to allow for more opportunities to discuss decisions made during planning. An extended time frame for data collection, such as a full academic year, may show changes in the teachers' technological content knowledge (TCK) and technological pedagogical knowledge (TPK) as they spend more time with the technology and better understand their students' learning needs. Only collecting data for one semester limited the chance to see any growth in the teachers' TCK and TPK.

Finally, it is also important to consider any limitations my role as a researcher presents to the study. Although I do not work with the teachers now, at one time I met them through my role as the Lead Teacher of Elementary Technology in their school system. In that role, I was responsible for the placement of interactive whiteboards in all three teachers' classrooms and laptop computers in two out of three of the teachers' schools. I also facilitated the district technology leadership group, of which all three teachers were members. However, my role as Lead Teacher did not place me as the teachers' superior, and it has been more than three years since I was in that role. In addition to having a prior relationship with the teacher participants, my own knowledge of technology integration is a potential bias that needs to be addressed. My own knowledge and experience may be a limitation because of the potential for it to influence my interactions with the teachers and my interpretations of the data I collected.

I used several validation strategies to mitigate these limitations (Maxwell, 2005; Yin, 2009). First, the rich description of each case allows for transferability because the readers of these cases can determine whether the findings are transferable to other settings due to familiarity with similar characteristics (Creswell, 2007). Second, I used member checking (Creswell, 2007), by having the participants read their cases and offer feedback, to make sure I presented an accurate portrayal of each case. Third, although I did not have additional observers or coders, I used multiple data sources to triangulate my findings (Creswell, 2007; Yin, 2009), including multiple observations, multiple formal and informal interviews, plus two think-aloud interviews. Finally, I made it clear to the participants in the initial interview that my role as a researcher was not to evaluate them, but rather to learn about the decisions they were making during planning for technology integration.

Implications for Future Research

The findings from this study suggest implications for future research including: 1) additional case study examples of the decisions teachers make that influence technology integration during planning to inform teacher educators, teachers, and administrators; 2) examples of existing technology professional development focusing on developing content and pedagogical knowledge as related to technological knowledge in elementary content areas; 3) study of the benefits of using universal and specialized technology tools in the elementary classroom; and 4) examples of planning for technology integration that addresses specific student learning needs. Each of these ideas for future research is expanded on below.

Additional Cases of Teacher Decision-Making during Planning

The teachers in this study provided extreme cases, all obtaining $20,000 in new technology for their classrooms through a district grant. The findings from this study indicate that the teachers' beliefs and knowledge of technology, content, and pedagogy influenced the decisions they made about integrating technology when planning. Additional research needs to be done with other teachers to examine how their beliefs and varying degrees of technological content knowledge (TCK) and technological pedagogical knowledge (TPK) influence the decisions they make during planning. Additional case examples of teachers planning for the integration of technology would inform teacher educators, teachers, and those in charge of planning for technology professional development. Additional Think Aloud interviews of teachers planning while considering technology would also provide examples for preservice teachers of the decisions teachers make when thinking about how the technology they want to integrate influences the content they are teaching and the best practices for teaching that content. Having videotapes of how teacher plan for technology-rich classrooms would be helpful to teacher educators, preservice teachers, and other inservice teachers.

Technology Professional Development

Technology professional development for teachers tends to focus on the technology tool (Harris, 2005; Harris & Hofer, 2011). However, findings from the ACOT studies suggest that teachers were encouraged to integrate technology in their classrooms when the focus of the technology professional development was on curriculum rather than technical skills (Sandholtz et al., 1997; Sandholtz & Reilly, 2004). The teachers in this study had technological knowledge, but were still developing their technological content knowledge (TCK) and technological pedagogical knowledge (TPK) and may have benefited from professional development targeting TCK and TPK. Judi Harris and her colleagues (Harris, 2005; Harris & Hofer, 2011; Harris et al., 2009) have published empirical research describing efforts being made to provide teachers with curriculum-based technology professional development. Harris and Hofer (2011) noted that

> Regardless of preferred pedagogical approach, however, it seems clear that an instructional planning strategy [shared through professional development] that is conceptualized and organized around curriculum content, teaching/learning context, and pedagogy primarily, and according to the digital tools and resources that can support different types of learning secondarily… can help teachers diversify their instructional approaches while concurrently encouraging appropriate educational uses of technological tools and resources. (p. 226)

If curriculum-based technology professional development can help teachers "diversify their instructional approaches" while integrating technology, then additional examples of technology professional development that emphasize content and pedagogy and work to develop teachers' TCK and TPK are needed to inform university, district, and school leaders who plan technology professional development. Most importantly, future research should continue to examine the results existing technology professional development emphasizing specific content connections at the elementary level because technology professional development tends to be universal instead of specialized for this audience.

Universal and Specialized Technology Tools in the Elementary Classroom

As a recommendation from their study of secondary social studies teachers, Swan and Hofer (2011) suggest that both universal and specialized technology tools have a place in the classroom. In this study, the music teacher had knowledge of technology tools specific to music, but, overall, the technology used by all three teachers was universal and not specific to the content they were teaching. Because elementary teachers are generalists, it makes sense that they tend to integrate technology tools that would be appropriate across disciplines. As we are considering ways to make technology professional development content specific, we need to study elementary school teachers who are using specialized content area technology tools in the classroom to determine what those tools are, how they are being used, and the considerations teachers make to integrate them into instruction. Knowledge of specialized technology tools would inform teacher educators, teachers, and those in charge of planning technology professional development. Additional case studies would provide insight into how and why teachers are using specialized content area tools in the elementary classroom.

Technology Integration Addressing Specific Learning Needs

Finally, additional research needs to be done examining how teachers are integrating technology to address specific learning needs in the classroom. Although the teachers in this study spoke of considering their learners during planning, they typically grouped the learners together, integrating technology to meet the needs of the class as a whole. Research suggests that technology can provide targeted supports to exceptional learners in the general classroom setting (Bray et al., 2004; Hasselbring & Glaser, 2000; Lewis, 1998), such as through the built-in audio and visual supports for struggling readers in eBooks (Karchmer, 2001; Lewis, 1998; Rhodes & Milby, 2007; Zucker et al., 2009). Teacher educators, teachers, administrators, and those planning technology professional development would benefit from descriptive case studies of teachers making decisions during planning about integrating technology to address specific student learning needs.

Conclusion

As access to technology becomes ubiquitous in schools (Gray et al., 2010), the *quality* of student access to technology needs to be examined. One way to do this is by exploring how teachers are planning for technology integration and the factors that influence the decisions they make during planning. This study examined the decisions three elementary school teachers made when planning in technology-rich classrooms. Although the teachers taught different content areas, they shared similar beliefs about why it was important for them to use technology in their classrooms, and those beliefs consistently influenced the way they planned for technology integration. The teachers' knowledge of content, pedagogy, and technology varied, but for all of the teachers, their knowledge influenced the decisions they made during planning. Understanding how beliefs and knowledge influence the decisions teachers make when planning for technology integration can inform instructors of content-area methods courses for preservice teachers and approaches to technology professional development for inservice teachers.

REFERENCES

Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education, 43*(4), 281-300.

Allan, W.C., Erickson, J.L., Brookhouse, P., Johnson, J.L. (2010). Teacher professional development through a collaborative curriculum project -an example of TPCK in Maine. *TechTrends, 54*(6), 36-43.

Anderson, R., & Balajthy, E. (2009). Technology in literacy education: Stories about struggling readers and technology. *The Reading Teacher, 62*(6), 540-542.

Angers, J., & Machtmes, K. (2005). An ethnographic –case study of beliefs, context factors, and practices of teachers integrating technology. *The Qualitative Report, 10*(4), 771-794.

Association of Mathematics Teacher Educators. (2009). *Mathematics TPACK Framework.* Retrieved from http://www.amte.net/sites/all/themes/amte/resources/MathTPACKFramework.pdf

Atkinson, T. S., & Swaggerty, E.A. (2011). Empowering fourth-grade researchers: Reaping the rewards of web 2.0 student-centered learning. *Language Arts, 89*(2), 99-112.

Ball, A.L., Knobloch, N.A., & Hoop, S. (2007). The instructional planning experiences of beginning teachers. *Journal of Agricultural Education, 48*(2), 56-65.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148.

Barron, A.E., Harmes, J.C., & Kemker, K.J. (2006). Technology as a classroom tool: Learning with laptop computers. In L.T.W. Hin & R. Subramaniam (Eds.), *Handbook of research on literacy in technology at the K-12 level* (pp. 271-286). Hershey, PA: Idea Group Reference.

Becker, H.J. (2000). Who’s wired and who’s not: Children’s access to and use of computer technology. *The Future of Children, 10*(2), 44-75.

Becker, H. J., & Ravitz, J. L. (1999). The influence of computer and Internet use on teachers' pedagogical practices and perceptions. *Journal of Research on Computing in Education, 31*(4), 356–384.

Beckett, E.C., Wetzel, K., Chisholm, I.M., Zambo, R., Buss, R., Padgett, H., Williams, M.K., Odom, M. (2007). Staff development to provide intentional language teaching in technology-rich K-8 multicultural classrooms. *Computers in the Schools, 23*(3-4), 23-30.

Bedard, C., & Fuhrken, C. (2011). Writing for the big screen: Literacy experiences in a moviemaking project. *Language Arts, 89*(2), 113-124.

Beeson, M.W. (2011). Technological pedagogical content knowledge in the elementary classroom: A case study of one teacher's decision making process. In *Proceedings of Society for Information Technology & Teacher Education International Conference 2011* (pp. 4273-4280). Chesapeake, VA: AACE.

Berg, S., Benz, C., Lasley II, T., & Raisch, C. (1998). Exemplary technology use in elementary classrooms. *Journal of Research on Computing in Education, 31*(2), 111.

Berliner, D.C. (1986). In pursuit of the expert pedagogue. *Educational Researcher, 15*(5), 5-13. doi: 10.3102/0013189X015007007

Berson, I.R., Berson, M.J., Desai, S., Falls, D., & Fenaughty, J. (2008). An analysis of electronic media to prepare children for safe and ethical practices in digital environments. *Contemporary Issues in Technology and Teacher Education* [Online serial], *8*(3). Available: http://www.citejournal.org/vol8/iss3/socialstudies/article2.cfm

Berson, M.J., & VanFossen, P.J. (2008). Another look at civic literacy in a digital age. *Contemporary Issues in Technology and Teacher Education* [Online serial], *8*(3). Available: http://www.citejournal.org/vol8/iss3/socialstudies/article1.cfm

Boling, E., Castek, J., Zawilinski, L., Barton, K., & Nierlich, T. (2008). Technology in literacy education: Collaborative literacy: Blogs and internet projects. *The Reading Teacher, 61*(6), 504-506.

Bos, B. (2009). Technology with cognitive and mathematical fidelity: What it means for the math classroom. *Computers in the Schools*, *26*(2), 107-114.

Bos, B. (2011). Professional development for elementary teachers using TPACK. *Contemporary Issues in Technology and Teacher Education*, *11*(2). Retrieved from http://www.citejournal.org/vol11/iss2/mathematics/article1.cfm

Bransford, J., Brown, A., & Cocking, R. (2000). *How People Learn: Brain, Mind, Experience, and School.* National Academy Press: Washington, D.C.

Bray, M., Brown, A., & Green, T.D. (2004). *Technology and the diverse learner: A guide to classroom practice.* Thousand Oaks, CA: Corwin Press.

Ching, C., Wang, X., Shih, M., & Kedem, Y. (2006). Digital photography and journals in a kindergarten-first-grade classroom: Toward meaningful technology integration in early childhood education. *Early Education and Development*, *17*(3), 347-371.

Clark, C.M., & Peterson, P.L. (1986). Teachers' thought processes. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed, pp. 255-296). New York: Macmillan.

Clausen, J. M., Britten, J., & Ring, G. (2008). Envisioning effective laptop initiatives. *Learning & Leading with Technology*, *36*(1), 18-22.

Clements, D.H. (2002). Computers in early childhood mathematics. *Contemporary Issues in Early Childhood*, *3*(2), 160-181.

Clements, D.H., & Sarama, J. (2007). Effects of a preschool mathematics curriculum: Summative research on the Building Blocks project. *Journal for Research in Mathematics Education, 38*(2), 136-163.

Common Core State Standards Initiative. (2010). *Common core state standards initiative: Preparing America's students for college and career.* Available at: http://www.corestandards.org/

Corn, J. O., Oliver, K. M., Hess, C. E., Halstead, E. O., Argueta, R., Patel, R. K., Tingen, J., & Huff, J. D. (2010). A Computer for every student and teacher: Lessons learned about planning and implementing a successful 1:1 learning initiative in schools. *Educational Technology*, *50*(6), 11-17.

Crawford, S.P. (2011). *The new digital divide.* Retrieved on July 15, 2012, from http://www.nytimes.com/2011/12/04/opinion/sunday/internet-access-and-the-new-divide.html?_r=3&pagewanted=all

Creswell, J.W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Crompton, H. (2011). Mathematics in the age of technology: There is a place for technology in the mathematics classroom. *Journal of the Research Center for Educational Technology, 7*(1), 54-66.

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920.* New York, NY: Teachers College Press.

Cuban, L. (2001). *Oversold and Underused: Computers in the classroom.* Cambridge, MA: Harvard University Press.

Cummins, J. (2008). Technology, literacy, and young second language learners: Designing educational futures. In L.L. Parker (Ed.), *Technology-mediated learning environments for young English learners.* (pp. 61-98). New York: Lawrence Erlbaum Associates.

Czarnecki, K. (2009). How digital storytelling builds 21st century skills. *Library Technology Reports, 45*(7), 15-19.

Davis, A.W. (2009). *Syncing up with the iKid: Portrait of seven high school teacher leaders transforming the American high school through a digital conversion of teaching and learning.* (Unpublished doctoral dissertation). The University of North Carolina at Greensboro, Greensboro.

Dodge, B. (2007). *San Diego State University WebQuest site: Webquest.org.* Retrieved from http://webquest.org/index.php

Doolittle, P.E., & Hicks, D. (2003). Constructivism as a theoretical foundation for the use of technology in social studies. *Theory and Research in Social Education, 31*(1), 72-104.

Dunleavey, M., Dexter, S., & Heinecke, W.F. (2007). What added value does a 1:1 student laptop ratio bring to technology-supported teaching and learning? *Journal of Computer Assisted Learning, 23,* 440-452.

Edelson, D.C. (2001). Learning-for-use: A framework for the design of technology-supported inquiry activities. *Journal of Research in Science Teaching, 38*(3), 355-385.

Edmunds, J. A. (2008). Using alternative lenses to examine effective teachers' use of technology with low-performing students. *Teachers College Record, 110*(1), 195-217.

Ericsson, K., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review, 87*(3), 215-251. doi:10.1037/0033-295X.87.3.215

Ericsson, K., & Simon, H.A. (1998). How to study thinking in everyday life: Contrasting think-aloud protocols with descriptions and explanations of thinking. *Mind, Culture, and Activity, 5*(3), 178-186. doi: 10.1207/s15327884mca0503_3

Ertmer, P.A., (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research & Development*, *53*(4), 25-39.

Ertmer, P., Addison, P., Lane, M., Ross, E., & Woods, D. (1999). Examining teachers' beliefs about the role of technology in the elementary classroom. *Journal of Research on Computing in Education*, *32*(1), 54.

Ertmer, P.A., & Ottenbreit-Leftwich, A.T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education, 42*(3), 255-284.

Ertmer, P.A., Ottenbreit-Leftwich, A., & York, C.S. (2006-2007). Exemplary technology-using teachers: Perceptions of factors influencing success. *Journal of Computing in Teacher Education*, *23*(2), 55-61.

Franz, D.P., & Hopper, P.F. (2007). Technology in mathematics: Issues in educating teacher candidates for rural math classrooms. *Issues in the Undergraduate Mathematics Preparation of School Teachers, 3.*

Freeman, B. (2012). Using digital technologies to redress inequities for English language learners in the English speaking mathematics classroom. *Computers and Education, 59*(1), 50-62. doi:10.1016/j.compedu.2011.11.003

Friedman, A. (2006). State standards and digital primary sources: A divergence. *Contemporary Issues in Technology and Teacher Education* [Online serial], *6*(3). Available: http://www.citejournal.org/vol6/iss3/socialstudies/article1.cfm

Friedman, A. M., & Heafner, T.L. (2007). You think for me, so I don't have to: The effect of a technology-enhanced, inquiry learning environment on student learning in 11th grade United States history. *Contemporary Issues in Technology and Teacher Education* [Online serial], *7*(3). Available: http://www.citejournal.org/vol7/iss3/socialstudies/article1.cfm

Gall, M., & Breeze, N. (2008). Music and eJay: An opportunity for creative collaborations in the classroom. *International Journal of Educational Research, 47,* 27-40.

Gallagher, J.J. (1975). *Teaching the gifted child* (2nd ed.). Boston, MA: Allyn and Bacon, Inc.

Ganesh, T.G., & Middleton, J.A. (2006). Challenges in linguistically and culturally diverse elementary settings with math instruction using learning technologies. *The Urban Review, 38*(2), 101-143.

Garthwait, A., & Weller, H.G. (2005). A year in the life: Two seventh grade teachers implement one-to-one computing. *Journal of Research on Technology in Education, 37*(4), 361-377.

Gaudelli, W., & Taylor, A. (2011). Modding the global classroom? Serious video games and teacher reflection. *Contemporary Issues in Technology and Teacher Education, 11*(1). Available: http://www.citejournal.org/vol11/iss1/socialstudies/article1.cfm

Gee, J.P. (2007). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.

Gerard, L.F., Varma, K., Corliss, S.B., & Linn, M.C. (2011). Professional development for technology-enhanced inquiry science. *Review of Educational Research, 81*(3), 408-448.

Gibbs, M.G., Dosen, A.J., & Guerrero, R.B. (2009). Bridging the digital divide: Changing the technological landscape of inner-city catholic schools. *Urban Education, 44*(1), 11-29.

Goldenberg, E.P. (2000). Thinking (and talking) about technology in math classrooms. *Issues in Mathematics Education.* Available at http://www2.edc.org/mcc/PDF/iss_tech.pdf.

Goodson, I. F., & Mangan, J. M. (1995). Subject cultures and the introduction of classroom computers. *British Educational Research Journal, 21*(5), 613–629.

Gray, L., Thomas, N., and Lewis, L. (2010). Teachers' use of educational technology in U.S. Public Schools: 2009 (NCES 2010-040). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Grimes, D., & Warschauer, M. (2008). Learning with laptops: A multi-method case study. *Journal of Educational Computing Research, 38*(3), 305-332.

Groff, J., & Mouza, C. (2008). A framework for addressing challenges to classroom technology use. *AACE Journal*, *16*(1), 21-46.

Guzey, S. S., & Roehrig, G. H. (2009). Teaching science with technology: Case studies of science teachers' development of technology, pedagogy, and content knowledge. *Contemporary Issues in Technology and Teacher Education*, *9*(1). Retrieved from http://www.citejournal.org/vol9/iss1/science/article1.cfm

Hannafin, R. D. (2004). Achievement differences in structured versus unstructured instructional geometry programs. *Educational Technology Research & Development, 52*(1), 19-32.

Hansen, C. C. (2008). Observing technology enhanced literacy learning. *Contemporary Issues in Technology and Teacher Education, 8*(2). Retrieved from http://www.citejournal.org/vol8/iss2/languagearts/article1.cfm

Harris, J.B. (2005). Our agenda for technology integration: It's time to choose. *Contemporary Issues in Technology and Teacher Education, 5*(2), 116-122.

Harris, J.B., & Hofer, M.J. (2011). Technological pedagogical content knowledge (TPACK) in action: A descriptive study of secondary teachers' curriculum-based, technology-related instructional planning. *Journal of Research on Technology in Education, 43*(3), 211-229.

Harris, J.B., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education, 41*(4), 393-416.

Hasselbring, T.S., & Glaser, C.H.W. (2000). Use of computer technology to help students with special needs. *The Future of Children, 10*(2), 102-122.

Heafner, T. (2004). Using technology to motivate students to learn social studies. *Contemporary Issues in Technology and Teacher Education* [Online serial], *4*(1). Available: http://www.citejournal.org/vol4/iss1/socialstudies/article1.cfm

Hermans, R., Tondeur, J., van Braak, J., Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers and Education, 51*, 1499-1509.

Hertz, M.B. (2011). *A new understanding of the digital divide.* Retrieved on July 15, 2012, from http://www.edutopia.org/blog/digital-divide-technology-internet-access-mary-beth-hertz

Hess, F.M., & Leal, D.L. (1999). Computer-assisted learning in urban classrooms: The impact of politics, race, and class. *Urban Education, 34*(3), 370-388.

Hew, K.F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: current knowledge gaps and recommendations for future research. *Educational Technology Research Development, 55*(3), 223-252. doi: 10.1007/s11423-006-9022-5

Higgins, T.E., & Spitulnik, M.W. (2008). Supporting teachers' use of technology in science instruction through professional development: A literature review. *Journal of Science Education and Technology, 17*(5), 511-521.

Hofer, M., & Swan, K. O. (2006). Reprint: Standards, firewalls, and general classroom mayhem: Implementing student-centered technology projects in the elementary classroom. *Contemporary Issues in Technology and Teacher Education, 7*(2), 42-58.

Hofer, M., & Swan, K.O. (2008). Technological pedagogical content knowledge in action: A case study of a middle school digital documentary project. *Journal of Research on Technology in Education, 41*(2), 179-200.

Holcomb, L.B. (2009). Results and lessons learned from 1:1 laptop initiatives: A collective review. *TechTrends, 53*(6), 49-55.

Horsley, D.L., & Loucks-Horsley, S. (1998). Tornado of change. *Journal of Staff Development, 19*(4), 17-20.

International Society for Technology in Education. (2009). *Nets for administrators.* Available at http://www.iste.org/standards/nets-for-administrators.aspx

International Society for Technology in Education. (2007). *NETS for students*. Available at http://www.iste.org/standards/nets-for-students/nets-student-standards-2007.aspx

International Society for Technology in Education. (2008). *NETS for teachers.* Available at http://www.iste.org/standards/nets-for-teachers.aspx

Jeffs, T., Behrmann, M., & Bannan-Ritland, B. (2006). Assistive technology and literacy learning: Reflections of parents and children. *Journal of Special Education Technology, 21*(1), 37-44.

John, P.D. (2006). Lesson planning and the student teacher: re-thinking the dominant model. *Journal of Curriculum Studies, 38*(4), 483-498.

Jonassen, D., Howland, J., Marra, R.M., & Crismond, D. (2008). *Meaningful learning with technology*. New Jersey: Pearson Education, Inc.

Jones, A., & Moreland, J. (2004). Enhancing practicing primary school teachers' pedagogical content knowledge in teaching. *International Journal of Technology and Design Education, 14*, 121-140.

Journell, W. (2009). Maximizing the potential of computer-based technology in secondary social studies education. *Social Studies Research and Practice, 4*(1), 55-70.

Joyce, B., Weil, M., & Calhoun, E. (2004). *Models of Teaching* (7th ed.). Boston: Pearson.

Kagan, D. M., & Tippins, D.J. (1992). The evolution of functional lesson plans among twelve elementary and secondary student teachers. *The Elementary School Journal, 92*(4), 477-489.

Karchmer, R. A. (2001). The journey ahead: Thirteen teachers report how the Internet influences literacy and literacy instruction in their K–12 classrooms. *Reading Research Quarterly*, *36*(4), 442–467.

Ke, F. (2008). Alternative goal structures for computer game-based learning. *International Journal of Computer-Supported Collaborative Learning, 3*(4), 429-445.

Kemker, K., Barron, A., & Harmes, J. (2007). Laptop computers in the elementary classroom: Authentic instruction with at-risk students. *Educational Media International*, *44*(4), 305-321.

Kieler, L. (2010). Trials in using digital storytelling effectively with the gifted. *Gifted Child Today, 33*(3), 48-52.

Koehler, M.J., & Mishra, P. (2008). Introducing TPCK. In AACTE Committee on Innovation and Technology (Eds.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3-29). New York, NY: Routledge.

Konold, C. (2002). Teaching concepts rather than conventions. *New England Journal of Mathematics, 34*(2), 69-81.

Lambert, J., & Gong, Y. (2010). 21st century paradigms for pre-service teacher technology preparation. *Computers in the Schools, 27,* 54-70.

Lee, R. (2006). Effective learning outcomes of ESL elementary and secondary school students utilizing educational technology infused with constructivist pedagogy. *International Journal of Instructional Media, 33*(1), 87-93.

Lewis, R.B. (1998). Assistive technology and learning disabilities: Today's realities and tomorrow's promises. *Journal of Learning Disabilities, 31*(1), 16-26.

Leu, D. J., Zawilinski, L. , Castek, J., Banerjee, M., Housand, B., Liu, Y., & O'Neil, M. (2007). What is new about the new literacies of online reading comprehension? In L. S. Rush, A. J. Eakle, & A. Berger (Eds.), *Secondary school literacy: What research reveals for classroom practice* (pp. 37–68).Urbana, IL: NCTE.

Levin, B.B., & Schrum, L. (2012). *Leading technology-rich schools: Award-winning models for success.* New York, NY: Teachers College Press.

Levin, T., & Wadmany, R. (2006). Teachers' beliefs and practices in technology-based classrooms: A developmental view. *Journal of Research on Technology in Education, 39*(2), 157-181.

Lim, C., & Chai, C. (2008). Teachers' pedagogical beliefs and their planning and conduct of computer- mediated classroom lessons. *British Journal of Educational Technology, 39*(5), 807-828.

Lindstrom, P. P., Gulz, A. A., Haake, M. M., & Sjoden, B. B. (2011). Matching and mismatching between the pedagogical design principles of a math game and the actual practices of play. *Journal of Computer Assisted Learning, 27*(1), 90-102.

MacKinnon, D., Lynch-Davis, K., & Driskell, S. (2009). Constructing and exploring Pascal's Triangle in TinkerPlots. *The Mathematics Teacher, 102*(8), 628-632.

Main, S., & O'Rourke, J. (2011). New directions for traditional lessons: Can handheld game consoles enhance mental mathematics skills? *Australian Journal of Teacher Education, 36*(2), 43-55.

Maker, C.J., & Schiever, S.W. (2005). *Teaching models in education of the gifted* (3rd ed.). Austin, TX: Proed.

Male, M. (2003). *Technology for inclusion: Meeting the special needs of all students.* Boston: MA: Allyn and Bacon.

Maxwell, J.A. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: SagePublications, Inc.

McLester, S. (2011). Lessons learning from one-to-one. *District Administration, 47*(6), 34-39.

Miranda, H., & Russell, M. (2011). Predictors of teacher-directed student use of technology in elementary classrooms: A multilevel SEM approach using data from the USEIT study. *Journal of Research on Technology in Education, 43*(4), 301-323.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017-1054.

Mistler-Jackson, M., & Songer, N.B. (2000). Student motivation and Internet technology: Are students empowered to learn science? *Journal of Research in Science Teaching, 37*(5), 459-479.

Moore-Hayes, C. (2011). Technology integration preparedness and its influence on teacher-efficacy. *Canadian Journal of Learning and Technology, 37*(3), 1-15.

Mouza, C. (2008). Learning with laptops: Implementation and outcomes in an urban, under-privileged school. *Journal of Research on Technology in Education*, *40*(4), 447-472.

Mouza, C. (2011). Promoting urban teachers' understanding of technology, content, and pedagogy in the context of case development. *Journal of Research on Technology in Education, 44*(1), 1-29.

Muir, M., Knezek, G., & Christensen, R. (2004). The power of one-to-one: Early findings from the Maine learning technology initiative. *Learning and Leading with Technology*, *32*(3), 6-11.

National Association for Music Education. (2010). *Press release: P21 and arts associations release 21st century skills map.* Retrieved on August 8, 2011, from http://www.menc.org/news/view/press-release-p21-and-arts-associations-release-21st-century-skills-map

National Council for the Social Studies. (2006). *Technology position statement and guidelines.* Retrieved on August 5, 2011, from http://www.socialstudies.org/positions/technology

National Council of Teachers of English. (2008). *The NCTE definition of 21st century literacies.* Retrieved August 2, 2011, from http://www.ncte.org/positions/21stcenturyliteracy

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA.

National Science Teachers Association. (2011). *Quality science education and 21st century skills.* Retrieved on August 5, 2011, from http://www.nsta.org/about/positions/21stcentury.aspx

Nespor, J. (2000). School field trips and the curriculum of public spaces. *Journal of Curriculum Studies, 32*(1), 25-43.

Niess, M. L., Ronau, R. N., Shafer, K. G., Driskell, S. O., Harper S. R., Johnston, C., Browning, C.,Özgün-Koca, S. A., & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 4-24.

Niess, M. L. & Walker, J. M. (2010). Guest editorial: Digital videos as tools for learning mathematics. *Contemporary Issues in Technology and Teacher Education*, *10*(1). Retrieved from http://www.citejournal.org/vol10/iss1/mathematics/article1.cfm

Norris, C., & Soloway, E. (2004). Envisioning the handheld-centric classroom. *Journal of Educational Computing Research, 30*(4), 281-294.

O'Brien, J. (2008). Are we preparing young people for 21st -century citizenship with 20th-century thinking? A case for a virtual laboratory of democracy. *Contemporary Issues in Technology and Teacher Education* [Online serial], *8*(2). Available: http://www.citejournal.org/vol8/iss2/socialstudies/article2.cfm

O'Hanlon, C. (2007). A measure of success. *T.H.E. Journal*, *34*(2), 26-32.

Obara, S., & Jiang, Z. (2009). Using dynamic geometry software to investigate midpoint quadrilateral. *Electronic Journal of Mathematics and Technology, 3*(3), 274-284.

Page, M.S. (2002). Technology-enriched classrooms: Effects on students of low socioeconomic status. *Journal of Research on Technology in Education, 34*(4), 389-409.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543-578. doi: 10.3102/00346543066004543

Pajares, M.F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*(3), 307-332.

Palak, D., & Walls, R.T. (2009). Teachers' beliefs and technology practices: A mixed-methods approach. *Journal of Research on Technology in Education, 41*(4), 417-441.

Park, S.H., & Ertmer, P.A. (2007). Impact on problem-based learning (PBL) on teachers' beliefs regarding technology use. *Journal of Research on Technology in Education, 40*(2), 247-267.

Partnership for 21st Century Schools. (2009). *P21 Framework Definitions*. Available at http://www.p21.org/documents/P21_Framework_Definitions.pdf

Penuel, W.R. (2006). Implementation and effects of one-to-one computing initiatives: A research synthesis. *Journal of Research on Technology in Education, 38*(3), 329-348.

Peterson, P.L., & Clark, C.M. (1978). Teachers reports of their cognitive processes during teaching. *American Educational Research Journal, 15*(4), 555-565. doi:10.3102/00028312015004555

Peterson, P.L., & Comeaux, M.A. (1990). Evaluating the systems: Teachers' perspectives on teachers education. *Educational Evaluation and Policy Analysis, 12*(1), 3-24.

Peterson, P.L., Marx, R.W., & Clark, C.M. (1978). Teacher planning, teacher behavior, and student achievement. *American Educational Research Journal, 15*(3), 417-432.

Pierson, M.E. (2001). Technology integration practice as a function of pedagogical expertise. *Journal of Research on Computing in Education, 33*(4), 413-430.

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common core standards: The new U.S. curriculum. *Educational Researcher, 40*(3), 103-116. doi: 10.3102/0013189X11405038

Prensky, M. (2001a). *Digital game-based learning*. New York: McGraw-Hill.

Prensky, M. (2001b). Digital natives, digital immigrants. *On the Horizon, 9*(5).

Public Schools of North Carolina. (n.d.). *Common core.* Available at http://www.ncpublicschools.org/acre/standards/common-core/

Public Schools of North Carolina. (2011). *Information and technology essential standards.* Available at http://www.ncpublicschools.org/docs/acre/standards/new-standards/info-technology/gradek.pdf

Putney, D., Bennett, E. & Head, C. (2004). Creating ebooks with young children. In R. Ferdig et al. (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2004* (pp. 5014-5018). Chesapeake, VA: AACE.

Reid, M.J. (2009). Curriculum deliberations of experienced elementary teachers engaged in voluntary team planning. *The Curriculum Journal, 20*(4), 409-421.

Rhodes, J.A., & Milby, T.M. (2007). Teacher-created electronic books: Integrating technology to support readers with disabilities. *The Reading Teacher, 61*(3), 255-259.

Robin, B.R. (2006). *The educational uses of digital storytelling.* Retrieved on November 5, 2011, from http://faculty.coe.uh.edu/brobin/homepage/Educational-Uses-DS.pdf

Robin, B.R. (2008). Digital storytelling: A powerful technology tool for the 21st century classroom. *Theory into Practice, 47*(3), 220-228.

Robinson, A., Shore, B.M., & Enersen, D.L. (2007). *Best practices in gifted education: An evidence-based guide.* Waco, TX: Prufrock Press, Inc.

Roschelle, J.M., Pea, R.D., Hoadley, C.M., Gordin, D.N., & Means, B.M. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children*, *10*(2), 76-101.

Rose, D. H., & Gravel, J. W. (2010). Universal design for learning. In P. Peterson, E. Baker & B. McGraw (Eds.), *International encyclopedia of education* (pp. 119-124). Oxford: Elsevier.

Rose, D.H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning*. Alexandria, VA: ASCD.

Rotherham, A. J., & Willingham, D. T. (2010). "21st-century" skills: Not new, but a worthy challenge. *American Educator*, *34*(1), 17-20.

Russell, M., Bebell, D., & Higgins, J. (2004). Laptop learning: A comparison of teaching and learning in upper elementary classrooms equipped with shared carts of laptops and permanent 1:1 laptops. *Journal of Educational Computing Research, 30*(4), 313-330.

Sabers, D.S., Cushing, K.S., & Berliner, D.C. (1991). Differences among teachers in a task characterized by simultaneity, multidimensionality, and immediacy. *American Educational Research Journal, 28*(1), 63-88. doi: 10.3102/00028312028001063

Salinas, C., Bellows, M. E., & Liaw, H. L. (2011). Preservice social studies teachers' historical thinking and digitized primary sources: What they use and why. *Contemporary Issues in Technology and Teacher Education*, *11*(2). Retrieved from http://www.citejournal.org/vol11/iss2/socialstudies/article1.cfm

Sandholtz, J.H., & Reilly, B. (2004). Teachers, not technicians: Rethinking technical expectations for teachers. *Teachers College Record, 106*(3), 487-512.

Sandholtz, J.H., Ringstaff, C., & Dwyer, D.C. (1997). *Teaching with technology: Creating student-centered classrooms.* New York: Columbia University Press.

Sardone, N.B., & Devlin-Scherer, R. (2010). Teacher candidate responses to digital games: 21st century skills development. *Journal of Research on Technology in Education, 42*(4), 409-425.

Savage, J. (2007). Reconstructing music education through ICT. *Research in Education, 78,* 65-77.

Sawchuk, S. (2009). "21st-century skills" focus shifts West Virginia teachers' role. *Education Week*, *28*(16), 1-3.

Schramm, W. (1971). *Notes on case studies of instructional media projects.* Working paper for the Academy for Educational Development, Washington, DC.

Schrum, L., & Levin, B.B. (2009). *Leading 21st century schools: Harnessing technology for engagement and achievement.* Thousand Oaks, CA: Corwin.

Scientific Reasoning Research Institute. (2012). *TinkerPlots software.* Retrieved on May 17, 2012 from https://www.srri.umass.edu/tinkerplots

Shank, G. D. (2006). *Qualitative research: A personal skills approach.* 2nd Edition. Upper Saddle River, NJ: Pearson.

Shaunessy, E. (2007). Attitudes toward information technology of teachers of the gifted: Implications for gifted education. *Gifted Child Quarterly, 51*(2), 119-135.

Shavelson, R.J. (1973). What is the basic teaching skill? *The Journal of Teacher Education, 24*(2), 144-151.

Shulman, L.S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.

Silva, E. (2009). Measuring skills for 21st century learning. *The Phi Delta Kappan, 90*(9), 630-634.

Songer, N.B., Lee, H., & Kam, R. (2002). Technology-rich inquiry science in urban classrooms: What are the barriers to inquiry pedagogy? *Journal of Research in Science Teaching, 39*(2), 128-150.

Stake, R.E. (1995). *The Art of Case Study Research.* Thousand Oaks, CA: Sage.

Staley, D. J. (2000). The role of technology in social studies education. *International Journal of Social Education, 15*(1), 1-127.

Staples, A., Pugach, M., & Himes, D. (2005). Rethinking the technology integration challenge: Cases from three urban elementary schools. *Journal of Research on Technology in Education, 37*(3), 285-311.

Stoddard, J. (2009). Toward a virtual field trip model for the social studies. *Contemporary Issues in Technology and Teacher Education, 9*(4). Retrieved from http://www.citejournal.org/vol9/iss4/socialstudies/article1.cfm

Stodolsky, S.S. (1988). *The subject matters: Classroom activity in math and social studies.* Chicago: The University of Chicago Press.

Suhr, K.A., Hernandez, D.A., Grimes, D., & Warschauer, M. (2010). Laptops and fourth-grade literacy: Assisting the jump over the fourth-grade slump. *Journal of Technology, Learning, and Assessment, 9*(5). Retrieved October 16, 2011 from http://www.jtla.org.

Superfine, A.C. (2008). Planning for mathematics instruction: A model of experienced teachers' planning processes in the context of a reform mathematics curriculum. *The Mathematics Educator, 18*(2), 11-22.

Swan, K., & Hofer, M. (2011). In search of technological pedagogical content knowledge: Teachers' initial foray into podcasting in economics. *Journal of Research of Technology in Education, 44*(1), 75-98.

Swan, K.O., & Hofer, M. (2008). Technology and social studies. In L.S. Levstik & C.A. Tyson (Eds.), *Handbook of research in social studies education* (pp. 307-326). New York: Routledge.

Tally, B. (2007). Digital technology and the end of social studies education. *Theory and Research in Social Education, 35,* 305-321.

The National Academies. (2005). *The concerns-based adoption model (CBAM): A model for change in individuals.* Retrieved on December 4, 2011 from http://www.nationalacademies.org/rise/backg4a.htm

Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68*(2), 202-248. doi:10.2307/1170754

Tubin, D., & Edri, S. (2004). Teachers planning and implementing ICT-based practices. *Planning and Changing, 35*(3&4), 181-191.

Tuthill, G., & Klemm, E. B. (2002). Virtual field trips: Alternatives to actual field trips. *International Journal of Instructional Media, 29*(4), 453-468.

Tyler, R.W. (1970). *Basic principles of curriculum and instruction.* Chicago: University of Chicago Press.

van 't Hooft, M. (2006). Tapping into digital literacy: Handheld computers in the K-12 classroom. In L.T.W. Hin & R. Subramaniam (Eds.), *Handbook of research on literacy in technology at the K-12 level* (pp. 287-307). Hershey, PA: Idea Group Reference.

VanFossen, P.J., & Berson, M.J. (2008). Civic literacy in a digital age. *Contemporary Issues in Technology and Teacher Education* [Online serial], *8*(2), 122-124.

VanTassel-Baska, J., & Stambaugh, T. (2006). *Comprehensive curriculum for gifted learners* (3rd ed). Boston, MA: Pearson Education, Inc.

Warschauer, M. (2006). *Laptops and literacy: Learning in the wireless classroom.* New York, NY: Teachers College Press.

Warschauer, M. (2007). Information literacy in the laptop classroom. *Teachers College Record, 109*(11), 2511-2540.

Warschauer, M. (2011). *Learning in the cloud: How (any why) to transform schools with digital media.* New York, NY: Teachers College Press.

Waters, J.K. (2009). Maine ingredients. *T.H.E. Journal, 36*(8), 34-39.

Watson, S.E., & Watson, W.R. (2011). The role of technology and computer-based instruction in a disadvantaged alternative school's culture of learning. *Computers in the Schools, 28*(1), 39-55.

Weston, M.E., & Bain, A. (2010). The end of techno-critique: The naked truth about 1:1 laptop initiatives and educational change. *The Journal of Technology, Learning, and Asssessment, 9*(6). Retrieved November 12, 2011 from http://www.jtla.org.

Wiggins, G., & McTighe, J. (1998). Understanding by design. Alexandria, VA: Association for Supervision and Curriculum Development.

Windschitl, M., & Sahl, K. (2002). Tracing teachers' use of technology in a laptop computer school: The interplay of teacher beliefs, social dynamics, and institutional culture. *American Educational Research Journal, 39*(1), 165-205.

Wofford, J. (2008). K-16 computationally rich science education: A ten-year review of the Journal of Science Education and Technology. *Journal of Science Education and Technology, 18*(1), 29-36.

Woolsey, K., & Bellamy, R. (1997). Science education and technology: Opportunities to enhance student learning. *The Elementary School Journal, 97*(4), 385-399.

Yelland, N. (2005). The future is now: A review of the literature on the use of computers in early childhood education (1994-2004). *AACE Journal, 13*(3), 201-232.

Yerrick, R., & Johnson, J. (2009). Meeting the needs of middle grade science learners through pedagogical and technological intervention. *Contemporary Issues in Technology and Teacher Education, 9*(3), 280-315.

Yin, R.K. (2009). *Case Study Research: Design and Methods (4th Ed.).* Thousand Oaks, CA: Sage.

Yinger, R.J. (1979). Routines in teacher planning. *Theory into Practice, 18*(3), 163-169.

Yinger, R.J. (1980). A study of teacher planning. *The Elementary School Journal, 80*(3), 107-127.

Zahorik, J.A. (1970). The effect of planning on teaching. *The Elementary School Journal, 71*(3), 143-151.

Zahorik, J.A. (1975). Teachers' planning models. *Educational Leadership, 33,* 134-139.

Zbiek, R.M., Heid, M.K., Blume, G.W., & Dick, T.P. (2007). Research on technology in mathematics education. In F.K. Lester (Ed.), *Handbook of research on mathematics teaching and learning* (2nd ed, pp. 1169-1207). Charlotte, NC: Information Age Publishing.

Zhao, Y., & Frank, K.A. (2003). Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal*, *40*(4), 807-840.

Zucker, T. A., Moody, A. K., & McKenna, M. C. (2009). The effects of electronic books on pre-kindergarten-to-grade 5 students' literacy and language outcomes: A research synthesis. *Journal of Educational Computing Research*, *40*(1), 47-87.

APPENDIX A

INITIAL INTERVIEW PROTOCOL

Introduction: Hello. Thank you for agreeing to talk to me today about the technology you have and use in your classroom. The purpose of my study is to understand the thought process and decisions teachers make to integrate technology into their lessons and how their pedagogical beliefs affect those processes. I am recording today's conversation for accuracy. Your name will be protected. Do you have any questions before we get started?

Semi-structured questions:

- Will you tell me a little bit about you? How long have you been teaching?
    - What grades have you taught? Have they all been at this school?
    - In what areas are you licensed/have a degree?
    - Is there anything else about your background in teaching that you would like to share?
- What was your goal in applying for the Innovation Grant through your school system?
- Will you tell me about the technologies you have in your classroom?
- What do you believe the role of those technologies is in your room? In your planning?
- What do you think about when you are considering integrating technology in your lesson?
- How do you plan for the integration of technology?
- How often in a week do you use technology in your lessons?
- How do you decide when it is appropriate to use technology in your lessons?

- Do you have anything else you would like to tell me about the way you plan for the use of technology?

Closing: Thank you again for taking the time to talk to me about how you plan for the use of technology in your classroom. I look forward to observing you and talking to you again.

APPENDIX B

INTERVIEW PROTCOL

I would like to talk to you about how you planned for technology use in the lessons I observed/am going to observe this week. Just to reminder you, I am recording today's conversation for accuracy, but your name will be protected. Do you have any questions before we get started?

What do you think about when you are considering integrating technology in your lesson?

How did you decide what technologies were appropriate to be integrated in your lesson?

What do you believe the role of those technologies is in your lesson? In your planning?

Do you have anything else you would like to tell me about the way you planned for the use of technology in this lesson?

Additional questions/prompts:
To be used if they are not already answered in the first two questions.

In what way did you consider the different learners in your room as you were planning,

and did technology play a role in how you planned for those learners?

How do you plan for the promotion of 21st learning century skills?

- Critical thinking and problem solving?
- Communication?
- Collaboration?
- Creativity?

How are you considering the Common Core Standards as you are planning for the use of technology in your room?

APPENDIX C

CONTACT SUMMARY

Participant:

Contact Date:

Today's Date:

What main issues or themes struck you in this contact?

Summarize the information you got (or failed to get) on each of the target questions you have for this contact.

Anything else that struck you as salient, interesting, illuminating, or important in this contact?

What new or remaining questions do you have in considering the next contact?

APPENDIX D

THINK-ALOUD INTERVIEW PROTOCOL

Introduction: Thank you for agreeing to plan a lesson aloud for me today so that I can better understand the decisions you make while planning. I understand that planning aloud in one sitting may not be your typical planning method, however, I appreciate your willingness to plan this way today so that I can observe your thought process.

The Warm-Up Activity

Before I ask you to begin planning, I would like to do a warm-up activity with you so you have a chance to experience the think-aloud method of completing a task. I am going to show you a short video clip of a teacher teaching a lesson. While you are viewing the video clip, I would like you to think-aloud, or talk about what you are seeing and thinking. Do you have any questions?

The Planning Think-Aloud Activity

Now I would like you to plan a lesson that integrates technology aloud for me. You may choose any subject area or objectives to be addressed. You may choose any type of technology. While you are planning, I would like you to verbally express all of your thoughts and ideas. I am recording your planning session for accuracy, but your name will be protected. Do you have any questions before we get started?

Possible Prompts

Can you tell me more?

What else will you do?

What objectives are you addressing? Have you thought about the Common Core Standards?

What about (other parts of a typical lesson plan)? (materials, instruction sequence, hook, closure, questions, assessment, etc.)

How have you thought about the different learners in your class? Gifted? ESL? EC?

Anything else you would like to add?

Closing Questions

Now that you have completed a planning think-aloud session, can you share your thoughts with me about what you just planned?

What made you decide to use the technology you chose to integrate?

APPENDIX E

OBSERVATION PROTOCOL

Observation Date:	Time:
Subject Taught:	Teacher and School:
OBSERVATIONS:	RESEARCHER THOUGHTS: