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Opening doors: a collective case study of integrating technology in the preschool through 3rd grade classroom in a developmentally appropriate way

Amy Louise Cox Cameron

Pepperdine University

Graduate School of Education and Psychology

OPENING DOORS: A COLLECTIVE CASE STUDY OF INTEGRATING TECHNOLOGY IN THE PRESCHOOL THROUGH 3RD GRADE CLASSROOM IN A DEVELOPMENTALLY APPROPRIATE WAY

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Judi Fusco Kledzik, Ph.D.- Dissertation Chairperson

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Amy Louise Cox Cameron

under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

Doctoral Committee:

Judith Fusco Kledzik, Ph.D.,

Chairperson Kay Davis, Ed.D.

Carrie Germeroth, Ph.D.

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DEDICATION

I could have never finished this journey without the support of my wonderful husband and four beautiful children. Their understanding, love and support, helped me persevere when times got tough. To my husband Greg, I could not ask for a better husband, partner, and best friend. It has been your encouragement and support, that has continued to keep me on this journey. You continued to believe that I could do this even when I doubted it. To my kids, Jamie, Haley, Holly and Tad, I appreciate your understanding of the times that I needed to work and encouragement to finish. And finally, to my mother and father, who without their belief in me, this would have never been accomplished. I love you all!

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VITA

EDUCATION

Pepperdine University — 2015
Doctorate of Education, Learning Technologies

University of Colorado — 2007
Educational Specialist Degree, Administration Policy and Leadership Studies

Regis University, — 1995
Master of Arts in Education, Learning & Teaching

University of Northern Colorado — 1989
Bachelor of Arts, Elementary Education, Music Minor

PROFESSIONAL EXPERIENCE

Jefferson County Public Schools — 2015--- Present
Assessment Specialist

Colorado Department of Education — 2013---2015
School Readiness Specialist

Douglas County School District — 1990--- 2013
Kindergarten, First, Second, Fourth and Sixth Grade Teacher Assistant Principal
Reading Specialist

PRESENTATIONS

Creating a Responsive P-3 Experience for Colorado's Children — 2014
Using Formative Assessment and Best Practices to Drive Instruction in Today's 21st Center Kindergarten Classroom — 2014

ABSTRACT

Children today are growing up in a technology-saturated world and yet early childhood teachers do not typically include technology in their classrooms, or if they do, they include it inappropriately. The literature states that integrating technology in early education can yield many benefits, but many teachers of young children avoid using technology because they do not know how to incorporate it appropriately. This dissertation is an exploratory observational study of early childhood teachers (preschool through third grade) who integrate technology in their programs in developmentally appropriate ways.

This study involved three classroom teachers who were identified as model teachers at integrating technology in their classrooms: a preschool teacher and two kindergarten teachers. The study was guided by the recommendations from the National Association for the Education of Young Children (NAEYC) and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College (2012) position statement for early childhood teachers in the appropriate use of technology and digital media in the early childhood classroom.

In this exploratory collective case study, visits to the classrooms were conducted several times and observations were performed. Checklists and field notes were used to record the findings. The teachers were interviewed before and after the observations to create a clearer picture of the classroom practices. This resulted in three cases that can serve as examples for teachers on how to integrate technology in the early childhood classroom in a developmentally appropriately way for young children. This study also provides recommendations for teachers who want to provide children with digital learning tools that can extend, enrich, and scaffold their learning. This study contributes four conclusions and five recommendations to guide teachers in integrating technology in a developmentally appropriate way for young children.

Chapter 1: Study Introduction

Few issues around education change as quickly and elicit such a strong response as the role of media technology and screen time (MeTS) in the early childhood classroom (Ernest, Causey, Newton, Sharkins, Summerlin, & Albaiz, 2014). Consequently, throughout history, educators have worried about how the new technologies of the day would affect young children. From movies to radio to television, and now computers and other digital devices, experts warn about the dangers of these new technologies and raise concerns that they will negatively influence cognitive development and academic achievement (Cordes & Miller, 2000; Kirkorian, Wartella, & Anderson, 2008). This dissertation will consider the research on television, computers-use, programming, and robotics with young children in the preschool through third grade classroom and ways to integrate digital media appropriately.

Although most experts recommend limiting technology use for children under the age of 3 (Cooper, 2005; Haughland, 2000), these concerns are unfounded for older children. Research has shown that there appears to be no advantage in avoiding quality, educational television or other technology for ages 3 through 8 (Bittman, Rutherford, Brown, & Unsworth, 2011). Studies have shown (Kirkorian et al., 2008; Pasnik, Penuel, Llorente, Strother, & Schindel, 2007) that early exposure to age-appropriate academic and educational media is associated with cognitive and academic gains; however, exposure to pure entertainment or violent content in media leads to lower cognitive development and academic achievement. Furthermore, there have been compelling studies arguing the advantages of using technology with children from age 3 to the third grade; these studies show that computer use has led to increased motivation, problem-solving, thinking skills, and more (Clements, 1994; Clements, Nastasi, & Swaninathan, 1993; Clements & Sarama 2002; Clements & Swaminathan, 1995; Haughland, 1992, 1999; Plowman

& Stephen, 2005). Additionally, exposure to high-quality educational television has also shown cognitive and academic gains (Kirkorian et al., 2008; Penuel et al., 2012).

In this study, all types of technology including television and computers have been considered. What is different with today's technology is that computers and video games interact with and involve the learner, drawing the learner to them. Because the learner is actively involved in digital media, it has been shown to support the natural way that young children learn by offering pictures and sounds that engage the learner (Couse & Chen, 2010). Papert (1993) noted that children learn when they are in the active role of seeing, listening, and doing. Therefore, the interactivity of computers and digital devices potentially holds great promise for enriching learning environments and active engagement for young children if used appropriately.

In 1993, Clements, Nastasi, and Swaminathan stated that the early childhood world was at a crossroads and needed to decide what path to take in terms of computers and young children. They claimed that early childhood educators needed to determine if they wanted to reinforce existing non-technological practice or to use computers as a catalyst to innovate education. Unfortunately, not much has changed in the last two decades in early childhood classrooms. Today, the question should not be whether young children should use computers, but how can they be incorporated into the early childhood curriculum in an appropriate way (Bers, 2008; Rosen & Jaruszewicz, 2009). Unfortunately, many early childhood providers are fearful of the dangers of technologically dominated childhoods. Consequently, computers and the Internet are largely ignored or not available at all in many early childhood settings (Cuban, Kirkpatrick, & Peck, 2001; Nikolopoulou, 2014; Rideout, 2011). Although, Clements and Sarama (2003) and others provided quite compelling evidence on the benefits of computer use with young children,

and despite all the years that have passed since this 2003 study was conducted, many early childhood teachers still avoid integrating technology into their programs.

In many early childhood programs, quality integration of technology does not happen because teachers lack the guidance and skills needed to use these tools effectively. Because there is little guidance for practitioners to follow on best practices to integrate technology in an early childhood setting (Wolfe & Flewett, 2010) and many early childhood teachers are not tech-savvy teachers and do not know how to integrate technology.

Children, however, demand that technology be an integral part of their learning environment (Judge, Puckett, & Bell 2006; Weintraub Moore & Wilcox, 2006). The young children of today are growing up in a digital world. They are bombarded, daily, by smartphones, tablets, computers, and more. These devices are a natural part of their world. The good news is that digital technology can be a playful bridge to integrate academics into the early childhood class through authentic and meaningful projects. Projects that integrate technology have shown to increase retention, improve problem-solving, and collaboration, and improve motivation and attitude toward learning (Vega, 2012).

Early childhood years, the years from preschool to third grade (P-3), are the most promising window of opportunity in which to influence children's lifelong trajectory in learning (Kauerz, 2013). The experiences that children have at this stage in life form the foundation for future learning. Kauerz (2013) stated that the P-3 continuum, the continuum from preschool to third grade, is one of the few reforms today that has been shown to close the achievement gap and brain science tells us that the earlier we work on closing the achievement gap, the easier and less expensive it is. Piaget, Vygotsky, other learning theorists, developmental scientists, and brain researchers have recognized the importance of the years from 3 to 8 (Kauerz, 2013). These

years are a time of life when strong foundational cognitive skills, social and emotional skills, and patterns of engagement in school and learning are being developed (Kauerz, 2010). The P-3 years are an opportune time to hook children into becoming life-long learners. One way to do this is to build on young children's intrinsic fascination with digital technology. Quality instruction includes using digital and media tools that encompass students' lives today. Those who educate young children have the opportunity to capitalize on the benefits these digital tools can provide.

For example, Papert (1993) took the constructivist approach and adapted it for the digital age using digital tools to allow students to actively build understanding. In the constructivist classroom, children are active builders of their own learning and build their learning on prior knowledge (Ackermann, 2010). Learners in this type of classroom use cognitive tools to interpret and organize their world. Papert took constructivism and expanded our understanding that learning occurs when the learner is actively constructing learning artifacts and socially interacting with the teacher and peers (Kafai, 2006). Constructionism proposes that technologies are powerful cognitive tools when used for designing, constructing, and programming (Bers, 2008; Papert, 1980). One way that children experience designing, constructing, and programming is through projects. Projects that include technology often support students in their learning and scaffold them to the next level (Bers, 2008). Projects that include digital tools invite learners to new and powerful ideas.

The National Association for the Education of Young Children (NAEYC, 2009) and the Fred Rogers Center for the Early Learning and Children's Media (2012) stated that digital learning is now a part of early childhood and to be effective, media and technology use in the classroom must be active, engaging, and guided by pedagogy. When working with young

children, one way to achieve this is implementing Developmentally Appropriate Practice (DAP; Copple & Bredekamp, 2009; NAEYC, 2009). DAP is based on the historical studies of Vygotsky, Dewey, Piaget, and Erikson. Being developmentally appropriate is at the core of an effective early childhood teacher.

One DAP method is hands-on exploration and play (NAEYC, 2009). In many schools around the nation and the world, hands-on exploration and play are being squeezed out of the curriculum and replaced with less effective methods (Miller & Almon, 2009; Rorem & Bassok, 2014). This is due to an increased obligation for young children to perform well on standardized tests. When technology is included, to improve test scores, DAP is also often not present. Many educators see digital media and technology as ways to hurry our young students into learning more and faster. DAP activities (especially the activity of play) are disappearing from our primary grades. With our increasing focus on the academics of our young children, many vital domains of a child's development are neglected (Miller & Almon, 2009).

One way to integrate technology developmentally appropriately with young children is to use technology in a playful way. Children talk about playing on the computer, and if they see it like playing and not a task, they will learn a great deal more. Resnik stated (2006) that when children are designing, creating, and inventing, this is a type of play. Children are playing out their ideas. In designing, like in play, children test out their ideas and revise as necessary. As Parette, Quesenberry, and Blum (2009) asserted, by not offering young children technology in developmentally appropriate ways, educators are *missing the boat.* If technologies are used in playful learning, to foster creative thinking and creative expression, children will become engaged and develop deeper understandings (Resnik, 2006).

Recent Statistics

Children begin using computers long before they enter formal schooling, yet it does not carry over into their usage in school: 53% of 2 to 4-year-olds; 90% of 5 to 8-year-olds use or have used a computer (Rideout, 2011). However, compare the previous statistics to a report from teachers on their usage in the classroom: (kindergarten – third grade) daily – 38% teachers; sometimes – 23%; never – 35% (Wartella, Lauricella, Robb, & Flynn, 2010).

Additional research on teachers, from the 2012 Survey of Early Childhood (Wartella, Blackwell, Lauricella, & Robb, 2013) found that many teachers' usage was low, even though they had access to technology: Teacher's frequency of use of digital cameras or computers was once a week by 50% who owned technology. Yet on a daily basis, 95% of the teachers used digital books (95%) and 80% of the teachers used digital music (86%). The report also found that most teachers' reported a high degree of confidence in using the technology, yet only 57% reported obtaining the required professional development and 39% felt they received the needed technical support. The research showed, that although teachers may have access to technology with some also having access to professional development, this does not result to the children's technology use or use in a developmentally appropriate way. Whereas, many studies have shown that children have grown in cognitive, social-emotional, reading, math, and school readiness skills (Brooker, 2003; Chantel, 2003; Clements et al., 1993; Haugland 2000; Haughland & Wright, 1997; Judge et al., 2006; Kankaanaranta & Kangassolo, 2003; Li, Atkins, & Stanton, 2006; Mouza, 2005; NAEYC & Fred Rogers Center, 2012; Sheridan & Samuelsson, 2003). The conclusion of the research is the teachers of young children need more support, guidance, and professional development to use technology in appropriate ways that yields positive results for children (Yelland, 2005).

Statement of Problem

The national trend in education is to have children learn more at earlier ages and ignore the developmental needs of the child (Miller & Almon, 2009; Rorem & Bassok, 2014). Schools are stressed by the many mandates for testing children, and all the pressures placed on them if children do not perform well. This increased obligation to perform well on the standardized tests has caused many teachers and schools to neglect developmentally appropriate practice. Consequently, this has encouraged many educators who do use technology to ignore the developmental areas and use computers with children in inappropriate ways like only in skill and drill practice (Haugland, 1999; Nikolopoulou, 2014; Parette, Quesenberry, & Blum, 2009) and by taking time away from other important developmental areas like physical play, outdoor play, art, music, and dance. Technology should not be used for activities that are not developmentally appropriate, contribute to learning, or are not effective. Unfortunately, many teachers are not aware of how to use technology effectively in DAP ways and use it inappropriately with children. Teachers need guidance on how to incorporate technology into their curriculum in a way that promotes play, creativity, exploration, and critical thinking skills (Kankaanranta & Kangassalo, 2003; Plowman, Stephen, & McPake, 2010; Rasinen et al., 2009; Weintraub Moore & Wilcox, 2006).

If teachers do not incorporate technology in DAP ways, there could be adverse consequences. In our primary grades, some of the efforts to include technology may have serious negative implications for the development of our children. Some current research claims that shifting of play for more academics and lack of developmentally appropriate learning practices could have dire consequences, not only for our children, but also for our nation.

Rushing our children to learn and neglecting to look at the whole child could prevent many children to develop to their full potential (Miller & Almon, 2009; Rorem & Bassok, 2014).

Purpose of the Study

Limited empirical research has been focused on this age group; however of the research done, much of the research has shown that integrating technology with young children yields many positive benefits (Alper, 2013; Bers, 2008; Clements, 1994; Clements et al., 1993; Clements & Sarama 2002; Clements & Swaminathan, 1995; Haughland, 1992, 1999; Kazakoff, Sullivan, & Bers, 2013; Korat, 2010; Pasnik et al., 2007; Penuel et al., 2012; Plowman & Stephen, 2005; Wartella et al., 2010). In addition, because of the change in education policy and higher academic expectations to be shown on tests, pedagogical practices using technology in the early grades are less appropriate for the young child (Haugland, 1999; Nikolopoulou, 2014; Parette et al., 2009). The purpose of this study was to observe teachers in their classrooms using technology and to document age-appropriate activities that are being done in a developmentally appropriate way. As a result of these observations, examples of technology that can be used to inform and inspire primary teachers on how to integrate technology in a developmentally appropriate way are presented.

Research Questions

Technology can benefit students in many ways if teachers scaffold technology in an appropriate way for young children. The formal research question that guided this study is, How are digital media and technology integrated in a developmentally appropriate way in the P-3 classroom? Sub-questions that were addressed in this study are

- What are the specific activities?
- What are teachers views on DAP and technology?

An important part of this study was to make sure that technology in the classrooms observed were integrated into the program to meet not only the academic needs of the child but also the developmental domains. According to NAEYC's (2009), overview of DAP, in a DAP classroom, the teacher's goal is to meet young children where they are and to help them meet achievable and challenging goals. Technology and quality digital media that is integrated into the classroom can help to meet these goals.

Overview of Methodology

The researcher conducted exploratory case studies of three classrooms across Colorado. Qualitative case study understanding requires experiencing the situation as it occurs in context (Stake, 2013). This required multiple visits to the classrooms to understand and interpret the situation. Yin (2013) suggested that case study be done in situations when (a) the researcher is asking a "how" or why question, (b) the researcher doesn't have control over the events, and (c) the focus of the study is a present day issue. Visits to a preschool and two kindergarten classrooms were conducted several times, and observations were performed on how these teachers answered the earlier questions in their classroom. Checklists and field notes were used to record the findings. The teachers were interviewed before and after the observations to create a clearer picture of the classroom practices.

Limitations and Assumptions

There are endless activities and projects that can be done with young students in a developmentally appropriate way. Classrooms that were studied were limited to classes in Colorado that represent the integration of technology in preschool and kindergarten. The researcher examined two grade levels with different curriculums, without limiting the subject matter or type of technology or digital media that she considered. The resulting

recommendations were limited by the classrooms and work observed. The dissertation does not provide recommendations across all subject areas or technologies. The researcher chose not to limit the subject matter or the technology and digital media that were observed to leave the possibilities open.

Because the researcher worked for the Colorado Department of Education, she traveled throughout Colorado, visited many primary classrooms, and interacted with many teachers. In many kindergarten classrooms, observed, developmentally appropriate practice is not valued. In the state of Colorado, many kindergarten teachers are trained as elementary teachers and therefore do not have the early developmental training needed for early childhood. Many teachers think that if they are not directly instructing students all day long, learning is not taking place. DAP encourages teachers to base their practice on three core assumptions: (a) teachers use practices that reflect child development research, (b) teachers use practices that account for each individual child and focused on the whole child, and (c) teachers use practices that take into account the socio-cultural context of each individual child's development (NAEYC, 2009). Technology integration also seems to be an area where teachers need more professional development. Technology integration in primary classrooms is also not regularly happening across the state. Because of this, in chapter 4, examples from this study of appropriate technology integration is offered to the field.

Significance of the Study

The study is significant in that it will add to the literature concerning developmentally appropriate technology use for early childhood grades P-3. Early childhood education has become an issue nationwide. President Obama (Department of Education's website, n.d.) stated, "I propose working with states to make high-quality preschool available to every child in

America… Let us do what works and make sure none of our children start the race of life already behind. Let's give our kids that chance" (Para. 1). With the focus of both technology and early childhood, this study will help teachers of young children develop activities and projects that could help involve children in active learning and encourages them to use higher-level thinking skills.

Because children are growing up in a digital world today, digital technology is a natural part of their world. They are bombarded every day by smartphones, tablets, computers, and more. Digital technology can be a playful bridge to integrate academics into the early childhood class through authentic and meaningful projects. Research shows that integrating technology with young children yields many positive benefits (Alper, 2013; Bers, 2008; Clements, 1994; Clements et al., 1993; Clements & Sarama 2002; Clements & Swaminathan, 1995; Haughland, 1992, 1999; Kazakoff et al., 2013; Korat, 2010; Pasnik et al., 2007; Penuel et al., 2012; Plowman & Stephen, 2005; Wartella et al., 2013). Teachers need guidance on how to incorporate technology into their curriculum in a way that promotes play, creativity, exploration, and critical thinking skills (Kankaanranta & Kangassalo, 2003; Plowman et al., 2010; Rasinen et al., 2009; Weintraub Moore & Wilcox, 2006). This study presents insights and models that can serve as guidance for early childhood teachers on how to use technology appropriately with the young children they teach.

Definition of Terms

The following terms are important for this study and are defined to help the reader understand how the terms are used in the content of this study.

Developmentally appropriate practice (DAP). Phillips and Scrinzi (2014) defined developmentally appropriate practice as teaching young children in ways that

- Meet children where they are, as individuals and as a group
- Help each child reach challenging and achievable goals that contribute to his or her ongoing development and learning.
- Teachers do this through intentional teaching and purposeful play.
    - The curriculum and experiences need to actively engage children. These experiences should be rich and include teacher-supported play with an integrated curriculum.
    - The teachers need to be intentional in their decisions on how to organize their day.
    - Teachers should provide a time when children have choice and the learning experiences and teaching strategies to help individual children make optimal progress.

P-3 continuum. In the context of this study, this means age 3 to third grade.

Organization of the Dissertation

The following chapters with the study addressed the research questions. Chapter 1 provides an overview and reason for the dissertation. Chapter 2 examines the history of technology with children, the theories of educational technology and frameworks used in practice that will guide the study and frame the analysis, including an extended discussion of the DAP, *The Framework for Quality in Digital Media for Young Children* (Fred Rogers Center for Early Learning and Children's Media, 2012), and NAEYC and Fred Rogers Center's (2012) joint position statement on *Technology and Interactive Media as Tools in Early Childhood Programs Serving Children from Birth through Age 8.* Chapter 3 will describe the methodology for the study and discuss the process of observation and evaluation of quality technology use.

Chapter 4 will explain the observations and the results of the content analysis of the observations as framed by the theory. Finally, chapter 5 concludes the findings and recommends quality activities and projects that are designed to engage young children and promote optimal development and learning.

Summary

Unfortunately, computer and digital media use with young children is done too often in ways that are not developmentally appropriate or in ways that do not enhance the curriculum or program. Digital tools used appropriately have the ability to inspire children to explore, discover, to play, and make natural connections to their world (Rushton, Juola-Rushton, & Larkin, 2009). Teachers using technology with young children should involve them in activities that are developmentally appropriate, engaging, not pressure-ridden, and make school fun. If children do not like school when they are young, chances are they will not like it when they are older (Gullo & Hughes, 2011). Education today needs teachers to extend DAP to technology and these digital tools need to build on a child's natural curiosity and desire to construct knowledge across the developmental domains. NAEYC and The Fred Rogers Center for Early Learning and Children's Media (2012) stated that digital learning is now a part of early childhood and to be effective, media and technology use in the classroom must be active, engaging, and guided by pedagogy.

This study observed exemplary teachers who embed meaningful and developmentally appropriate activities and projects infused with technology into their classroom practice. It concludes with ideas, activities, and projects that integrate technology in a developmentally appropriate way that engages young learners to reach their full potential and meet the needs of the whole child.

Chapter 2: Literature Review

Overview

This study is an exploration of technology integration in preschool through third grade (P-3) classrooms. In the study, the researcher observed exemplary teachers in primary classrooms who integrate technology both in a developmentally appropriate way and in a way that meets the guiding principles laid out in the *Framework for Quality Digital Media for Young Children* (Fred Rogers Center, 2012) and the joint position statement of NAEYC and the Fred Rogers Center for Early Learning (2012). It concludes with examples of what works in practice and these examples can serve as a model for teachers integrating technology into the P-3 classroom.

Several themes emerged in the literature that warrant attention. The first topic is using New Media Literacy (NML) with young children (Apler, 2013). New media skills include research skills, technical skills, and critical analysis skills and build on traditional literacy skills (Apler, 2013). Then, the topic of developing science, technology, engineering, and mathematics (STEM) skills with young learners has recently come into focus. STEM initiatives have largely been at the middle and high school level, but more research is being conducted focusing on the benefits of integrating STEM into the curriculum with young children (Highfield, 2015). Next, technology can be, and in many cases should be, used to assist in teaching reading, writing, and mathematics skills. In addition, computer programming and robotics can be used in the early childhood program.

This chapter gives a brief description of the literature involving young children and technology. It begins by discussing the P-3 continuum and how this is a tremendous time of growth and development in the life of a child. It also gives a historical and recent perspective of

technology integration in the early childhood classroom. Next, learning sciences articles that support the use of technology in P-3 classrooms will be considered. Learning sciences is an interdisciplinary science that brings together the research of psychology, education, computer science, and anthropology in new ways of thinking about learning (Sawyer, 2006). Then the chapter discusses the many benefits for children using technology in an appropriate way based on the position statement of DAP by NAEYC and the Fred Rogers Center and The Framework for Quality in Digital Media for Young Children (2012). It will conclude with how technology and the theoretical frameworks work together to provide indicators for quality integration of technology in a developmentally appropriate way for young children.

In 1993, Papert stated that literacy meant not only that children learn to read and write, but that it also meant that they think differently and include technology and media to become fully literate. Twenty years later, this statement is even more relevant today. Pink (2006) claimed that the future would be placed in the hands of the creators and empathizers, pattern recognizers, and meaning makers. Media literacy helps children develop the skills to become the thinkers, the creators, and the makers they will need to become to be successful in a multimedia society (Rogow, 2015). Because children are immersed in multiple technologies from electronic books, video games, software, Internet content, music, videos, computers, tablets, and much more, it has become increasingly important that young children understand how technology tools can be used to learn and to help improve their literacy. Yet as Plowman and Stephen (2005) warned, using programs for young children is not merely scaling down versions of adult hardware and software. Children are not scaled-down adults. Educators are challenged by understanding technology and staying current with it as it changes rapidly and knowing how to

use technology appropriately with young children to enhance learning, problem solving, and communicating to help them become fully literate (Clements & Sarama, 2002).

P-3 Continuum

Why concentrate on children ages preschool through third grade? The P-3 reform is gaining momentum and is one of the few reforms that have shown to close the achievement gap (Bogard, 2003; Connelly, 2013; Kaurz, 2013). P-3 is a critical age when children's educational pathways are determined (Kauerz, 2013). Early in life is also the ideal time to prevent or close the achievement gap. If children are given a stronger start in their academic careers, their success in later grades will be greater (Kauerz, 2013). This is also a time in life when strong foundational cognitive skills, social and emotional skills, and patterns of engagement in school and learning are being developed (Kauerz, 2010). These early years are an opportune time to hook children into becoming life-long learners. Building on their intrinsic fascination with technology can help. Giving children a good start in early grades sets the tone for later educational and lifelong success.

Many principals have not had early childhood training and are not familiar with the development of young children. The National Association of Elementary School Principals (NAESP, 2014) recently released a book for principals with guidelines on the P-3 continuum. In this book, there are six competencies laid out for principals and leaders for effective P-third grade-level communities. The first, second, and third competencies relate to the focus of this study. The first competency is to embrace the P-3 early learning continuum from age 3 to third grade. There are three specific types of skills and knowledge that children are learning at this age that are foundational cognitive skills in literacy and numeracy, social and emotional competence, and engagement in school and learning (Kauerz, 2013). The second competency is

to ensure *developmentally appropriate teaching*. This includes quality teaching and developmentally appropriate curriculum and assessments to ensure the growth and learning for all children. It also aligns ambitious standards, curriculum, and assessments with a consistent framework for learning for ages 3 to third grade. The third competency is to provide personal, blended learning environments that promote blended face-to-face technology and enhanced learning from digital tools. These environments should support rigorous, developmentally appropriate, individual learning.

The NAESP guide for principals is a tool for leaders to use to improve practice with children age 3 to grade 3. It is backed by relevant and recent research findings and outlines the characteristics that constitute a quality P-3 grade program. It also connects principals with additional tools and resources to improve practice. It was developed because an NAESP (2014) survey indicated that though more than 60% of elementary schools include preschool, little has been developed in P-3 leadership. The guide not only fills the void in the literature, but also allows principals a place to draw upon research to understand developmentally appropriate practice and enhance leadership at the P-3 level (NAESP, 2014).

This study will also help fill the void of P-3 literature. It will serve as guidance for both leaders and teachers of P-3 children integrating technology across the curriculum. It will enhance teachers' skills in teaching with digital tools to engage and hook students into school and lifelong learning. This study will help teachers by providing models for early childhood teachers on integrating technology into the classroom.

History of Technology in Education

Fewer than four decades ago, computers were only found in the fields of research, government, business, and military. They were big and complicated. Computers filled a room

and required advanced math skills to program. Despite this, in the 1960s, Seymour Papert had the vision to develop a programming language for children (Ito, 2009). At the time, people did not believe that this could ever happen. However, in 1967, the first version of Logo, a child-friendly programming language was developed. In the late 1970s, Logo spread as the first programming language for children (Bers, 2008). The first interactive video games came onto the scene in 1961. *Spacewar* was created by MIT student Steve Russell (Kent, 2010). In the early years, most video games were played in arcades because personal computers were not yet viable in homes. In 1971, the arcade game *Pong* was created, and a year later Atari began. Atari re-released *Pong* as a home video game in 1975 (Bellis, 2015). In 1977, the Apple II computer was released as a personal computer for hobbyist and educators (Ito, 2009). The Apple II started the personal computer revolution. Child-friendly computers were soon found in homes and schools that could afford them. These early personal computers were vehicles to spread the Logo programming language throughout a mass market. Soon after, personal computers were found in affluent homes all over the world and children were introduced to a new way of learning. In the 1980s, home computers were often thought of as game computers. In the late 1980s, Nintendo launched a computer only for video games as the video game industry gained in popularity.

In the late 1980s and early 1990s, educational software began to appear on the market. The earliest group of software and computer games for children was based on predominately the drill and practice pedagogy. However, Piaget's concept of the constructivist learning approach centered on learners doing; creating was growing in popularity. The 1980s and 1990s a new educational software movement, NML, involving the constructivist theory was spreading and offering a new approach for education. NML, combined gaming, entertainment, and education

and this new media genre has been called children's software and learning games. Some referred to this as edutainment because it combined education and entertainment. These games were designed to be both fun and educational. Edutainment programs for children, as such *Number Munchers*, *Oregon Trail, Reader Rabbit, KidPix,* and *Where in the World Is Carmen Sandiego,* were among the first educational and learning software that promised to make learning fun (Ito, 2009). Also, in the 1980s and 1990s researchers studied the impact that these new technologies had on the lives of young children (Clements & Gullo, 1984; Clements et al., 1993; Clements & Sarama, 1998; Haugland & Shade, 1988; Haughland & Wright, 1997).

Early Studies on Technology with Young Children

Over one 100 years ago, John Dewey (1922) touted the benefits of more active and self-directed learning. His philosophy on how children develop centered on the idea that children should be treated with respect and encouragement rather than punishment. According to Papert (1993), the computer was a way to offer the possibility to change education and individualize it for children in a manner that Dewey imagined. Papert envisioned that the computer would change education in an exciting way and consequently labeled the computer as the children's machine. However, as Dewey, Papert, and many others discovered, bringing change to the educational environment was and is a difficult task, especially with young children.

Part of the difficulty was caused by concern centered on the consequences of integrating technology. Some assumed that new media use with young children will result in adverse effects on language development, as was found with television (Bittman et al., 2011). But, as Papert (1993) noted, other media put children in the passive role and because children can interact with computers, video games, and other new media and children are engaged, this does not seem to be the case. Children can be active users of digital technology including, but not limited to,

hardware of various kinds, educational software, electronic communications, the Internet, and multimedia authoring tools. Children are drawn to computers because of this interactivity (Wartella & Jennings, 2000). Some early studies suggest that computer use is not recommended for children under the age of 3 (Cooper, 2005; Haugland, 2000). But research has also shown that teaching young children with computers as young as 3, and certainly by the age of 5, can be valuable (Haughland, 1995; Milne, 2012). Milne's (2012), study concluded that teaching technology to 5-year olds is a valuable addition to their schoolwork. When using technology with 5-year olds, the teaching focus should be clear and tasks should be authentic, but limited to a small number of choices that are relevant to the child. Haughland (1995) found that engagement in learning with kindergarten students increased when using technology.

Douglas Clements conducted some early studies that showed how computers were valuable for young children. He was a pioneer in studying Logo use with young children in the 1980s and 1990s. He found that Logo combined with appropriate learning activities and scaffolding, yielded significant advantages on children's academic and cognitive abilities. In a study that took place in 1986 with preschool children working with Logo, Clements et al. (1993) reported that children became more self-directed, collaborative, and showed improved language skills. In another study, kindergarten through sixth grade children showed improvement in math skills and problem-solving strategies. Children also developed a metacognitive approach toward problem-solving and learning (Clements, Battista, & Sarama, 2001). Programming and technology also have been shown to have positive effects on young children with disabilities. Digital technology can enhance mobility for children with disabilities, help create a sense of control, and add to their self-esteem (Clements & Swaminatha, 1995).

Other early studies on computer use with young children showed developmental gains. Children were also reported to show higher self-concept and demonstrated increasing levels of spoken communication, cooperation, and a positive attitude toward learning (Haugland & Wright, 1997; Clements, Nastasi & Swaminathan, 1993). Computer use was shown to contribute to children's cognitive and logical thinking abilities. Haugland & Wright's (1997) study concluded that the motivation of kindergarten and primary children toward handwriting increased with the use of computers. An earlier study by Haugland (1992) found that preschoolers who use computers to support curricular objectives have significantly greater gains compared to peers who did not have the computer experiences. Gains in intelligence, language skills, conceptual abilities, nonverbal skills, structural knowledge, long-term memory, manual dexterity, verbal skills, problem solving, abstractions, and conceptual skills for those who used computers versus those who did not use computers have also been observed. Even though these early studies presented the myriad benefits that children can glean from technology that is integrated into the early childhood program, technology is still questioned and not included in the early childhood curriculum in many settings.

Additional studies showed that children tend to want to work with friends when using technology; this creates peer tutoring opportunities, socialization, and collaboration (Clements, 1999). Vygotsky (1978) stated that children learn to communicate to become a part of their culture and computers can be a valuable vehicle for children to communicate with peers and adults. Studies by Clements and Sarama (2002) also reported that computers could serve as a social catalyst with young children if used appropriately. They also found that children spend nine times more time in conversation with peers while working with computers than they do with puzzles. Additionally, this study reported that computers can have unparalleled opportunities for

learning through exploration, creativity, problem-solving, self-guided instruction, and collaboration, including helping, teaching, and sharing ideas (Clements & Sarama, 2002). Even when children have their own computers they tend to work in groups when working with technology (Druin et al., 1998). Children learn many foundational social interaction skills such as negotiating turns, managing operations, and sharing the enjoyment of the screen. They also tend to ask more questions and seek more advice from their peers (Plowman & Stephen, 2005; Wartella & Jennings, 2000). Computer use with young children has also been used as a tool to facilitate social interaction, cooperation, and friendship formation (Wartella & Jennings, 2000).

Finally, the location of computers in a school matters for how they are integrated into the classroom. In research as early as the year 2000, Becker showed that students were twice as likely to use computers if they were located in the classroom and not a lab. Yet, in many elementary schools today, most of the computers are still housed in a lab. The idea of a computer lab implies that computers should be separate from the regular program and not an integral part of the curriculum or program. If computers are placed in the classroom and children are given the opportunity to use technology in any way, they wished Druin et al. (1998) discovered they often chose open-ended, exploratory activities. Papert (1996) observed that there is a passionate love affair between children and computers. Children get a gleam in their eyes and a desire to *play* with computers. When computers are easily available in the classroom, the children have more opportunities to explore and feel empowered. Early childhood teachers need to take advantage of this enthusiasm and build on the possibilities to provide rich context as an integral part of the program.

The Current Landscape

The world our young children are growing up in has changed drastically over the recent decades or years even, and the pace of change continues to be extremely rapid. It is important that children are given sufficient opportunities and experiences with current technology to keep up with the changes. The shift to new media and digital literacy continues to shape the world in which children live (NAEYC & Fred Rogers Center, 2012). Young children are growing up with digital technology as an essential and natural part of their world (Kankaanranta & Kangassalo, 2003). They are exposed to television and movies, play computer, video, and learning system games, and interact with virtual pets and virtual worlds (Livingstone & Bovill, 2001; Vandewater et al., 2007). Skyping with grandparents and other loved ones is common practice for young children today. They also Google areas about which things they want to learn more. This is the technical world in which children live today; educators should equip children with the tools and knowledge to be successful.

There is a substantial body of literature on technology transforming middle school, high school, and college, but little is known about younger children's conceptions of technology and how it is used in a developmentally appropriate way (DAP will be discussed below) in an early childhood environment (Mawson, 2008). Early childhood technology has not received the attention that it has with older children (Kankaanranta & Kangassalo, 2003), but there is a growing body of more recent research that supports using technology with young children.

Early studies showed promise (previous section) and researchers have continued to build their understanding. For example, computers and associated technologies have been shown to help young learners to develop fine motor skills, alphabet recognition, pre-mathematical skills,

and school readiness skills (Brooker, 2003; Chantel, 2003; Judge et al., 2006; Kahkaanaranta & Kangassolo, 2003; Li et al., 2006; Sheridan & Samuelsson, 2003).

Research has also show, that when used wisely and appropriately, technology and new media can engage, motivate, and increase persistence in children and serve as a catalyst for social interaction (Clements et al., 1993; Haughland & Wright, 1997; Mouza, 2005; NAEYC & Fred Rogers Center, 2012). Technology tools should be used with young children in ways that enhance opportunities for children's cognitive, social, emotional, physical, and linguistic development and positively influence their level of self-confidence. Haugland (2000) suggested that integration should occur in the program or curriculum and not used as an add-on to the regular schoolwork, but serve as a catalyst to transform learning (Yelland, 2005). Technology integration in early childhood and recognizing it as developmentally appropriate remains problematic. Early childhood teachers have the opportunity to embrace technology, or they may be *missing the boat* with young children (Parette et al., 2009).

According to Rushton et al. (2009), the two great responsibilities of teachers of young children are to develop a learning environment that is engaging and purposeful and to conduct themselves in a professional manner that allows children to feel emotionally involved to allow children to release certain neurotransmitters that support learning. Creating a stimulating environment and actively engaging the mind help strengthen a child's neurological network of the child's rapidly developing brain. Early childhood is the time when rapid brain development is taking place and encourages children to make connections with their world. This enriched environment will help the child connect emotionally, cognitively, and physically. When students have multiple ways to experience their learning, it makes it easier for them to understand how it occurs and what they need to know in the world (Rushton et al., 2009). Providing computers and

technology stimulate children's curiosity and allow them to engage in numerous learning opportunities. One way to get children emotionally involved is to include centers consisting of computers, a writing workshop lab, science area, and dramatic play materials that excite the imagination and creativity of the young learner. New technologies make it even easier to interest the child and get him/her emotionally invested and engaged in learning.

Learning Sciences Foundations

In the early 1900s, John Dewey spread the ideas of hands-on learning and experiential learning. Computers were not around when he was alive, but he probably would have been a great supporter of virtual environments (Bers, 2010). Later, Piaget (1950) created the constructivist epistemology that proposed that children constructed meaning and learning out of their experiences. Again, children learn by doing. Papert (1980) expanded on Piaget's concept of constructivism with constructionism. Constructionism shares constructivism's approach to learning as building knowledge, but adds the idea that this happens while the learner is constructing something in a social context (Kafai, 2006). In constructionism, children create their own objects with technology and learn from the objects by discussing the objects with others (Bers, 2008). Papert (1980) had children programming long before anyone thought young children were capable of this skill. In constructionism, computers can be powerful educational learning tool and children learn by creating, doing, programming, and discussing (Bers, 2008). Constructionism offers a framework for creating learning environments rich in technology and design-based learning. Resnik, Bruckman, and Martin (1996) asserted that some design activities are richer than other activities. They claim that the activity should create two types of connections: personal and epistemological. The activities should be personally motivating for the student and encourage a new way of thinking. Linking the activities to the child's interests

and experiences will make the activities personally motivating and connected. Construction kits that are linked to important domains of knowledge will encourage a new way of thinking and epistemological changes.

An ideal way to integrate technology concepts using constructionism is through project-based learning (PBL). The roots of PBL also can be traced to John Dewey. In the early 1900s, he discussed the importance of learning by doing inquiry (Krajcik & Bumenfield, 2006). Learning science (Sawyer, 2006) has shown that concepts are learned better and more deeply when they are situated in authentic, real-world experiences; projects do for young children. Projects allow children to use technology as cognitive tools to understand the world around them and build objects to show what they know. PBL affords young children the opportunity to understand the concepts more deeply. Students taught through PBL have experienced increases long-term retention of content when compared to traditional instruction. In high-stakes tests, PBL helps students perform as well as or better than traditional learners do. PBL also improves problem-solving and collaboration skills, and engages students in learning (Vega, 2012). In project-based learning, students engage in real and meaningful projects and actively construct their understanding by working through the projects (Krajcik & Blumenfield, 2006). Projects allow students to investigate, question, propose hypotheses, discuss their ideas, and try out new ideas.

PBL is one approach a P-3 educator could use in class. Whatever is used in practice should be guided by a good theory regarding how people learn. Vygotsky's (1978) work on development and learning is part of the foundation of Developmentally Appropriate Practice (DAP) and early childhood education. For example, Vygotsky's work on how children learn through play is the hallmark of DAP. NAEYC position statement (2009), stated that play is an

important vehicle for developing self-regulation as well as for promoting language, cognition, and social competence. Vygotsky (1978) stated, "The influence of play on a child's development is enormous" (p. 96). Play, according to Vygotsky, is needed by a child to advance from one developmental stage to another. It is not just a pleasurable activity, but also a need for a child. Children use play to make sense of their world and to find their own place in it. Young children work hard while they play and learn in so many ways. Research shows that children who are involved in play have better language skills, social skills, empathy, more creativity, higher levels of thinking, and greater self-control (Miller & Almon, 2009). Very related to this work, Resnik (2006) suggested that the best learning occurs when children learn through designing, creating, and inventing. In the process of designing and creating, children are learning through play. They play out their ideas with each new creation. Integrating technology with children's play is one way to integrate technology in a developmentally appropriate way.

Developmentally Appropriate Practice

"You can't make children grow faster by pushing them, just as you can't make flowers grow faster by pulling them" (Otto Weininger as cited Rushton et al., 2009 p.360). Developmentally appropriate practice urges educators to meet children where they are, and then lead, guide, and challenge them to grow academically and developmentally. This means that the teacher needs to go at the child's rate and not expect the child to meet a standard that may be set by the teacher, district, state, or nation (Rushton et al., 2009). The goal of DAP is to provide children with optimal experiences to help their development. DAP encourages teachers to base their practice on three core assumptions: (a) teachers use practices that reflect child development research, (b) teachers use practices that account for each individual child and focuses on the whole child, and (c) teachers use methods that take into account the socio-cultural context of

each individual child's development (NAEYC, 2009). According to Copple and Bredekamp (2009), there are practices that are agreed on that are appropriate for children ages 3-8. First, the curriculum and experiences need to actively engage children. These experiences should be rich and include teacher-supported play with an integrated curriculum. Next, the teachers need to be intentional in their decisions on how to organize their day. Teachers should provide time when children have choice and the learning experiences and teaching strategies to help individual children make optimal progress.

Copple and Bredekamp (2009) also listed several practices that are not developmentally appropriate. Programs should not be highly linear in instruction and not have an inflexible timeline. They should not rely heavily on whole group instruction or fragmented lessons that are not meaningful to children. Similarly, teachers should not have a rigid adherence to packaged one size fits all curriculum or follow predetermined scripts without regard to children's responses. Finally, early childhood curriculum should not have a narrow focus or highly prescriptive requirements with rigid timelines for achieving them.

DAP focuses on the domains of development and learning, which are: academics, physical, social/emotional, and cognitive. It not only recognizes that many aspects of children's learning and development follow sequences, with later abilities, skills, and knowledge building on those already acquired, but also that development and learning proceed at varying rates from child to child, as well as at uneven rates. As children grow, they develop greater complexity in self-regulation and symbolic or representational capacities. Children develop best when they have a safe and secure environment consisting of relationships with attentive adults and opportunities for positive relationships with peers. Because development and learning are social processes and influenced by culture, talk, and interaction should be encouraged. Children are

constantly seeking meaning from their environment, so play is valued and used as a vehicle for developing self-regulation as well as for promoting language, cognition, and social skills. Because development and learning occur when children are challenged to achieve at a level just beyond their current mastery and also when they have many opportunities to practice newly acquired skills, opportunities will be planned for children to reach goals and practice new skills. Interacting with adults and peers will help in this process. Finally, approaches to learning, such as persistence, initiation, and flexibility are encouraged (NAEYC, 2009).

The position statement on DAP by the National Association for the Education for Young Children (2009) stated that the teacher's knowledge and decision-making are vital for effectiveness with young children. In the current testing and accountability age that education is in, states and other stakeholders have laid out expectations for children at various grade levels. Teachers know their children and should be in a position to make decisions for children using resources and tools to help guide them. This is the heart of effective teaching. Effective DAP teaching strategies, according to NAEYC (2009), are (a) acknowledging what children say or do, encouraging persistence and effort; (b) giving specific feedback; (c) modeling attitudes and ways to approach problems; (d) demonstrating the correct way to do something; (e) creating or adding challenges to tasks that go a bit beyond a child's ability; (f) asking questions that provoke thinking; (g) giving assistance; (h) providing information; and (i) giving directions for children's actions. In addition, there are seven essential life skills that developmental researchers call *executive functions* of the brain. They are used to manage feeling, attention, emotions, and behavior. Children practice these skills often in a DAP classroom to reach their goals. These are focus/self-control, perspective taking, communicating, making connections, critical thinking, taking on challenges, and self-directed engaged learning (NAEYC, 2009).

One of the key elements of DAP is allowing children to investigate, explore, and play to learn. Research shows that play promotes self-regulation and other valuable life skills (Copple & Bredekamp, 2009). Play encourages both learning and development as they are interrelated. Playing and collaborating with more capable peers or adult guidance in the child's zone of proximal development (ZPD), naturally will allow the child to reach the next level. "The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state" (Vygotsky, 1978, p. 86). As children play together, they naturally scaffold for each other to grow and learn. Play is not just a pleasurable activity for a child, but also a need. Children use play to make sense of their world and to find in their own place in it. Young children work hard and learn in many ways while they play.

In a developmentally appropriate classroom where technology is integrated, teachers should take several considerations in mind to be effective (Donohue, 2015):

- Teachers should be digitally literate
- Technology should be integrated into pre-service, teacher education, and professional development opportunities.
- Children should be offered hands-on opportunities to play with it before using it.
- Teachers should be offered access to evidence-based practices and examples of effective practice.

The Framework for Quality in Digital Media for Young Children: Considerations for Parents, Educators, and Media Creators

The Framework for Quality in Digital Media for Young Children created by The Fred Rogers Center (2012) was meant to guide parents, educators, and digital media creators through

three guiding principles and five action areas. It was developed through their own research and also through research generated from the work of the Joan Ganz Cooney Center, Common Sense Media, and others. The Fred Rogers Center framework, spelled out three guiding principles. The first one is that quality digital media should safeguard the health, well-being, and overall development of young children. This principle is also listed in the *Developmentally Appropriate Position Statement* by NAEYC (2009). Digital media should never be used to harm young children. The second guiding principle is that quality in digital media for young children should take into account the child, the content, and the context of use. When focusing on children, the cognitive levels, abilities, emotional needs, and developmental stages should be considered when using digital media. The content of the digital media used should be intentionally chosen to educate, introduce new information, develop a particular skill, or entertain. When focusing on the context, interactivity, and engagement of the children should be the priority. In addition, the decision to use a particular affordance should be intentional according to the use. The context of interactivity and engagement with the digital media product should be a priority as well as engagement with peers, teachers, and parents. The quality of a media product should be grounded in evidence that guides parents, educators, policy makers, and others to make decisions about the product.

The Framework for Quality also has five action areas for quality. These are research, professional and career development, curation and crowdsourcing, communication and awareness, and public policy. The goal of the Framework is to help guide parents, educators, and media creators understand the development process to better use digital media with young children. It is still a work in progress and with the ever-changing digital climate, it should often be revised (Fred Rogers Center for Early Learning and Children's Media, 2012).

A checklist for identifying exemplary uses of technology and interactive media for early learning that was developed for the Pennsylvania Digital Media Literacy Project combined the recommendations from the *Framework for Quality* into a checklist for educators (Fred Rogers Center, 2012). This checklist is intended to guide teachers' and principals' thinking when integrating technology and interactive media into their classrooms and programs. This checklist will be used in this study during the observations of the teachers and can be found in Appendix A.

The NAEYC and Fred Rogers Center Joint Position Statement

In 2012, NAEYC and the Fred Rogers Center for Early Learning and Children's Media made a joint position statement where they claimed technology and interactive media are tools that can promote learning when they are used appropriately and intentionally within a framework of developmentally appropriate practice. The statement reiterated the importance of integrating technology according to the developmental levels of the child. The position statement offered 14 guiding principles for integrating technology in the early childhood classroom (NAEYC & Fred Rogers Center, 2012). These include the use of technology in an age appropriate, developmentally appropriate way in the early childhood classroom. The statement also stressed that developmentally appropriately teaching practices must always guide the intentional selection of technology and interactive media. By this, the technology used should be hands-on, interactive, playful, and enhance children's cognitive and social abilities. In addition, technology should be equitable for children with special needs and dual language learners. Finally, digital citizenship should be included as a part of any program. In the context of early childhood, digital citizenship refers to adult guidance for young children on their emerging understanding of the use, misuse, and abuse of technology. Digital citizenship enables young children to create

appropriate, responsible, and ethical behaviors online to ensure their safety and security. This position statement will guide this study in determining the appropriateness of the technology use. Finally, the statement also called for further professional development and training opportunities for teachers and early childhood educators on these principles. More research needs to be conducted to understand better how young children use and learn with digital tools and interactive media. The complete position statement list can be found in Appendix B.

Donahue (2015) provided *keywords* that serve as essential characteristics of appropriate use of education with young children. Many of these essential characteristics correspond to the NAEYC recommendations. The first of these keywords is that technology and media are defined as *tools* to be used along-side other materials in a quality early childhood program. Second, being *intentional* means the teacher knows how to use the technology, when to use it and most importantly why to use it. Next, teachers are *effective* with technology when they use it to advance the learning opportunities for all young children in the classroom to help them meet their goals. Additionally, *integration* means involving technology all throughout the day and not a separate activity. Similar to the NAEYC and Fred Rogers Center's joint position statement (2012), *balanced* means that technology will be used in addition to and not instead of essential early childhood practices. The position statement also stated that children should be *interactive and engaged* with technology, their peers, and caring adults. Children should not be involved in passive use with media. Furthermore, the position statement also stated that *access and equity* are important in the early childhood setting and this responsibility involves technology. All children should have access to opportunities to high-quality media and technology. Additionally, teaching with digital technology requires teachers to *select, use, integrate, and evaluate* experiences with digital media in intentional ways. Lastly, as with other recommendations,

professional development needs to happen to support educators to enhance their digital literacy program. These frameworks and position statements will guide the creation of checklists and for the observations conducted in the classrooms in this study.

Concerns in Using Technology With Young Children

Many researchers do not recommend computer use under the age of 3, but if used appropriately, interactive technology can be beneficial for children 3 and above (Cooper, 2005; Haugland, 2000; McPake & Plowman, 2013). Children's early experiences with technology can enhance learning when supported by adults (McPake & Plowman, 2013). Although, a program that uses technology with young children needs to acknowledge and address the concerns that some advocates have with using technology in the early childhood classroom (Donahue, 2015; Cordes & Miller, 2000; NAEYC & Fred Rogers Center, 2012; Resnik, 2006). Among frequently raised concerns are:

- The access and equity issue needs to be addressed and close the achievement gap, not make it wider.
- There is the concern that children would be exposed to inappropriate material and develop negative online relationships.
- There is a growing concern that children use computers as a mindless activity, and thus creativity is stifled; the concern is this will have a negative impact on social and emotional development.
- Computers can place children at risk for repetitive stress injuries, visual strain, obesity and other unhealthy consequences of a sedentary lifestyle.

Developmentally Appropriate Technology Use

An important aspect associated with digital technology for young learners is the concept of play. Although it is accepted that children learn through play, there are questions about how this is done through technology. Resnik (2006) contended that computers should be more like paintbrushes and less like televisions. They should allow children to explore playfully, experiment, design, and invent. Plowman and Stephen (2005) stated that there is a need for a more developed pedagogy for the use of computers with children in a playful way. With computers, play does not refer to random, unstructured engagement; rather it describes creative, experimental, and purposeful activity with which effective early childhood teachers can scaffold to ensure that genuine learning occurs (McDonald & Howell, 2012). Children in the primary classroom are often referred to as *playing with the computer*.

The ideal early childhood classroom offers a balance of exploration and play (Wyeth, 2006). Merchant's (2005) work has shown that children's experiences are enriched when children spontaneously integrate laptop computers into their imaginative play. The teacher's role, while the children play with digital technology is to scaffold for children to reach the next level. Throughout the literature, scaffolding is listed as an important element in using technology in a developmentally appropriate way. Students benefit more from computers when teachers are actively involved in the process. The teachers should closely guide and scaffold for children to reflect on their thinking behaviors, and this promotes higher-level thinking skills. Scaffolding for children using digital technology is critical to gain the higher level thinking skills benefits (Vygotsky, 1978; Yelland, 2005). When children and teachers interact together with computers, teachers can convey powerful ideas (Haugland, 2000).

Children play out their new ideas as they test the boundaries, experiment, explore, and learn new concepts with digital technology. Resnik (2006) referred to this as playful-learning, which is how young children naturally learn. We live in a creative society, and because childhood is one of the most creative periods in our lives, through playful-learning, children could serve as models for adults (Resnik, 2006). Making sure that children's creativity is nurtured and developed and providing children with opportunities to exercise, refine, and extend their creativity should be a goal of the primary school teacher. New approaches to education and new technologies to support these approaches can help.

Children also love playing video games. Video games often have a bad reputation in the educational world. Gee (2005) stressed that children learn many literacy skills when using technology, especially video games. Additionally, he stated that video games are supported by the research in cognitive science and can enhance learning for students in school and home. Video games teach children that some forms of learning are fast-paced, immensely compelling, and rewarding (Papert, 1993). While playing video games, young people engage in activities that are long, hard, complex, but they enjoy it (Gee, 2005). If video games are age appropriate, and teachers are intentional in selection in the games, they will reap the added benefit of excitement and engagement of learning. When playing video games, children see themselves as playing and do not realize the learning that is occurring. The NAEYC (1996) stated that teachers should choose computer software and video games, in the same way that they choose appropriate books. Games that include multiple levels and increasing amounts of challenge were more engaging for children (Education Development Center & SRI International, 2012). Until recently, there were not a lot of video games designed for young children, but more and more

games tailored to young children are now available. Many of these are targeted at the development of emergent literacy skills (Blanchard & Moore, 2010).

When digital technology is a natural part of the program, children often talk more when working on computers in pairs or small groups and this encourages cooperation and collaboration and motivates them to work more effectively and problem-solve (Yelland, 2005). Repeatedly, the literature states that technology integration with young children should happen in ways that include the recommended teacher strategies of DAP. Resnik (2006) stated that activities that integrate computation and craft provide a good context for learning math, science, and engineering ideas using hands-on design and experimentation. Although, Nikolopoulou (2014) found that computer use mainly happened daily in the hour of free activities when children had a choice to use the computer and not integrated into their everyday curriculum.

The integration of technology comes naturally in a DAP classroom. The integration of digital technology should promote discovery, delight, curiosity, creativity, self-expression, and pleasure in learning (Plowman & Stephen, 2003). Papert (1998 as cited in Haughland, 2000) recommended that children use computers in ways that allow them to have free access and control of their learning experience. Computers should also provide concrete experiences for children.

Digital technology and play are valued for their ability to promote development in children while creating long-term projects (Alper, 2013). Appropriately using technology with young children excites and engages them in new ways. Classrooms that engage and excite to create deeper learning activate the executive parts of the brain (Rushton et al., 2009). Rosen and Jaruszewicz (2009) suggested that the chosen technology should allow children to use their imaginations and creativity and to develop ideas as their skills emerge. Preparing a technology-

rich environment should include equipment that enables children to communicate and interact, and that encourages collaborative problem-solving and play-based inquiry.

Teachers selecting technology need to look at the developmental level of the children and understand how it will be used. Technology use matches up well with many developmental needs in the classroom by allowing children to explore, manipulate symbolic representation, match alternative learning styles, and meet individual needs. Children with disabilities often benefit greatly from this powerful tool, enabling them independence (Wardle, 2007). Unfortunately, sometimes computers are used with children in inappropriately by only using them as skill and drill practice tools (Haughland, 1999). This is only one use, but they should also be used to expand, enrich, implement, individualize, differentiate, and extend the overall curriculum (Wardle, 2007).

Pedagogical Methods

There were several areas in the literature showing ways that teachers can integrate technology with young children. There are also a few programs and approaches used with young children that naturally lend themselves to the integration of technology such as, New Media Literacy, STEM, technology to promote literacy and math skills, computer programming and robotics, and the Reggio Emilia program and Montessori program. These will be discussed below.

New media literacy. Literacy in education is defined as the ability to read and write. Literacy often dominates instructional time in the primary grades. Children are learning these foundational skills beginning in preschool and are expected to be fairly fluent by the time they are in third grade. Labbo (1996) suggested a wider definition of literacy to include multimedia and computer-based print because children as young as three and four see family members using

this technology, and often interact with technology themselves. In the 21st century, information is not only dispersed through print materials, but also through digital media. This creates a need for literacy to mean more than reading and writing because children need the skills to be able to access, analyze, evaluate, and create digital media. This expanded version of literacy is called New Media Literacy (NML) and incorporates critical thinking skills that children need to possess to function successfully in today's world. According to Alper (2013), what makes NML new is that it bridges the gap from sometimes traditionally isolated digital learning to more social learning, focused on critical thinking and reflection. In their NML paper, Henry Jenkins (2006) stated that children would grow socially, physically, intellectually, culturally, and emotionally through experiences with NMLs. As Jenkins wrote, "The new literacies almost all involve social skills developed through collaboration and networking. These skills build on the foundation of traditional literacy, research skills, technical skills, and critical analysis skills taught in the classroom " (p. 4). NMLs are critical for young children to learn in this digital world.

NMLs do not replace traditional print literacy; rather they expand the possible interpretations and creations of texts. According to Alper (2013), NMLs are informed by the learning theories of Dewey, Piaget, Vygotsky, and Papert: learning theorists who inspired developmentally appropriate practice. Jenkins (2006) listed the 12 core media skills: play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking, negotiation, and visualization. These are all skills that quality early childhood educators aim to teach and are lifelong metacognitive skills for critical thinking (Alper, 2013). Media literacy is about helping children become the thinkers and makers they need to be today in order to develop the life skills that they need to become literate today's multimedia environment (Rogow, 2015).

Technology changes so quickly that children should not simply be taught how to use digital devices, but media literacy should instead concentrate on core competencies that apply across technology (Scheibe & Rogow, 2012). Just knowing how to use a certain program or device is not enough for future success. In the guide for teachers, (Scheibe & Rogow, 2012) suggested that teachers focus on core competences that reflect thinking skills in the context of using technology. The first of these competencies is that all children should have access to high-quality media technologies and content and learn how to use these effectively. Next, children need to understand basic media messages; this includes an awareness of decoding media messages and being able to think independently about them. Third, they need to be able to evaluate media and make informed, rational judgment about the value of the media and its purpose. Fourth, children should learn how to create media messages for multiple purposes. They should also know how to reflect on media messages and think about personal perspectives and experiences that influence reactions. Children need to understand how to join and interact collaboratively in media activities. Finally, children should learn how to act on one's insights to media messages. Encouraging children to ask questions about media messages will help them to become better decision makers in determining the media message. In teaching these competencies, children will gain skills needed for a wide range of media literacy.

When considering NMLs, educators need to look at integrating digital devices other than desktop computers. One digital device that is becoming popular in classrooms is the tablet. Studies are just beginning to surface on the use of tablets with young children. The tablet has proven to be a viable tool for young children. It allows them to represent their ideas through drawing and writing. In a study by Couse and Chen (2010), most of the children preferred the drawing with the tablet to the traditional drawing media. Getting and Swainey's (2010) study

with first graders and iPads revealed that children work together using apps for literacy purposes with little teacher interaction. The students were highly motivated and for some who demonstrated undesirable behavior at other times, these devices contributed significantly to attentiveness. Sandvik, Smørdal, and Østerud, (2012) found that iPads provided opportunities for children to interact in purposeful first and second-language interactions. Because iPads use is increasing in the early childhood classroom, Northrop and Killeen (2013) created a framework for teachers to describe how to integrate iPads in the classroom to build early literacy skills. They suggested that teachers should teach the concept first without the iPad. Next, they should explain and model the app. Third, teachers should allow students time for guided practice. Finally, once students have a solid understanding of the app, allow independent practice. Even if children do not have experiences with tablets before attending school, they develop skills very easily. Because they have grown up in an environment where they are immersed in technology and watch others use it, they intuitively know how to use them.

Teaching STEM skills. STEM stands for the study of science, technology, engineering, and mathematics. These disciplines are seen by many as the key to future jobs in the 21st century. Yet, little is taught in the Preschool through third grade classrooms to lay the foundation for STEM skills (Kazakoff & Bers, 2012) many professionals claim that students lack understanding in these areas. Because there is a need for more STEM, it has been a focus in many educational programs today. However, these programs have largely been initiated in middle and high school, but there has been little integration in the elementary grades, especially the early elementary and preschool years. The earlier these skills are introduced to children, the less gender-based stereotypes regarding STEM careers exist (Metz, 2007); females tend to shy away from these fields, not because of lack of intellectual abilities, but because they do not think

of the fields as ones for women (Rasinen et al., 2009). Therefore, it may be helpful to introduce STEM skills while children are young to change this trend. The belief is that if girls are introduced to technologies early in life, it may debunk the stereotype that STEM jobs are only for males.

Students need to develop a deep understanding of the fundamentals of science, mathematics, and technology across preschool through 12th grade. Initiatives are emerging for young learners to develop literacy in engineering thinking and technology proficiency (Raizen, 1995). Experts also claim that skills, such as higher-level thinking, need to be introduced earlier (Kuhn, 2002). High-quality computers programs often naturally develop other higher-order thinking skills when they allow children to create, change, save, and retrieve ideas; this can promote reflection and engagement, and help connect ideas from different areas (Clements & Sarama, 2002).

Many countries are pouring money into early education in hopes that they can compete with the rising standards of the 21st century. STEM initiatives are at the forefront of these concerns. Both the Partnership for the 21st Century Skills (2011) and President Obama's mandated "Educate to Innovate" (Whitehouse.gov, 2009) stressed the need to prepare students with STEM skills that they will need in a global society. Research shows that students who enroll in advance science and math classes in high school tend to enroll and have success in 4-year colleges. The research supports the need for elementary students to be exposed to STEM subjects early because this would encourage students to take math and science classes in middle school and high school (DeJarnette, 2012). Earlier is not always better, but introducing STEM skills earlier might spark interest in STEM careers later in life (Bagianti, Yoon, Evangelou, & Ngambeki, 2010). Integrating simple STEM skills into a project-based approach (discussed

earlier) with technology is a great way to incorporate skills such as counting, measuring, reasoning, hypothesizing, and analyzing ideas (Highfield, 2015).

Using technology in learning reading, writing, and math. Learning to read is one of the hardest cognitive challenges that children will encounter. Computer programs designed to support young readers take children through the steps of learning to read in an appropriate digital environment support young readers (Cooper, 2005). Digital devices would be used to encourage, scaffold, and support young learners. Technologies provide unique affordances for reading and writing and require unique strategies and skills to build upon than those associated with conventional print (Hutchison & Reinking, 2011). Some of these affordances include offering educators new tools for literacy such as changing font size, using text-to-speech features, to help beginning readers, and using the Internet to collaborate on learning activities (Anderson-Inman & Horney, 2007). Digital devices may someday have the ability to provide individual feedback through avatars; software will supplement conventional text with dynamic graphics, and multimedia will allow the mixing of text, images, and speech (Scalon & O'Shea, 2012).

Computers should not replace quality face-to-face reading instruction, but students can benefit from the support of skills from computers following this individual instruction from a teacher. In a study containing kindergarten and first-grade students, both showed benefits from e-books in vocabulary development compared to a control group (Korat, 2010). Korat also found that presenting children's books as digital text with activities, could improve phonological awareness, word-reading skills, and vocabulary in kindergarten and first-grade readers. A review of reading interventions using different technologies, show effects on literacy, but not the same effects across the different studies (Pasnik et al., 2007). Positive effects from this study were found for interventions that used televisions, computers, and talking books. This study also

found that the teachers who had positive results received extensive professional development. Reading skills that children showed consistent positive effects were in letter knowledge, phonological awareness, word recognition, and story comprehension.

Other studies by Clements and Sarama (2002, 2003) and Yelland (2005) have provided empirical evidence that computers help young children comprehend mathematical concepts in dynamic ways that increase their problem solving strategies. For example, computers have been shown to foster deeper conceptual thinking. In addition, children learn counting skills, sorting skills, and other math skills with computer manipulatives (Clements & Sarama, 2003). Clements and Sarama also found that computers helped young children with mathematical skills when students received more than one year of instruction in computers and for children from a low socio-economic background.

Computer programming and robotics in the P-3 classroom. Marina Bers (2008), in her book *Block to Robots*, discussed four basic tenets of constructionism that should be considered when working with young children and robotics. These are

- *Learning by design:* children learn best when given opportunities to design, create, and build projects that have meaning to them.
- *Technology tools for learning*: from building blocks to robots-constructionism recognizes the significance of *objects to think with*. This is a long-standing tradition in early childhood and is recognized in developmentally appropriate practice, Montessori, and the Reggio Emilio programs (these programs will be discussed below). Hands-on learning has long been recognized as best practices in early childhood.
- *Powerful ideas and wonderful ideas*: powerful ideas are based on Papert's claim (2000) that powerful ideas afford a new way of thinking. Wonderful ideas are based on the

Eleanor Duckworth's (1999) concept that ideas can be wonderful because they provide a basis for thinking about new things. Powerful ideas are wonderful ideas that stand the test of time. A powerful idea needs to have five types of connections: cultural, personal, domain, epistemological, and historical.

- *Learning about learning with technology*: thinking *about thinking* plays a very important role in the constructionist theory. Self-reflection and has had an important role in many early childhood programs and allowing children to practice the metacognitive skill of thinking about what they are learning, will serve them will in their later years of schooling.

It may surprise people that computer programming and robotics would be an advantageous activity for young children. Papert (1980) stated that robotics provide a unique way to integrate math, science, and technology into the elementary curriculum. Children are given the opportunity to design, build, and program a meaningful creation. It also helps in developing high-level and metacognitive thinking skills. To make robots come to life, children need to learn computer programming. Research has shown that children as young as 4 years old can understand basic computer programming and build simple robots (Bers, Ponte, & Julick, 2002.) Not only do robotics and computer programming excite and engage children, but they also provide a way to introduce many important skills for young children. For example, sequencing is an important skill for young children to learn for both early math skills and early literacy skills. In a study by Kazakoff and Bers (2012), children increased their ability in sequencing by participating in a robotics and programming program in as little as a week. Teaching robotics and programming in a developmentally appropriate way can be a powerful tool in early childhood and yield many positive results. Robotics has also been shown to improve children's

motor skills and eye-hand coordination through the playing with mechanical parts to design a machine. Children learn through collaboration and teamwork when doing robotics (Bers, 2010).

As our world becomes increasingly technological, children need technology activities that motivate them. Robotics combined with computer programming is an exciting way to motivate children. Clements (1999) reported in an earlier study that computer programming could help young children improve visual memory, basic number sense, and problem-solving and language skills. Children at this age can learn and apply concepts of programming if they have programs that are tailored for them. Scratch Jr. is one of the programs developed for young children to learn programming. Simple robots are enticing forms of technology because most children see them as toys, and they have a natural desire to play and engage with them (Highfield, 2015).

Reggio Emilia. An early childhood program where technology integrates beautifully is called the Reggio Emilia model. Lois Malaguzzi and his colleagues created the program. Reggio Emilia is an Italian city where high value is placed on early childhood. Reggio educators have long believed that their program cannot be taken and replicated somewhere else to produce the same results, because any program needs to work with the local culture and personal experiences of the children. Many of their ideas; however, can change practice in our early childhood classes (Wein, 2014). The practices were inspired by the works of Dewey, Piaget, Vygotsky, and others who promoted a child-centered classroom (Martinez & Stager, 2013). Children are encouraged to express themselves in many ways, including through words, movement, drawing, painting, building, and dramatic play. Classrooms are organized to support collaboration and problem solving (Edwards, Gandini, & Forman, 1998). The core practices of

Malguzzi's design, which should influence American educators, are discussed in the section below.

The image of the child as a competent meaning maker. The teacher allows children to make meaning from their experiences, and adults need to look and listen for the meaning. The adult's role shifts from one of manager to one of supporter. As Vygotsky (1978) would say, the adult's role is to scaffold the learning for the child in the child's Zone of Proximal Development and help the child reach the next developmental level.

Collaboration as a sharing of work, not merely dividing up tasks. Educators need to work together on their work by sharing experiences and planning together and later reflecting and revising the work.

Pedagogical documentation. Documentation is a standard part of this classroom practice. This is a tough shift for teachers, but documenting student learning using authentic, observational assessment tools not only helps educators discover what a child knows or does not know, but also what future instruction should look like for that child. This takes time and energy, but reflecting on this documentation makes learning visible and provides a window into the child's brain that is more indicative of the child's learning than standardized, multiple-choice testing. This process is made easier for the teacher by using digital tools to take movies, pictures, or recordings.

Multiple modes of representation of experience. This concept embodies project-based learning and the Makerspace classroom. This means that children express their ideas through many different ways: painting, music, dances, constructing with blocks or wire. As Martinez and Stager (2013) stated that there may be no better model for learning through making, tinkering and engineering than in the Emilia classroom. Children use real tools to problem solve and the

role of the teacher is that of researcher aimed at understanding the child's thinking. In the Reggio classroom, digital tools are not isolated from non-digital tools like in a computer lab. Rather, they are included among all other tools to use for classroom projects (Alper, 2013). Malaguzzi (as cited in Edwards et al., 2012) believed that the child had a hundred languages and computer literacy was one of these languages.

Aesthetic sensibilities and design. The educational environment is emphasized in this structure. The function and beauty are not separate. The environment takes into consideration the local culture and community. Educational activities and projects emerge from the children in their environment. The environment is considered the "third teacher" after the parent and the teacher (Martinez & Stager, 2013).

Engagement with the local community. Reaching out to the community and involving the community in the classroom is not common in the American classroom. Engaging the community and including the outside world into the classroom teaches children how to make relationships and interact with others in the community.

Montessori. The Montessori program child-centric program must have seemed radical in the early 1900s, but it had remarkable success with the hardest to reach children (Buckleitner, 2015). It was the application of the theory coming from Froebel and Pestalozzi and was a contrast to America's behaviorism-steeped curriculum. Froebel and Montessori were educators who were at the forefront of the field (Bailey & Blagojevic, 2015). Based on their theories, Froebel and Montessori created educational tools that could facilitate the learning process and structured curriculum and pedagogy around these materials. Froebel and Montessori would probably welcome the new digital tools to further their educational process.

Among the Montessori groups today, the use of technology continues to be debated, but Virginia McHugh Goodwin, the Executive Director of the Association Montessori International/USA, feels that Maria Montessori would appreciate the way that technology takes children to another level (Buckleitner, 2015). Montessori was a game maker and constantly was involved in creating innovative materials. She probably would have embraced the iPad and other technology that allowed children to interact and self-teach. She always put children's needs in front of any curriculum and would see technology as a tool for tomorrow's mind.

Summary

Preparing our children early with these skills will enable them to be successful in their digital future. Digital devices are excellent learning tools, imparting skills far beyond expectations. Using these tools, teachers can spark the learning process in young children (Haugland, 2000). Young children appear to come to school with a wide range of ideas about technology. They are growing up in a world where technology encompasses their lives. Most educators agree that computer literacy is vital in today's world for young learners (Judge et al., 2006). However, teachers need training and guidance on how to provide children experiences in effectively

Most young children find digital tools of any kind, intrinsically appealing, and intuitive to use, but, as Plowman and Stephen (2003) warned, using programs for young children is not merely scaling down versions of adult hardware and software. Children are not scaled-down adults. Research confirms that young children are not passive users of technology. They are active users including but not limited to hardware of various kinds, educational software, electronic communications, the Internet, and multimedia authoring tools (Rideout, 2011).

Given the importance of digital tools in today's world and how children are growing up immersed in technology, the earlier children are introduced to the tools, the more successful they will be in their educational career. Young children learn best through hands-on, exploratory investigation, and developmentally appropriate practice. Therefore, it is imperative that teachers of young children introduce and use technology in a developmentally appropriate way. Plowman and Stephen (2005) stated that there is a need for a more developed pedagogy for the use of computers with children in a playful way. Teachers need to be thoughtful about the technology used and match it to the learning goals and needs of the children in their classroom. Many teachers do not know how to do this and consequently ignore technology or use it inappropriately in the classroom. This study provides examples of teachers who are implementing technology with young children in a developmentally appropriate way.

Chapter 3: Research Methodology

Limited empirical research has been focused on children in preschool through third grade (P-3). Yet, the research that has been conducted shows that integrating technology with young children yields many positive benefits (Brooker, 2003; Chantel, 2003; Clements et al., 1993; Haugland 2000; Haughland & Wright, 1997; Judge et al., 2006; Kankaanaranta & Kangassolo, 2003; Li et al., 2006; Mouza, 2005; NAEYC & Fred Rogers Center, 2012; Sheridan & Samuelsson 2003; Yelland, 2005). In addition, with policies requiring testing of younger children and higher academic expectations, many teachers who use technology in the early grades do not use it appropriately with the young child because they use highly prescriptive curricula that are not grounded in child development research. Unfortunately, they do not see play as effective; this violates long-established principles of child development grounded in research that contend young children learn through play and exploration (Miller & Almon, 2009: Haugland, 1999; Nikolopoulou, 2014; Parette, Quesenberry, & Blum, 2009; Rorem & Bassok, 2014). The purpose of this study was to explore age appropriate activities that demonstrate technology-rich classroom instruction in a developmentally appropriate way that is integrated into the curriculum. One example of developmentally appropriate practice could be students interacting with technology in a playful way. At the conclusion, descriptive examples of what occurred in the different classrooms illustrate what teachers were doing and why the technology was useful to help other primary teachers integrate technology in a developmentally appropriate way. The research included interviews of one preschool and two kindergarten teachers and observations of their classrooms. The researcher conducted one interview before the classroom visit and a second interview of the teachers after the visit to obtain a greater understanding of what was happening, how the teacher designed the experiences, more context about the

classroom and school, and background on the teacher. The interviews were recorded and then transcribed for analysis. After careful analysis of the practices observed and the interviews, the researcher offered suggestions for primary teachers based on the Fred Rogers Framework for Quality Digital Media (2012) and the joint position statement from the Fred Rogers Center and NAEYC (2012) on how to integrate technology is a developmentally appropriate way.

Research Questions

The formal research question that guided this study was how are digital media and technology integrated in a developmentally appropriate way (DAP) in the P-3 classroom? The sub-questions that were addressed in this study are

1. What are the specific activities?
2. What are the teachers' views around DAP and technology?

This chapter describes the research methodology and procedures that were used in this qualitative exploratory case study. This chapter is organized into the following sections: (a) description of research design, (b) population and sample, (c) human subject concerns, (d) instrumentation, (e) validity and reliability, (f) data collection procedures, (g) data analysis, and (h) summary.

Research Design

Exploratory case study methods were used for this qualitative study. According to Yin (2013), case studies are used to explore subjects and ideas when a *how* or *why* question is being asked. This approach is particularly useful when the researcher is trying to uncover the relationship of a phenomenon and the context in which it is happening. The researcher in this study was trying to discover the phenomenon of how technology can be used appropriately in a primary classroom. The researcher conducted observations in a preschool and two kindergarten

classrooms. The reason for using an observation was to gather information on behaviors, actions, and interactions in real time (Rallis & Rossman, 2012). The purpose for using case study design and observation methods in this study was primarily for exploration and discovery to gather ways to integrate technology appropriately in a P-3 classroom.

This was a collective case study of one issue and multiple cases used to explore the issue (Creswell, 2013). The issue of technology integrated in the early childhood classroom in an appropriate way was the focus of each case, and there were three different cases to illustrate best practices. The collective case can show different perspectives of how teachers use technology with young children in an effort to help other teachers learn more.

The teachers in these classrooms were interviewed before and after the observations. The pre-interview served to provide the researcher with background on the lesson and subject area and teaching strategies so the researcher could better prepared for the observation (Appendix C). The teacher was also asked background experiences using technology and professional development that they had. The interview allowed the teacher to share other ways that he/she has integrated technology throughout the school year. During the post-interview, the teacher answered questions about what was observed by the researcher, thus allowing the teacher to give background on how she prepared students for the lesson (Appendix D). The post-interview also allowed the teacher elaborate other ways that she may follow up with the lesson. The interviews and observations were qualitative ways to collect evidence of developmentally appropriate technology use at the primary grade level.

Population and Sample

The target population of P-3 schools is those within Colorado. There are 178 school districts that contain approximately 1800 schools in Colorado. A small number of schools were

selected using purposeful sampling. Two main criteria for selecting the classrooms were grade level (preschool or kindergarten) and high teacher use of technology. High use of technology in the classroom was either self-reported by the teacher or the teacher was recommended by a principal or educational technology leader in the district. Finally, the researcher selected teachers that showed different perspectives on how to use technology with young children that were appropriately guided by the literature review of learning sciences, DAP, The Framework for quality in Digital Media for Young Children, The NAEYC & Fred Rogers Center's joint position statement and the pedagogical methods for technology integration in chapter 2.

The selected teachers had students ages 3 through 5 and were from three different school districts in the state of Colorado. The observations of teachers occurred in the spring when most of the students have had an introduction to technology and were beginning to explore it on their own.

Ethical Considerations

The participants observed in this study were the teachers and their practices in the classrooms. Children were in the classroom settings but were not the focus of the study and the researcher did not interact with them. The study was classified as Exempt, Category 1, because the study focused on and evaluated normal education practice. It is common practice for observers to dome into the classrooms to review classroom activities. The participants were all over 18 years of age, and the risk to participants was minimal. The researcher gained permission from both the principals of the participating schools and the teachers involved. One school district has its own IRB process and the researcher obtained approval from the school district. In order to keep the risk low, every effort was made to allow the participants to remain confidential while collecting the data necessary. The participants were guaranteed that the information would

not be used as part of the participants' performance evaluations. In addition, the researcher emphasized that participation and individual information was held confidential and explained the steps taken to keep private information anonymous. The participants were assured that no names of teachers or the schools would be used in the final write up of the study or any publications from the study. The researcher obtained a waiver of informed consent procedures, so the participants did not have to sign permission so that there is not a record of their name in the study.

Data Gathering Procedures

Two forms of data were gathered: observational data that was recorded in field notes and interviews that were later transcribed from the teachers. Pictures were taken of the educational environment and activities (in a way that did not include faces) and these were added to the field notes. According to Gray (2009), "Observation involves the systematic viewing of people's actions and recording, analysis, and interpretation of their behavior" (p. 397). The researcher recorded field notes and used checklists guided by the recommendations from the literature review in Chapter 2 to accurately record the activities. The field notes consisted of the layout of the classroom, the people involved, the activities, the physical elements in the classroom, the actions of the teachers, the time of day, and the goals that were set for the classroom. An empty table shell was also used to guide the observations (Yin, 2013; Appendix E). The classrooms were visited several times to get a complete picture. The field notes and checklists were documented and analyzed immediately following the observation. Gray (2009) suggested that in writing up the field notes, there are several components to be considered. First, the primary observations should be kept in chronological order. These observations from the study were dated; they contain actual conversations and approximate recall of conversations. Recordings of

the teachers' pre and post-observation interviews were included with the field notes; since these were recorded and transcribed, the researcher has access to the actual conversations that occurred from the interviews. In addition, in the field notes, the researcher reflected and recalled situations in the classroom using the notes taken and checklists from the observations. Third, the researcher re-analyzed the data, ideas, and inferences. In this step, themes and insights started to emerge and were noted. The researcher noted the experiential data, impressions, and personal feelings at the analytic stage. The third form of data was pictures of the classroom set up, classroom projects, and the final products that were generated by the activities. These images were used to add to the written description of the classroom and illustrate the technology use and classroom environment.

Interview data was collected by the researcher during an interview of each teacher, both before and after the observation. As noted above, these interviews were recorded. The first interview inquired how and when the teacher integrates technology into the school day. Another goal of the first interview was to learn about the methods or approaches the teacher used to better guide the observations. The pre-observation interview protocol used to guide the interview conversation can be found in Appendix C. The second interview focused on answering any questions that the researcher had about what occurred the observation. The questions for this second interview were not fully determined until after the observation as they were used to fill in the gaps to create a complete picture. Appendix D includes all the questions asked of all teachers; each teacher did not answer each question. An asterisk was placed by the questions answered by all three teachers. The first and second interviews took 15 to 20 minutes of the teacher's time. The interview recordings of all interviews were transcribed and coded by the researcher.

Validity and Reliability

Four tests are used to establish the quality of empirical social research. Construct validity, internal validity, external validity, and reliability (Yin, 2013). In this study, construct validity is identifying the correct operational measures for the concepts being studied. To help ensure construct validity, the data collected, including observational field notes, checklist, and interviews of the teachers were guided by checklist that have been published in the literature on the topic. Internal validity was established through the data analysis and the coding of the data, specifically through pattern matching. Patten matching logic, according to Yin (2013) compares the findings with a predicted pattern made before collecting the data was used to strengthen the internal validity. The patterns from the cases were compared to the NAEYC and Fred Rogers Center's position statement (2012) and other literature in chapter 2. External validity deals with the issue of knowing whether the findings can be generalizable beyond the immediate case. Because only three classrooms were observed, the findings are not generalizable, but examples from the cases can be used so that teachers in other classrooms and can gain ideas for what might work. In addition, they may be used to guide further studies that have generalizable findings.

Validation in a qualitative study occurs throughout the steps in the process of the research when the researcher checks for accuracy of the findings by using certain procedures (Creswell, 2009; Yin, 2013). These steps were taken to ensure the validity of this study. First, the researcher employed *triangulation* to build a coherent justification for the themes from the interviews, observations, and checklists. The themes were established, and case studies written by using the checklists, notes, empty table shells, pictures, and results of the analysis of the interviews. The case studies were written with rich and thick description to illustrate the findings. Then, the researcher clarified her bias that she brought to the study by an honest

narrative of a self-reflection. In a case study, reflexivity or bringing personal experience into the discussion will be done at the epilogue at the end of the study in order not to interfere with the flow of the description (Creswell, 2013). Stake, Denzin, & Lincoln (2005) stated that the researcher needs to continually reflect considering impressions. The researcher spent as much time as needed in each teacher's classroom to thoroughly understand the technology used in the early childhood classroom. The researcher had peers knowledgeable in DAP and early childhood education read the descriptions and questions were asked to make sure that the accounts were understandable, to strengthen the validity.

Qualitative reliability means that the researcher's approach is consistent across the different cases. The first step the researcher followed to ensure reliability was to check the transcripts written from the taped interviews by listening to the interviews again to make sure that they were accurate. The researcher then coded the transcriptions of the interviews to look for emergent themes. This was done several times. New codes were added when warranted. Next, she compared the data with the codes and wrote memos about the codes to make sure that they stayed consistent. Finally, the researcher was the only one coding the data; crosschecking codes was part of the process. HyperRESEARCH software was used to code the data, and pattern matching was conducted to determine the codes that most occurred. The researcher also made sure the same procedures were followed for each case. In each one of the classrooms, the data was collected, and protocol checklists were used to ensure consistency; the checklists, were flexible to allow documentation of situations or technologies that were not anticipated.

Data Analysis

There are four different strategies that can be used to analyze data. These are relying on theoretical propositions, working your data from the "ground up", developing a case description,

and examining plausible rival explanations (Yin, 2013). This study was guided by the research questions and the framework created by the Fred Rogers Center and the position statement of the NAEYC and the Fred Rogers Center; therefore, it was analyzed using the first method, relying on theoretical propositions. These frameworks and statements guided the development of the codebook used in HyperRESEARCH and was the basis for the pattern matching. Because this study was exploratory, the researcher was looking for patterns of good developmentally appropriate technology use; the frameworks and statements from the literature provided good examples. The researcher had recorded, in detail, what was done in each classroom during the technology activity, and a detailed description was written of each case. The literature discussed in chapter 2, which entailed many good examples of appropriate use, also guided the research and helped the researcher during pattern matching. The checklist for identifying exemplary uses of technology and interactive media for early learning from the Pennsylvania Digital Media Learning Project (Appendix A) was used as well as checklists that prompted for examples of New Media Literacy, STEM skills, tech in teaching literacy and mathematical skills, computer programming and robotics, project-based learning, and play as was found in the literature. Using the literature to guide the process helped ensure the validity of the data. In addition, checklists prompted the researcher to look for different appropriate pedagogical methods such as age-appropriate tools and activities that met instructional goals for the developmental needs of the child.

An analysis of themes was conducted to understand the complexity of the case (Creswell, 2013). The analysis in a qualitative study is ongoing. Stake (1995) believed that the role of the researcher is to interpret and build of a clearer view of the case through the explanations and descriptions. The researcher continually reflected on the data and wrote memos throughout the

study. The steps included organizing the data for analysis, transcribing interviews, and sorting notes. Next, all the research was be read and reflected on for the overall meaning. Third, using pattern matching logic, the interview transcriptions and observations were coded in HyperRESEARCH. The coded data reflected patterns used in the classrooms that were discussed in the literature. The case studies were written from the coded data and included a rich description of technology use in the classrooms and the interpretations gleamed from the data.

Summary

This chapter summarized the methodology for the exploration of the integration of technology in a developmentally appropriate way in the primary classroom. A collective case study design was used for this research, with three different classroom teachers. The study used multiple modes of data collection (observation, interview, and pictures) to capture the teachers' views and practices of the integration of technology with young children. The data analysis process involved coding and pattern matching methods to identify the components that constitute technology use in a developmentally appropriate primary classroom. Finally, a rich description of the activities and procedures for each classroom is offered as examples for teachers in the field.

Chapter 4: Findings

The purpose of this collective case study was to observe teachers in primary classrooms integrating technology and document age-appropriate activities that were being done in a developmentally appropriate way. In this exploratory case study, the researcher visited three classrooms from different locations in the state of Colorado. Two of these classes were kindergarten classrooms and one was a preschool classroom. The results reported in this chapter are presented in three sections. The first section shows participant demographic information, the second section reports qualitative findings from the case studies addressing the research questions, and the third section presents a summary section of the key findings identified by the pattern matching of the data.

Description of the Teacher

Teacher #1. The first kindergarten classroom was located in the northwest corner of Colorado. This classroom was located in a small school district with only 2400 students and five elementary schools. It was in a rural community, and the entire population of this small town is only 8981 people. The school district made a commitment to the young children of their community and provides full-day kindergarten for all of their students. The school district has also made a commitment to providing the schools with technology. Because it is a smaller school district and does not have the money of a larger school district, to get the resources they need, they pull from many different funding sources. Ipads were provided for the classrooms by a local educational foundation, and yearly the school and teachers apply for various technology grants. The school also provides the teacher with an educational assistant for half of the day.

This teacher formerly taught in the Denver metro area, but moved to the rural town 6 years ago where she has been teaching ever since. Even though she has taught kindergarten for

17 years, she claims to be relatively new to technology. She has taken iPad classes through the Northwest Colorado Board of Cooperative Educational Services (NW BOCES) and she also has a mentor at her school who worked with her and helped her learn more about integrating technology. The teacher said that when she was at her prior school, they had a computer teacher at the school; therefore, she did not have a need to learn about technology and use it in her classroom. At the prior school, she thought that the children were getting what they needed when they visited the computer lab. When she moved to this small school district, they did not have a computer teacher and so it was up to her to expose her students to technology.

Teacher #2. The second kindergarten teacher works in the Poudre School District. This district is 65 miles north of Denver in Ft. Collins, Colorado. Ft. Collins is the fourth largest city in Colorado and home to Colorado State University. The Poudre School District serves 27,000 students, which makes it the ninth largest school district in Colorado. The classroom visited in this study was in one of the 31 elementary schools in the school. The school was built in 2003 in a newer part of Fort Collins where more young families with children live. Both Larimer County and the Poudre School District have made a commitment to providing the schools in the district with the technology resources.

The teacher has an extensive background in technology and has taught many different grades for 28 years. She has a minor in computer science and has served as an Intel Teach to the Future Trainer, an exemplary educator for SMART Board Technologies, and a technology trainer for the district. She returned to the classroom to teach kindergarten this year. She said she felt like spending 3 years as a technology trainer was like spending 3 years in a technology workshop. She was excited to get back to the classroom to put into action everything that she had learned in her three years as a technology trainer.

Teacher #3. The preschool is in the St. Vrain School District, which has more than 30,000 students. It is the eighth largest school district in the state and is located about 30 miles north of Denver. This school district has 23 preschools, and this is the second school year for this preschool. The school is a STEM preschool. According to their website, the school offers children foundational integrated learning experiences in science, technology, math and engineering. One of the goals of the school is to inspire children with age-appropriate technological tools and materials to spark and accelerate learning while developing life-long traits necessary for responsible citizenship. They also claim to use technology skills in an integrated and interactive way enhancing cognitive and social abilities in developmentally appropriate ways. The school serves both 3-year-olds and 4-year-olds.

This teacher has been working with early childhood and elementary age kids in a variety of capacities for the past seven years. The preschool teacher teaches two half-day preschool classes. One class consists of mainly 3-year-olds who attend two days a week, and the other is for 4-year-olds who attend three days a week. The children in the school come from different socio-economic status groups. This preschool is made up of regular education students; students who are part of the Colorado Preschool Program (and receive tuition assistance); students who have been designated as exceptional learners; students with individual educational plans (IEPs); and English Language Learners. The students' background knowledge in technology is also varied. The school personnel try to offer opportunities for their students and parents who do not have technology at home. They open the computer lab once a week on Wednesday afternoons and invite families in to come work with the iPads and computers for educational purposes. They also have the Maker Space area and have after school clubs that expose the children to

technology. The teacher believed that it is important to expose children to technology and has always tried to be an advocate to get technology into the school.

Table 1

Description of Teacher

Description of Teachers	District Size	School Type	Experience with Tech	Professional Development	School Support	Devices
Kindergarten Teacher #1	2400	Rural	Fairly new	District, conferences & BOCES and has personal mentor	Google Training	5 desktop computers, 6 iPads, SMART Board and Doc Cam
Kindergarten Teacher #2	27,000	Suburban	Extensive	Tech Trainer	SMART Board and Table	3 desktop computers, 6 iPads, SMART Board and Doc Cam, SMART Table
Preschool Teacher	30,000	Rural	Some	District	Maker Space, Robotics, Computer lab for parents	6 iPads, Little Tykes computer, doc cam

Research Questions

The main question that guided this study was "How is Technology Integrated in the P-3 Classroom in a Developmentally Appropriate Way?" The sub-questions are addressed below. The sub-questions were:

- What are the specific activities?
- What are the teacher's views on DAP and technology?

Answering the sub-questions will answer the main, guiding question.

What are the specific activities?

Teacher #1. This kindergarten classroom had the five classroom desktop computers in one corner of the classroom. All of the computers had headphones. These were strategically placed near the table where the teacher held guided reading groups so she could help with the computers if needed. The iPads were located on the other side of the room. Tables were on the side of the room near the iPads. The SMART Board and doc cam were located in the middle of the room where there was space for the whole group. This was the area where the teacher conducted small group and whole group teaching. The classroom also had a writing center, housekeeping center, and other developmentally appropriate learning centers. The children knew how to use the technology and were very eager to help each other. This was what she said about how she integrated technology:

> As far as the activities, I try to link them to the standards and have it (technology) reinforce those. We've really shifted completely this year and we are now 100% standards based, targets, exemplars, and assessments. So, everything that we incorporate into our day has to be linked to our standards. But, everything can be. Everything I do I can link to a standard. Especially literacy, oral language, you can link anything to oral language because these kids just need to talk and think and have conversations.

This teacher integrated technology in many different ways. The subjects that were observed were literacy, math, and buddy reading. The first subject observed was math. There were two kindergarten classes in the school (this class and another one taught by another teacher) and they differentiated by combining the classes and then dividing the children back into two classes by ability. The children who were ready to learn subtraction went to the other classroom and this teacher kept the children who were still working on addition. She began with the whole

group on the floor to *warm up their brains*. Then she divided them into four groups. There were four to five children in each group, and the groups rotated through the learning centers. The first group went to the computers and worked independently practicing word problems on www.abcya.com. The second group played a game with the educational assistant who came in to help the math class. The third group worked independently on the iPads and used the math app Kids Math. Finally, the fourth group sat on the floor with the teacher and played an interactive game on the Smart Board (see Appendix F). The teacher differentiated among the addition learners by intentionally selecting a different game with different learning goals for each group that was played using the SMART Board. The two groups working independently at the computers and the iPads helped each other; even though the students at the computers had earphones on, they interacted with each other. Each center was a playful game that supported the goal of learning addition. The games were age appropriate and appeared to scaffold the learning by using pictures to aide in the addition problems. This helped the students be successful and independent.

The next lesson that was observed in this kindergarten class was a literacy lesson. The children were learning about informational writing and were writing about animals. At writing time, the children researched their animal by logging onto *YouTube for Kids*. They watched the movies about their animal and took notes on a template provided by the teacher. This was a developmentally appropriate way to introduce researching to five-year-olds because of the scaffolding for the children. The teacher modeled how to do this all year long and this was the first time that the children were to perform this task on their own. The children also worked in small groups. These groups were intentionally formed with advanced and novice writers to enable the students to scaffold and help each other. The teacher made sure that the students

would work together and get along. The groups ranged from two children to four. This ensured that all children would be able to complete the task.

Next, literacy centers were observed. These were conducted in a way that was similar to the math centers. The children came in from recess and sat on the floor for directions. There were four learning centers. The first center was the computers where the students researched an animal for their informational writing unit. The teacher set up Symbaloo account, which is a free bookmarking service in the cloud that makes it easy for children to access resources. She loaded *National Geographic* books on animals into the Symbaloo bookmarking service, which enabled the children to choose the book on the animal that they were writing about and have it read to them. Listening helped them add to their research on their animal. On the iPads, the children practiced their fluency in reading. They read books and recorded them on quickvoice. As the teacher said, "I can tell them what they need to do to improve their fluency, but until they listen to their own reading, they don't get it." The other two groups worked with the teacher and an assistant. The teacher worked with the students individually on reading skills and the assistant worked with them on writing skills. The students stayed at the centers for 15 minutes and then switched. This teacher has strategically placed the computers right next to her guided reading table so she could trouble-shoot the computers if needed with little interruption to her reading group.

Later in the day, the class participated in what the teacher called Skype Play. She has been piloting this all year long and has Skyped four or five different classes from all over the country. Sometimes she does this formally and other times informally. Informally, means that the kids were just playing in the classroom, and anyone who wanted to could go to the computer and talk to the class they were Skyping. This particular day, it was more formal because all the

kids participated. They Skyped with a class in Denver and played the game Headbands. They had been working on the comprehension strategy inferring and talked about how good readers needed to use the clues that authors give. In this game, a child put a picture and word on his/her head and then a child (in the classroom that they were Skyping) would describe it and give clues about the word on the headband. The child with the picture on the headband tried to guess what it was from the clues given by the child (at the other location). All of the children took turns being the guesser and the one who gave the clues.

This school also had a group of older children (third through fifth graders) who were tech experts, called techperts. The techperts were responsible for helping the teachers and students with technology. A techperts visited this kindergarten classroom once a week. The kindergarten teacher created a website for her class and piggybacked off the Storyline Online concept (where famous people read books to children). The techpert recorded the kindergartner reading a story using iMovie. Technology encouraged these two students to interact and talk about their learning. The teacher then downloads this on the website for children and parents to enjoy. This website is closed, and only families are invited. This website was a way that she connected with family members through technology.

Like in many schools, this class had buddies from an older grade. Staying with the goal of working on informational writing, the students used the app Skitch in the following way, building on what they had done previously. The week before, the fifth-grade student took a picture of his/her kindergartener buddy and then the kindergartener told the fifth-grade buddy what captions to add to the picture. This week the kindergarteners were supposed to create the picture with captions. The kindergartners took a picture of an animal and added captions with information about the animal. The fifth graders were to serve as a resource to help their

kindergartener buddy with the process. Then, the kindergartner, with the fifth-grader's help, emailed the pictures to the teacher. The teacher printed the pictures so that the kindergartners could take them home. This activity encouraged interactivity and social communication. The kindergartners felt empowered to be in charge but knew that they had the fifth graders to support them. After the activity and right before lunch, the teacher put on a book from Storyline Online. This website has famous people reading books enhanced with music and sound effects.

Another way the teacher integrated technology and encouraged children to become global citizens was Tweeting with other classes. This class Tweeted with a class in Hong Kong. She has been tweeting with this class for three years. The teacher stated,

> It's really fun because there are so many differences in our communities, and so we really hit similarities and differences and learn to ask good questions. They'll pose a question to us, and it will make my students want to know more about the subjects. That leads us to researching. This is guided. Obviously everything is guided. They will want to Google and where they can look for information. They are very good at saying you know 'let's go to Google for that or go to YouTube and try to find a video.' My biggest goal with five-year- olds who are still so egocentric and life is just about them and home and school and especially in (this small town). Families (here) don't travel very much, (the next town) is about as far as they will go, I just want their eyes to be opened up that there is a world outside of (their town). I want them to see that people are the same as us and people are different that us and that we can celebrate how we all live. So that's my biggest goal to take things outside these walls.

Teacher #2. In this kindergarten classroom, there were six iPads, three desktop computers, a SMART Board, and a SMART Table. The teacher was trained on the SMART

Table when she received her SMART Technologies training. She wrote a grant to get SMART Tables into the district (see Appendix G & H) when she was a technology trainer. She was very passionate about getting the tables into the classrooms because they encouraged social and academic development. She had one of the first generation of tables released. She admitted that these tables are limited in what they can do and may not be worth their $5,000 price tag.

Technology was used from the moment the children walked into the classroom. The teacher used the SMART Board to take attendance and have the children make their lunch choice for the day. The fifth graders delivered the morning announcements daily from the school's student-run TV station. Next, the class began the morning's literacy centers. The children had a learning contact that they followed for 6 days called *My To-Do List*. The teacher created a to-do list form for the students. To keep track of progress, each day the teacher had the children colored in a block on the to-do list designating the center they attended that day. They were to color the block on the form in the color of the day; the day the researcher observed, happened to be yellow. In this classroom, there was a mixture of technologically enriched activities and non-technological activities. The teacher said that she got a lot of her ideas for the centers from Pinterest. She pulled a preselected group to the table, and the rest of children were able to choose where they wanted to go. iPads are assigned to each table, so, only one child per table could use an iPad. This classroom was using Smart Recorder, and children were again working on their reading fluency by recording themselves reading a book (like in the previous classroom). This was a new activity for these children. They were actively engaged in recording their reading and listening to it. At the computers, the teacher had the children play on the program Starfall that allows the children to practice early literacy and math skills. After approximately 15

minutes, she rang the bell, and the children cleaned up, marked what center (in yellow) they attended on their learning contract and met back on the rug. Then the whole process repeated.

Later in the day, technology was also available at center time. This time, the students were assigned to a center. The teacher indicated that computers, iPads, and the SMART Table were always out, but the other centers rotate and sometimes certain centers were available and sometimes not. The centers were a nice mixture of technological and non-technological activities and included: a sand table, computers (www.abcya.com), iPads, and the SMART Table, circle connectors (a non-technological building toy), puzzles, and big blocks. The afternoon was less structured than the morning, but the teacher had the children assigned to a center. Each center had four to five students. The technology was considered one center and students could choose the device they want to use and what they want to do. This was purposeful because the kindergarten teacher wanted the children to have a chance to play with technology so they can focus on learning and thinking when it is time to do so. The student who chose the iPad was using the app Pixie, which is a drawing app. The children at the SMART Table were playing with many of the games on the table. Most of these were sorting or classifying games, and required the students to interact and collaborate. Children at the SMART Table needed to interact and communicate while playing the games. Interaction and playful games, including make-believe play, was and element at every center. The afternoon center time lasted a half an hour and allowed the children to do a lot of interaction, collaboration, and play.

The teacher indicated that she has plans to integrate technology to help connect the children to others outside the classroom. She would like to connect her students with other kindergarten students in another country, so the children can be exposed to another culture; Skyping and KidBlog was how she planned to do this.

She shared,

> I want to do global collaboration. I want to open the doors a little bit for the children. So another one (activity) that is amazing is KidBlog. Kindergartners can do it. They can talk to each other, and it's really messaging and talking.

KidBlog is a website that is a safe and simple way for children to write in an authentic and meaningful way and engage with a global network. KidBlog also has app for the iPad also that the children can use.

Other apps and programs that she used were Tumblebooks, Scholastic BookFLIX on the computer and the Mathseeds app on the iPad. Tumblebooks is an online collection of animated, picture books. Scholastic BookFLIX is an online collection of video books. Both of these require a subscription, which she obtains through her school district. Mathseeds is geared for kids aged 3-6 and teaches the core math and problem solving skills with fun, highly interactive and rewarding lessons. She has found that the SMART exchange and SMART technologies have amazing resources. To access the SMART Notebook, a software activation key comes with a paid product or subscription. The SMART Notebook allows a teacher to create activities, concept maps, build shapes, and more and project the activities onto a screen or SMART Board. These are activities she would like to promote.

Teacher #3. In the third classroom at the STEM school, the preschool teacher conducted a 4-week unit on robotics with the students. She began by connecting robots with something that the students were familiar with, the human body. The teacher compared the human body and body parts of a human with the parts a robot needs to function. Beginning with the human body, they talked about how a body has a brain and a heart. Next, they talked about the body of a robot. They, then, talked about the computer brain and the computer-processing unit (CPU).

Then they spent a week talking specifically about senses. They compared human's five senses, how robots sense things, and how senses give humans and robots the information they need to interact with their environment. Finally, they talked about what jobs a robot could do and how robots could be programmed. The unit was very incremental and built on and connected to what the children already knew. This was done; therefore, the children had enough background knowledge to understand programming robots. The 4-week unit was a developmentally appropriate way to introduce robots and programming to preschoolers.

The teacher said they introduced robotics to encourage problem-solving, critical thinking, collaboration, and some of the other 21st-century skills. She indicated that the unit went well. The results of the unit were interesting and not exactly what she had anticipated. She expected that language development would be evident as they talked through what they did, but what was interesting was that the robotic activities attracted her English language learners and her students who were on a speech IEP the most. These students, despite their low language abilities, ended up being some of the more interested and successful kids when it came to working with the robots. It was an interactive unit and enhanced the students' cognitive and social abilities of all children because the students had to discuss and problem-solve how they would program the robot to make it perform.

The first class the researcher observed was the 3-year-olds during Free-Play time. The children were allowed to choose anything that they wanted at this time. The room contained a blocks center, sand table, painting, play-doh, iPads, a Little Tykes Computer, a dramatic play center that has been turned into a garden center, and robotics that had been introduced in a previous unit. In the robotics unit, they used Bee-Bots and Cubelets to introduce robotics to these preschoolers. Bee-Bots are programmable floor robots that are built for young children.

The Bee-bot is a colorful bee that can be programmed by students to move and turn. It can remember up to 40 instructions entered by students. Cubelets are magnetic robot blocks that snap together to make different robot toys. These younger group of children in the first class were mainly playing with the robot Cubelets and Beebot. They played with the Beebot and tried to make it do what they wanted it to do. They talked and tried to help each other program the robot to make it move in a certain direction. They were successful about half of the time. One boy tried to use the Cubelets but instead of putting the blocks together to make the robot do something specific, he just liked the click all the blocks together. These 3-year-olds were mainly exploring and playing with the Beebot and the Cubelets.

The next day, the teacher did a specific lesson with the older group of children. These children were 4-year-olds and will be attending kindergarten next year. In the activity, the teacher had a mat with pictures on the mat it (see Appendix I). She had the children pick picture cards. Then, the children were to program the Bee-bot to go from one picture to the next. This programming task required problem-solving, critical thinking, and collaboration. The children had to decide which buttons they would need to push and how many times. The biggest challenge for the children was remembering to clear what had previously been programmed into the Bee-bot. The teacher scaffolded the learning by providing cards with arrows signaling the direction that they wanted the robot to go. She placed a card for each time the child was to push the button on the robot. The children worked together and helped each other determine how many times the button would need to be pushed. Often, one of the children would get excited and push the button too fast without listening to his/her peers; they would have to start all over.

What are teachers views on DAP and technology?

Teacher #1. This kindergarten teacher's philosophy was that integrating technology with 5-year-olds should be done in a very guided way. She spends all year modeling and guiding the children as they explore with technology. She also feels that it is important to give her children technology to just practice and let them experiment. It is like any other manipulative in your classroom. In her words

> You have to let them play with it first, or they will use it in an inappropriate matter. They're curious and they are going to try and go places where they can't go. They know where they want to be, and they know how to get there. It is important to make sure that the technology stays appropriate and at their level.

One goal in integrating technology was to open her students' eyes to the world outside of the small town where they live. She said that most of her students do not travel; she wants them to understand that people all over the world are the same and yet different. Her intention was for her learners to celebrate how we all live. She believed that children should use technology for both skill reinforcement and in creation. She stated,

> I think so often, teachers get locked into iPads and just use them for the apps and games, but I think that there is so much more that you can do with them, especially with the young ones. I mean it has to be guided with the little kinders. But I think if they at least begin with the guided use of technology that by the time they are in first, second, and third grade, they will have that foundation and then will be able to start being a little bit more independent.

Her views on developmentally appropriate practice are as follows:

> Developmentally appropriate is looking at the whole child and it is making sure that it (the activity) is at their ability level. It's very guided, and it's hand on learning. It is encouraging the development of that whole child. It's not taking it to that extreme of all academics. It's also not all play. There is a nice happy medium of the two that they can come together and work together.

Teacher #2. The second kindergarten teacher felt that technology makes teaching easier in a developmentally appropriate way. It can easily meet all different types of learners and differentiate to meet all learning needs. She loved teaching 5-year-olds and wanted her students to treat technology as a learning tool much like a pencil. Her goal was to have children so excited about learning that they choose to do it, even at playtime. She stated,

> A lot of teachers just use it (technology) as a fun thing you know, but I want it to be like it's just like their pencil. You know it's not just fun games and let's play, it's really thinking and taking thinking to a different level.

In her words, she described developmentally appropriate practice:

> It's kid by kid for sure. Every kid is different. I would have to say that you have to get to know your learner first and every kid's got his or her own map. So one thing that works with one, won't work for another, you got tweak everything you do.

She believed that technology is developmentally appropriate because it makes easy to meet individual needs.

> Every kid is different… you have to get to know your learner first and every kid's got his or her own map. So one thing that works with one, won't work for another, you got tweak everything you do. That's the thing with technology, it is easy to deal with different learning styles and you can move up to hard materials so easily. You can

differentiate so much easier with technology. Just with a push of a button, you can differentiate.

Despite the hefty price tag, one thing she loved about the Smart Table that she had in her classroom was that the children have to interact and communicate while using the table. She does not often see them interacting when using iPads, but with the table they have to engage and communicate with each other. At centers, she said that she formally had the children rotate every 15 minutes, but she noticed that the longer they stayed at a center, the more sophisticated the play became. She then allowed the students to stay at the centers the entire 30 minutes. At the beginning of the year she noticed, they were just learning how to share, but now they have more complex, creative play. Through the centers, they learn how to negotiate and get along with each other.

Teacher #3. The preschool teacher believed that developmentally appropriate practice has to do with the kinds of technology that are incorporated, how the students are allowed to utilize that technology, and how the teacher supports the students' understanding of using that technology. She does this in her preschool classroom by using inquiry instruction. In her words,

> Inquiry instruction is a great way to integrate technology into the classroom. (When using inquiry instruction and technology) it doesn't become forced, and it's not overly structured. It's more exciting and engaging and kids do it because they want to do it and not because they have to do it.

She also felt that students should interact with the all types of learning tools (digital and non-technological based one) and not spend all day, every day, at the computers. She stated,

> I do try to limit the amount of time that they are spending on the technology because their brains are still developing, and we want to make sure that we are doing it appropriately.

She is careful about what kind of apps and software that she allows the students to use. She wanted to make sure that they are both meaningful and connect to the curriculum. She believed that children need to build background knowledge with technology because everything we do today is on computers, and if we want to be realistic about the type of jobs that students are going to have when they are older, we have to make sure that we are preparing them to use technology. In her words,

> They (students) will even be using technology that isn't even invented yet. I limit the amount of time that students have on the iPads or computers because their brains are still developing, and we need to make sure we are doing it appropriately. I want them to be interacting with the tools, but I don't want them to spend all day every day at the computers. I want them to play. I want them to be in dramatic play and the blocks and art and writing during all the other centers too. I also want to give them opportunities to use technology to let them create whatever they want.

Table 2

Technology Activities Used in the Classrooms

Domain of Activities	Literacy	STEM	New Media Literacy	Robo-tics	Global Citizen-ship	DAP & Tech
Kindergarten Teacher #1	Research on YouTube for Kids, Symbaloo account with National Geographic Books, iPads practiced reading fluency using QuickVoice.	Math Word problems-abcya.com, iPad- Kids Math, Interactive math games on SMART Board	Created iMovie reading favorite book, displayed on class website, used Skitch to create picture with captions		Skype Play with K class in Denver. Played Head-bands, Tweets with class in Hong Kong.	Modeling, allow children to play with tech first, open their eyes to the outside world

(continued)

Kindergarten Teacher #2	Smart Record for fluency on iPads, Starfall and abcya.com on Computers, Tumblebooks Scholastic BookFLIX	Sorting and classifying activities on SMART Table Mathseeds app on iPad			Kid Blog (She plans to)	Tech-nology is used to dif-ferentiate, allow children to play with tech first, use tech to interact and commu-nicate.
Preschool Teacher	Little Tykes computer, iPad games	Program-ming the robots		Robo-tics Unit with Beebots and Cube-lets		Uses inquiry based learning and have a mix of tech activities and non-tech activities.

Relating the Cases to DAP Checklists

The *Checklist for Identifying Exemplary Uses of Technology and Interactive Media for Early Learning* (The Pennsylvania Digital Media Literacy Project, 2012) guided the coding scheme for the three case studies. The *Checklist* was based on the NAEYC and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College joint position statement (2012) and was developed by The Pennsylvania Digital Media Literacy Project and Developmentally Appropriate Practice guidelines. In addition, a few codes were added that were not on the checklist because they appeared multiple times for example, the teacher used flexible group. Using pattern-matching logic (Yin, 2013), it was found that many key elements were present in all three classrooms that could guide other teachers in the selection of technology and the integration of this technology. Table 3 identifies the top six characteristics:

Table 3

Key Characteristics of the Classrooms

Key Characteristic	Times Occurred
Technology is deliberately chosen and meets developmental needs	30
Using technology to support goals and standards	29
Technology offers scaffolding and reinforcement of skills	28
Students have access from experts and other peers	19
Technology connects the students beyond the classroom	18
Tools are age appropriate and understandable	16

Table 4

The Next Six Key Characteristics

Key Characteristics	Time Occurred
-Tools are age appropriate and understandable	14
Teacher used flexibility in grouping	14
Technology supports learning, complementing play conversations, and social interactions	14
Technology encouraged interaction of peers	12
Technology is interactive, playful, and encourages creativity	12
Teachers felt like they had the resources that they needed	11

Summary

The main question that guided this study was, How is Technology Integrated in the P-3 Classroom in a Developmentally Appropriate Way? Each teacher had a different background

with technology, but all sought out professional development opportunities to increase their knowledge. The three teachers worked in schools with different demographics, but they all felt they had the resources and materials needed to integrate technology in their classroom. They all had their own style and procedures that they used in integrating technology, but there were commonalities that occurred in all three case studies.

The most frequent thing that occurred in all three classrooms was that technology was deliberately chosen and to meet developmental needs of the children. Technology, programs, and apps were deliberately chosen to meet instructional goals for the developmental needs of the children, including distinct cognitive abilities, motor skills, social-emotional needs, and interests of the children. These children were not just using the computers or iPads to do whatever they wanted. The teachers were very mindful of what technology and programs were chosen and had specific objectives for choosing them.

Next, the technology used by the teachers in the classroom was geared to support goals and standards and technology offered scaffolding and reinforcement to children of different abilities. Kindergarten and preschool teachers have standards that are meant to guide their teaching and it was evident that these teachers selected technology tools to help children meet these standards. In the literature, it continually stated that when integrating technology with young children, it should involve interaction with the technology, peers, and adults. Technology and interactive media in these classrooms offered opportunities for joint engagement and collaboration with peers and experts. In these classrooms, the computers and iPads were placed where children engaged in conversation, cooperative play, exploration, and problem-solving together.

Technology was also used to connect to the lives of students to the world beyond the classroom. One kindergarten classroom Skypes, Tweets, and connects with other classrooms around the world. This teacher also has a website where she connects with family members. Finally, in all three classrooms the tools selected by the teacher for the children to use were age appropriate and provided clear instructions and prompts. The preschool teacher indicated that she made sure that her children were not looking at screens the whole time at choice time. The kindergarten teachers offered a healthy blend of technological and non-technological activities as choices for children. Integrating technology in a developmentally appropriate way, according to these examples, takes a teacher who understands technological capabilities and affordances, intentionally chooses programs, technology and apps to be age appropriate, meets grade-level standards, and offers scaffolding. In addition, the technologies are interactive and encourage collaboration and play.

The use in the three classrooms represents domains from the literature of using technology to support reading, writing, and math, new media literacies, STEM, and robotics. The teachers' views on developmentally appropriate technology use in the primary classroom were similar. They all concurred that children should be able to play with technology before they are expected to perform a specific activity. They all also agreed that technology in the classroom should be a learning tool like any other manipulative. They all also, offered the children technological and non-technological choices during literacy, math, and choice time. Finally, they saw technology as a way to open the classroom to the outside world and expose the children to different cultures and experts.

Chapter 5: Discussion

Technology and digital media are an integral part of a young child's world; therefore, it is natural that it be a part of a young child's educational learning environment (Judge et al., 2006; Weintraub Moore & Wilcox, 2006). Every day, children are bombarded by smartphones, tablets, computers, and more. These devices are a natural part of their world. The good news is that digital technology can be a playful bridge to integrate academics into the early childhood class through authentic and meaningful projects and activities. The bad news is that in many early childhood programs, quality integration of technology is not happening because there is little guidance on best practices to integrate technology in an early childhood setting for practitioners (Wolfe & Flewett, 2010). Many early childhood teachers are not tech-savvy and don't know how to use technology in a developmentally appropriate manner.

The formal research question that guided this study was, How are digital media and technology integrated in a developmentally appropriate way in the P-3 classroom? Sub-questions in this study were:

- What are the specific activities?
- What are teachers' views on DAP and technology?

An important part of this study was to make sure that technology was integrated into the program to meet not only the academic needs of the child but also the developmental domains. A secondary piece was to examine if the teachers use technology intentionally to scaffold learning and provide developmentally appropriate technological experiences. Technology integrated in a DAP classroom can help teachers meet young children where they are and scaffold their learning to meet achievable and challenging goals.

The purpose of this study was to observe primary teachers who integrate technology in their programs in a developmentally appropriate way and then offer these examples to the field. Three exploratory case studies were conducted. They involved one preschool teacher and two kindergarten teachers, all of whom use technology as an integral and natural part of their classroom practice. Data were collected through interviews of the teachers and observations in their classrooms. This chapter contains a brief literature review highlighting key research that shows how young children benefit from using technology, a summary of what was done in case studies and the methodology used to analyze them, a discussion of the key findings, conclusions, and recommendations for further study.

Brief Literature Review Highlights

Developmentally appropriate practice urges educators to meet children where they are and then lead, guide ,and challenge them to grow academically and developmentally. This means that the teacher needs to go at the child's rate and not expect the child to meet a standard that may be set by the teacher, district, state, or the nation (Rushton et al., 2009). The goal of DAP is to provide children with optimal experiences to help their development. DAP encouraged teachers to base their practice on three core assumptions: (a) teachers use practices that reflect child development research, (b) teachers use practices that account for each individual child and focus on the whole child, and (c) teachers use methods that take into account the socio-cultural context of each individual child's development (NAEYC, 2009).

Both the NAEYC and the Fred Rogers Center have established a framework and position statement to guide educators in integrating technology in a developmentally appropriate way with young children. The *Framework for Quality Digital Media for Young Children* created by

the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College (2012) stated that quality digital technology and media should:

- Safeguard the health, well-being, and overall development of young children.
- Take into account the child, the content, and the context of use.
- Be grounded in evidence that guides parents, educators, policy makers, and others to make decisions about the product .

The joint position statement of the National Association for the Education of Young Children and the Fred Rogers Center for Early Learning (2012) stated,

- Teachers should intentionally select technology and interactive media;
- Technology should be integrated, age appropriate and developmentally appropriate;
- Technology should be hands on, interactive, playful, and enhance children's cognitive and social abilities;
- Technology should be equitable for special needs and language learners;
- Technology programs should contain an element of digital citizenship for young children.

Research has also shown that when used wisely and appropriately, technology and new media can engage, motivate, increase persistence in children, and serve as a catalyst for social interaction (Clements, Nastasi, & Swaminathan, 1993; Haughland & Wright, 1997; Mouza, 2005; NAEYC & Fred Rogers Center, 2012). Technology tools should be used with young children in ways that enhance opportunities for children's cognitive, social, emotional, physical, and linguistic development and positively influence their level of self-confidence. Haugland (2000) suggested that integration should occur in the program or curriculum, not used as an add-on to the regular schoolwork, so that it serves as a catalyst to transform learning (Yelland, 2005). However, developmentally appropriate technology integration in early childhood classrooms

remains problematic. Early childhood teachers should take the opportunity to embrace technology, or they may be *missing the boat* with young children (Parette et al., 2009).

Several themes emerged in the literature on integrating technology in a DAP way that benefit children warrant attention. The first was using New Media Literacy (NML) with young children (Apler, 2013). New media skills include research skills, technical skills, and critical analysis skills that build on traditional literacy skills (Apler, 2013). Second, the topic of developing science, technology, engineering, and mathematics (STEM) skills with young learners has recently come into focus. STEM initiatives have largely been at the middle and high school level, but more research is being conducted focusing on the benefits of integrating STEM into the curriculum with young children (Highfield, 2015). Next, technology can be and in many cases should be used to assist in teaching reading, writing, and mathematics skills. Finally, computer programming and robotics can be used in the early childhood program (Bers, 2008). These will be considered further as they were seen in the case studies.

Description of Participants and Case

Three case studies were conducted in three different school districts in Colorado. The first kindergarten teacher taught in a small rural school district. She was new to technology, but taught kindergarten for 17 years. In the last few years, she has taken the initiative to learn about technology and integrate it in all aspects of her teaching. She learned from both a mentor in her school and from many classes offered within and outside of by the school district. This kindergarten teacher integrated technology throughout the day in many different subjects, in various ways. She had both technology and non-technological centers for literacy and math. She emphasized collaboration and pairing fifth grade buddies with the kindergarteners to help

scaffold the use of technology, programs, and apps. One of her goals was to open her student's eyes to the world around them.

The second kindergarten teacher worked in a bigger school district in a suburban school. She had 28 years of teaching experience and an extensive background with technology as she spent the last three years as a technology trainer for the district. This teacher also intentionally and thoughtfully integrated technology at literacy time and center time as a choice along with other non-technological choices. Because of this integration, the children in this classroom were engaged in their learning. This teacher was a SMART Board exemplary educator and integrates both the SMART Board and SMART Table into her teaching.

The third teacher was a preschool teacher who taught in a small preschool in a small rural town, but bigger school district. She had been working with early childhood and elementary age kids in a variety of capacities for the past seven years. She felt that integrating technology is important because she thought the children she teaches need to be prepared for a digital world. She believed that preschoolers need to have access to technology, but it needs to be regulated. She was intentional to which programs and apps the students are exposed.

Methodology

Exploratory collective case study methods were used for this qualitative study (Creswell, 2013). Two forms of data were gathered: (a) observational data from classroom visits, which was recorded in forms and as field notes and (b) interviews with the classroom teachers. To provide more information for the field notes, pictures that were taken of the educational environment and activities were used to supplement the written information. An empty table shell and checklist was also used to guide the observations (Yin, 2013; Appendix A & E). The classrooms were visited several times to get a complete picture. The field notes and checklist

were written up and analyzed immediately following the observation. Two interviews were conducted with each teacher; one interview occurred before the classroom visit and one after the visit. The interviews were recorded and transcribed. Observational data collection was obtained by observation by the researcher.

More specifically, this study was guided by the research questions and *A Framework for Quality in Digital Media for Young Children* created by the Fred Rogers Center and the joint position statement of the NAEYC and the Fred Rogers Center; therefore, the analysis used theoretical propositions as a basis for the pattern matching (Yin, 2013). The framework and joint position statement guided the development of the codebook and was used in the qualitative analysis. During the analysis, other codes emerged and were added to the codebook. The analysis was done using the software tool HyperResearch. This tool assisted the researcher to be more reliable in the analysis (Yin, 2013). Because this study was exploratory, the researcher was looking for patterns of good developmentally appropriate technology use as suggested by the literature and then observed. During the classroom visits, the researcher recorded, in detail, what was done in each classroom during the technology activity and a detailed description was written of each case. The checklist for identifying exemplary uses of technology and interactive media for early learning from the Pennsylvania Digital Media Learning Project (Appendix A) was also used as well to guide the observations. In addition, the researcher looked for examples of NML, STEM skills, tech in teaching literacy and mathematical skills, computer programming and robotics, project-based learning, and play as was found in the literature to be promising practices for DAP. Using the guidelines from the literature to guide the process helped ensure the construct validity of the data (Yin, 2013). To help ensure reliability, checklists were used; in addition, they prompted the researcher to look for different appropriate pedagogical methods

such as age-appropriate tools and activities that met instructional goals for the developmental needs of the child. In the analysis, using pattern-matching logic (Yin, 2013), it was discovered that many key elements were present in all three classrooms. These elements could serve to guide teachers in the selection of technology and the integration of this technology and are discussed below.

Summary of Findings

The formal research question that guided this study was How are digital media and technology integrated in a developmentally appropriate way in the P-3 classroom? This question was answered by a discussion of the conclusions of the sub-questions. In the classroom observations, much was observed that could help guide primary teachers in integrating technology; through an analysis of the observations and interviews, these observations of technology were linked to DAP use of technology. The most commonly occurring developmentally appropriate practices were (see Table 3 in chapter 4): technology intentionally chosen to meet developmental needs and meet the goals and standards; technology offered scaffolding and reinforcement giving access to experts; technology connected learners beyond the classroom; and technology use was age appropriate and understandable. Other DAP uses observed, but less frequently were (see Table 4 in chapter 4): technology supporting learning, complementing play, conversations, and interactions; teachers using flexible grouping; children actively engaged; technology that was interactive, playful, and encouraging creativity; technology encouraged interaction of peers; and the teachers felt as though they had the resources they needed. These were found in all three classrooms.

Research question 1: What were the specific activities? In all three classrooms, technology was offered throughout the day in many different ways. In the kindergarten

classrooms, it was offered as a choice at center time and used as a rotation during math and literacy time for small groups. This enabled scaffolding and differentiation to occur. In all three classrooms, it was offered as a choice at center time and also used in small group lessons. According to NAEYC and the Fred Rogers Center (2012), technology is successfully integrated into the program when the emphasis is on the activity and not the technology because the use of technology is routine. This was observed in all three of these exemplary classrooms. For example, in one of the kindergarten classrooms, the children in one of the small groups were working on researching their animal on the computers and the children in another small group were working on fluency in reading on the iPads. The teacher's established routines with technology enabled her to work with another group in reading. As the other kindergarten teacher stated,

> A lot of teachers just use it (technology) as a fun thing you know, but I want it to be like it's just like their pencil. You know it's not just fun games and let's play, it's really thinking and taking thinking to a different level.

This teacher saw technology blending into the background and becoming transformative at the same time.

Technology is deliberately chosen to meet developmental needs and standards.

Technology that was deliberately chosen was observed most frequently in each classroom. The activities, programs, technology, and apps were intentionally chosen for the children and were both deliberately chosen to meet developmental needs and/or tie with the curriculum, learning goals, and standards; the technology addressed distinct cognitive abilities, motor skills, social-emotional needs, and interests of the children. For example, abcya.com, a program designed for young children ,was chosen by both of the kindergartner teachers for their children. These

children were not just let loose on the computers or iPads to do whatever they wanted, instead they were to practice word problems designed for kindergarten which reinforced the math standard that they were working on. The teachers were very mindful of what technology and programs were chosen and had specific objectives for choosing them. As one of the kindergarten teacher stated,

> As far as the activities, I try to link them to the standards and have it (technology) reinforce those. We've really shifted completely this year and we are now 100% standards based, targets, exemplars, and assessments. So, everything that we incorporate into our day has to be linked to our standards. But, everything can be. Everything I do I can link to a standard. Especially literacy, oral language, you can link anything to oral language because these kids just need to talk and think and have conversations.

Technology offered scaffolding and reinforcement and gave access to experts. Symbaloo, which is a free bookmarking service in the cloud that makes it easy for children to access resources, was used to scaffold researching on animals for one of the kindergarten classes. The teacher loaded *National Geographic* books about animals into the bookmarking tool so all the children needed only to do was click on the book they wanted and it would be read to them. The children also learned about their animals by watching videos from *YouTube for Kids*. While accessing the books or watching the videos, the children then took notes on a template provided by the teacher. This was a way for the children to access information in an independent way and a developmentally appropriate way to introduce and scaffold researching to kindergartners.

All of the classrooms chose programs and apps to reinforce skills. The kindergarten classrooms were using Starfall, abcya.com, YouTube for Kids, Tumblebooks, Bookflix, and apps such as Skitch, QuickVoice, Smart Recorder, Mathseeds, and Ace Kids Math. Studies have

shown that using appropriate and quality programs and apps have improved academic, cognitive, and social development (Bergen, 2000; Couse & Chen, 2010; McManis & Gunnewig, 2012; Judge et al., 2006; Kankaanranta & Kangassalo, 2003; Kirkorian et al., 2008; Clements & Sarama, 2003; Wartell & Jennings, 2000; Yelland, 2005). As one kindergarten teacher stated,

> Every kid is different… you have to get to know your learner first and every kid's got his or her own map. So one thing that works with one, won't work for another, you got tweak everything you do. That's the thing with technology, it is easy to deal with different learning styles and you can move up to hard materials so easily. You can differentiate so much easier with technology. Just with a push of a button, you can differentiate.

In the preschool classroom, the teacher did a unit on robotics with the children. The preschool teacher found that with the robotic unit they implemented had multiple results: It encouraged language, yet, the students who were on an IEP for speech and her ELL students were the children most interested were. Because they were so engaged, this gave them an authentic way to practice and develop their language skills. Both the kindergarten teachers had the computers and iPads at their literacy centers and used programs that allowed for skills reinforcement and scaffolding. One in particular was the recording apps used to scaffold reading fluency. The children could listen to their reading and understand what they needed to improve. They found that there were many programs and apps helped in various areas.

Experts and other peers often offered new social opportunities with technology and because the children had access to these experts, scaffolding was available for the student. This was done in different ways in each classroom. One kindergarten classroom used older children as experts to scaffold the learning for the kindergartners. The older children first modeled how

to use the technology and then served as a resource while the kindergartners tried to use the app Skitch on the iPad. In another case, a third-grade "expert" filmed the kindergartners reading a book on iMovie that was later put on the class website. This school also used older children to be experts and provided help to both the younger children and the teachers if needed. The teacher explained,

> We have the techpert group in our building that our principal is very supportive of. Its philosophy is that teachers are holding kids back from using technology. These kids know a lot more than teachers do, and it is ok that teachers learn, so the experts teach the adults. They will go and work with the classroom teacher. These students are even going into the community and helping some of the companies to train their workers on some of the new capabilities with Google.

Technology connected beyond the classroom. Technology was used to connect the lives of the students to the world beyond the classroom. The classroom should be a reflection of the society that children live in. Technology is allowing children to interact with their society. Both of the kindergarten teachers felt that it was important to open the doors and expand their students' knowledge of the world beyond their classroom. Technology is enabling 5-year-olds to connect with other 5-year-olds on the other side of the world! Technology tools such as Skype, Kidblog, and Twitter were used in these classrooms to connect beyond the classroom. The teacher in the first case study stated,

> My biggest goal with five-year- olds who are still so egocentric and life is just about them and home and school and especially in (this small town). Families (here) don't travel very much, (the next town) is about as far as they will go, I just want their eyes to be opened up that there is a world outside of (their town). I want them to see that people

are the same as us and people are different than us and that we can celebrate how we all live. So that's my biggest goal to take things outside these walls.

The children in this kindergarten class live in a small community and technology has opened up the world to these five-year-olds. This teacher has Skyped with four or five classrooms all over the United States and Twitters with Hong Kong. She also has a website where she connects with family members and shares projects that the students are doing.

The other kindergarten teacher plans on doing this, but first will have her students blog with other students. She stated,

> I want to open the doors a little bit. So another one (activity) that is amazing is KidBlog. Kindergartners can do it. They can talk to each other, and it's really messaging and talking.

Technology was age appropriate and understandable. Technology used in all three classrooms was age appropriate and understandable. The researcher observed that the students in all three classrooms were able to access and interact with the programs and apps chosen by the teachers. Children chose to use technology in the same way that they chose to play with puzzles or blocks. It was a natural part of their learning environment. At choice time, technology choices and non-technology choices were offered, and children could choose what they wanted to do. Classroom procedures in each classroom varied, but it was evident that much time had gone into developing the procedures. The first case study kindergarten teacher said,

> (Everything I do) is guided, just very guided apps and websites appropriate for their age and (I do) a lot of modeling.

The technology use in the classrooms was seamless, authentic, and natural. The students used the computers and apps to practice reading fluency in a way that excited and engaged them.

The technology was used as a learning tool like any other learning tool. Most of the literature stated that to be effective using technology with young children, it should be interactive, actively engaging, and encourage conversations and creativity (Burnett, 2010; NAEYC & Fred Rogers Center, 2012; Parette et al., 2009; Plowman & Stephen, 2003; Resnik, 2006: Rosen & Jaruzewicz, 2009; Rushton et al., 2009).

Age appropriate sometimes means limiting technology use for younger children. In the interview, the preschool teacher indicated that she made sure that her children were not looking at screens the whole time at choice time. Here are her words:

> I do try to limit the amount of time that they are spending on the technology because their brains are still developing, and we want to make sure that we are doing it appropriately.

Research question 2: What are the teachers views on DAP and technology?

Developmentally appropriate practice was evident in all three classrooms. The teachers were intentional with the learning experiences that occurred in the classrooms and gave the students opportunities to explore and play with the technology before they were expected to focus on a specific activity or project. Just like any other manipulative, children need to play first. One kindergarten teacher noted,

> I want them to have a chance to play with technology so when it is time to really learn and think in the morning, they can focus on it.

The other kindergarten teacher stated,

> I give them technology just to practice. I want to get it in their hands. Let them experiment. It's like any other manipulative in your classroom. You have to let them play with it first, or they will use it in an inappropriate matter. So it is using it like you would anything else with a child. They're curious, and they are going to try and go

places where they can't go. They know where they want to be, and they know how to get there.

Not only did these teachers ensure that technology engaged their students, but they also made sure that the groups that used were designed to differentiate. These were flexible groupings; sometimes they were skills-based, other times ability based, and other times mixed; however, they were all done with purpose. All the teachers discussed how the groups were intentionally formed to meet the children's academic and developmental needs.

Developmentally technology use suggest that younger the child, the more the screen time should be limited (NAEYC & The Fred Rogers Center, 2012). This was the view of the preschool teacher. She stated that she is intentional in limiting her young children's exposure to technology. This was observed during choice time. Children were encouraged to make another (non-tech) choice after they had interacted with a screen for a certain amount of time. During the robot unit in this preschool class, the Bee-bot and Cubelets fascinated the children. They loved making the Bee-bot move and took turns programming it. This was a fabulous opportunity for interaction with technology and each other in a playful way. It also encouraged collaboration and problem-solving as they tried to program the Bee-bot to do what they wanted it to do.

Discussion and Recommendations for Practice

Because there were only three case studies were conducted, the findings from this study are not generalizable; but they can serve as examples of classrooms that have integrated technology effectively and appropriately in early childhood. The findings are consistent with the literature available on integrating technology into the primary classroom. The classrooms showed examples of robotics, the use of technology to support the teaching of reading, writing and math, new media literacy and teaching STEM skills. Each teacher had a different

background with technology, but all sought professional development opportunities to increase their knowledge. The three teachers worked in schools with different demographics, but they all felt they had the resources and materials needed to integrate technology in their classroom. They all had their own style and procedures they used in integrating technology, yet, there were commonalities that occurred in all three case studies.

The observed teachers included six themes from the *Checklist for Identifying Exemplary uses of Technology and Interactive Media for Early Learning* (Pennsylvania Digital Media Literacy Project, 2012) that made technology integration successful in their classroom. These were (a) using technology to support goals and standards, (b) deliberately choosing technology to meet developmental needs, (c) sing age appropriate and understandable tools, (d) giving students access to experts and other peers, (e) using technology to connect the students beyond the classroom, and (f) offering scaffolding and reinforcement of skills through technology. Another commonality was that these teachers all felt as though they had the resources that they needed and support from their leadership.

Conclusions and recommendations from this study for other teachers to consider when integrating technology into their classroom practice are as follows: technology should be a learning tool; technology should be actively engaging and interactive; technology should offer opportunities for scaffolding and reinforce of skills and also creation; technology should open doors; and there is a need for more teacher training. These were the most frequently occurring in all three of the exemplary classrooms and could serve as guides for other classroom teachers.

Technology should be used as an intentionally chosen learning tool. Technology often is used in early childhood programs as a reward or add-on and is not integrated into the curriculum or program. Many schools still have computer labs and haven't changed even though

Becker reported in the year 2000, that children were twice as likely to use a computer if placed in the classroom and not a lab. In the first case study, the teacher admitted that when the school had a computer teacher and lab, she felt like she did not have to include technology in her program. She reported,

> When I taught in Littleton, I did nothing with technology. I didn't even know how to attach a word document to an email. It was bad. But I think part of that was because we had a computer lab and a computer teacher and so I didn't feel like I needed to learn it at that point because they (the students) would get it (computer training) at the computer lab every week and that was good enough… since I moved here, we didn't have a computer coach of any kind, I had to learn.

She realized she needed to learn about it and integrate into her program in an authentic way. She now deliberately chooses the digital tools that the children will use and ensures that they are age appropriate and are tied to a learning standard.

What this teacher does is in line with what the experts and researchers said that technology should be integrated, interactive, engaging, and socially interactive, for children to benefit (Burnett, 2010; NAEYC and Fred Rogers Center, 2012; Parette et al., 2009; Plowman & Stephen, 2005; Resnik, 2006; Rosen & Jaruzewicz, 2009; Rushton et al., 2009). One of the key messages from the NAEYC and the Fred Rogers Center's (2012) position statement was that when technology is used intentionally and appropriately, technology and interactive media are effective tools to support learning and development of young children. It also stated that teachers need to take the time to evaluate media for the classroom and make appropriate adaptations. Technology that is fully integrated into the classroom program yields the most positive results (Judge et al., 2006). For technology to be effective with young children, they

need to see it and treat it as a learning tool, like any other learning tool in the classroom. It should not be technology for technology sake. It is not the magic bullet and should not replace quality instruction from a classroom teacher in reading and math, but as newer and better technologies and programs are developed, it can enhance achievement for all children.

Technology, programs, and apps need to be evaluated and intentionally chosen to meet only the academic standards, but also the developmental needs of the child. With the wealth of education programs and apps on the market, teachers need to take the time to evaluate these tools and give careful attention to the appropriateness (NAEYC & Fred Rogers Center, 2012). Using the *Checklist For Identifying Exemplary Uses Of Technology And Interactive Media For Early Learning* created by the Pennsylvania Digital Media Literacy Project (2012) based on the NAEYC and the Fred Rogers Centers position statement, teachers can evaluate their practice and employ the recommendations to transform their classroom practices. A comprehensive report from Hirsh-Pasek, Zosh, Golinkoff, Gray, Robb, and Kaufman (2015) provided guidelines for educators in selecting apps to use with young children. The researchers concluded that apps best support learning when they require an active mental effort, and are engaging, meaningful, and socially interactive. Intentionally using these guidelines in selecting educational apps will help educators to determine the ones that will give students an educational meaningful experience.

Technology can benefit students in many ways if teachers scaffold technology in an appropriate way for young children. In all three classrooms, the teachers were observed doing just that. In the first kindergarten classroom, the bookmarking tool Symbaloo was used to scaffold appropriate books for the children to listen to. In the second classroom, children performed sorting and classifying activities on the SMART Table. In the preschool classroom, literacy and math programs and apps were programmed on the Little Tykes Computer at their

age and ability level.

In each of the classrooms, the teacher was mindful to select programs and activities that involve technology that supported an educational goal or standard important in today's standard driven educational world. In Colorado, teachers are expected to use the Colorado Academic Standards with the Common Core embedded as a guide for their teaching. In preschool and kindergarten, the Reading, Writing, and Communicating standards are oral expression and listening, reading for all purposes, writing and composition, and research and reasoning. In math, the standards are number sense, properties and operations, and shape, dimension, and geographic relationships. There are also science, social studies, the arts, and health and physical education standards. The teachers use the standards to guide their teaching and selection of educational tools and activities. As one of the kindergarten teachers stated,

> As far as the activities, I try to link it to the standards and have it (technology) reinforce those. We've really shifted completely this year, and we are now 100% standards-based, targets, exemplars, and assessments. It's been a big shift this year. So, everything that we incorporate into our day has to be linked to our standards. But, everything can be. Everything I do I can link to a standard. Especially literacy and oral language, you can link anything to oral language because these kids just need to talk and think and have conversations.

Technology should be actively engaging and interactive. When the focus is shifted to technology as a learning tool, teachers can avoid the passive, non-interactive, and potentially harmful use that is not appropriate in an early childhood class (NAEYC & Fred Rogers Center, 2012). Repeatedly, the literature stated that technology and digital media with young children should be playful, engaging, and interactive (Burnett, 2010; Gullo & Huges, 2011; Hirsh-Pasek

et al., 2015; Kapadia, 2014; NAEYC & Fred Rogers Center, 2012; Rushton et al., 2009). Technology should encourage conversations with adults and other peers. Classrooms that engage and excite students create deeper learning by activating the executive parts of the brain (Rushton et al., 2009). When children are provided many opportunities to engage in their learning, the connections between what has been taught and how they can use it is evident in the classroom and their everyday lives (Rushton et al., 2009). Because of this, teachers have a responsibility to offer children a wide variety of experiences to explore and practice. As one of the kindergarten teachers said,

> I like to balance the technology in two ways. One, I think it is a great way to practice skills, especially on apps. They (the students) can practice their sight words, they can practice their math, can practice their handwriting, and practice all of those skills in a way that they are more engaged. So, that is one of the ways that I integrate it, but I also really want them to see that technology isn't just for consuming and playing games, but that they can produce information and share it. So, we also try to produce digitally.

All three classrooms had a blend of technology choices and non-technology choices. Teachers who have had success using digital technology, set up their classroom so that the computer is used in a social, child-directed way where children can explore just as any other learning opportunity in the classroom (Bers et al., 2002). Playing on the computer does not refer to random, unstructured engagement; rather it describes creative, experimental, and purposeful activity that a teacher has purposely set up, so learning occurs (McDonald & Howell, 2012). Donahue (2015) stated that in being intentional, a teacher uses a higher order teaching skills. This means that he or she understands if, when, how and most importantly, why to use technology.

Technology should offer opportunities for scaffolding, reinforcement of skills, and creation. The technology was also chosen to offer scaffolding and reinforcement. NAEYC and the Fred Rogers' (2012) offered,

> Effective uses of technology and media are active, hands-on, engaging, and empowering; give the child control; provide scaffolds to ease the accomplishment of the tasks; and are used as one of many options to support children's learning. (p. 6)

Technology should not be used for developmentally inappropriate activities (e.g., electronic worksheets) or passive activities, but if used appropriately, these tools can promote learning and development (NAEYC & Fred Rogers Center, 2012). It can naturally scaffold for a child in his/her zone of proximal development (ZPD) and help him or her to the next level. "The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state" (Vygotsky, 1978, p. 86). This is done in a playful, interactive way.

Not only can technology reinforce and scaffold for children, but in the process, it can also help children create and produce projects. Young children do not often get the opportunity to create with technology, but research showed that when children are engaged, creating, and inventing they learn the best (Papert, 1980; Resnick, 2006.) This was shown in the kindergarten class that was conducting research. The teacher scaffolded the activity by creating a template for the children to complete. These students not only learned about the animal that they researched, but they also produced a paper and presented their findings to their peers. The robotics unit for the preschool children not only allowed the children to learn new ideas and practice skills, but also encouraged them to create robots and test out their creations. The teacher first scaffolded this unit by helping the children understand robots by showing how they were similar to objects

or things the preschoolers already knew. Next, these "little engineers" practiced math concepts, scientific inquiry, and problem-solving. They also participated in social interactions and negotiations while playing with the robots. Bringing the Beebots to life required computer programming (Bers, 2010) and the teacher scaffolded by making cards for the children to follow. The Cubelets required the students to assemble them together to create a new robot. In watching these children problem solve, after they were familiar with the process because of the scaffolding, one could almost see the wheels turning in their little brains.

Technology should open doors. In all the classrooms observed, the teachers discussed the importance of technology broadening the children's understanding of the world. The International Society for Technology in Education (2007) has six standards for students. The second standard is *communication and collaboration*. Under this standard, students should

> C. Develop cultural understanding and global awareness by engaging with learners of other cultures.

From Google to Skype to Twitter, technology is allowing 5-year-olds in Colorado to connect with 5-year-olds all over the world. As Thomas Friedman (2007) declared, because of globalization 3.0, the world is flat, shrinking, and empowering individuals around the world. Growing up in this global society, our children need to be exposed to different cultures and different communities. Because of technology, our world is shrinking; this makes it important that children learn about other cultures in other parts of the world. According to one of the kindergarten teachers, when her students have a question, their first response is to go to Google. They understand that if you have a question, the answer is probably somewhere out there on the web.

Because children venture out onto the web, it is even more important than ever that the teachers who are integrating technology incorporate an element of digital citizenship to help their students make informed decisions and stay safe while out there on the web. According to NEAYC and Fred Rogers Center (2012), it is up to the adults to protect and empower children. Students need to learn to ask the critical questions about the technology and media that they use. The first kindergarten teacher noted that the use of technology was guided all year long. She modeled from the beginning how to make good decisions and keep safe. She also ensured that the movies and programs that the children may view are appropriate. She mentioned that some of the YouTube videos, even YouTube for Kids, may contain inappropriate commercials.

In addition, technology can also strengthen home/school connections. Using technology, parents, grandparents, and other family members can enter the child's educational world. Using a website to post movies, pictures, newsletter, allows for constant communication to the parents. Because parents now have this connection and a better understanding of what is happening, they can ask questions about the child's school day and interact with their children about their learning in school. Digital portfolios of each student can include pictures, videos, and anecdotal notes on the children and can be shared at conferences or through email (NAEYC & Fred Rogers Center, 2012). Children are producing the content and the teacher is archiving it. A portfolio also allows for observation and assessment is an authentic way to record a child's academic achievement and developmental growth and the ideal way to assess young children. In addition, through online portfolios, children can see their work online and realize they can be producer of content for others to view, and not just a passive consumer.

Need for more teacher training. Despite the promise of technology, there is definitely a need for professional development for teachers of young children to understand how to integrate

technology appropriately (Judge et al., 2006; Kankaanranta & Kangassalo, 2003; Plowman et al., 2010; Rasinen et al., 2009). Developmentally appropriate technology use (DATU) defined by Rosen and Jaruszewicz (2009) is the use of digital tools with young children to build on their natural fascination to actively collaborate, construct knowledge with digital devices. It considers both the academic achievement of children and developmental growth of children.

Rosen and Jaruszewicz (2009) created a framework that early childhood teachers can use to guide them in an appropriate integration of technology. Early childhood educators should

1. Become technologically literate themselves.
2. Understand the developmental and cultural characteristics and particular needs and interests of their students as related to technology.
3. Make responsible choices about access to technology, equipment, and media.
4. Know how to scaffold children's technology exposure and experiences with appropriate expectations and strategies.
5. Engage in regular documentation and assessment of children's emerging technological competencies and literacy. (p. 167)

The research looked for these were characteristics when identifying classes to observe. The researcher found it was difficult to find exemplary P-3 classrooms that included all of these elements. Because of this, the researcher, along with the literature, recommends a need for more professional development for teachers of young children to assist them in understanding how to integrate technology appropriately (Plowman et al., 2010; Judge, 2006; Kankaanranta & Kangassalo, 2003; Rasinen et al., 2009). NAEYC and Fred Rogers Center (2012, p.10) offered

> Early childhood educators need training, professional development opportunities, and examples of successful practice to develop the technology and media knowledge, skills, and experience needed to meet the expectations set forth in this statement.

All three of the observed teachers had different backgrounds with educational technology, but all three also took classes and enlisted in opportunities to learn more. The districts of the teachers offered some opportunities, but the teacher on her own sought other opportunities outside of the district. One kindergarten teacher was a technology trainer for 3 years, one teacher signed up to take a class to learn more about Google this summer, and another teacher signed up to learn about Scratch Jr., a website that allows young children to program, create, and share.

There is a need for more professional development in using technology for teachers of young children. Preschool teachers often do not have professional development opportunities and the classes that kindergarten teachers take are often geared to teachers of older children (Mouza, 2005; Judge et al., 2006; Plowman et al., 2010; Rasinen et al., 2009). Teachers who understand and feel comfortable with technology will be more effective in encouraging students learn at a deep level with it (Sarama & Clements, 2003). As the preschool teacher who was observed so eloquently put it:

> When it comes to using things like this (technology) with early childhood students you (teachers) just have to try things to see what their (the students) response is to it and go from there. You have to decide what is needed to support their (the students) next steps. If you don't ever try, you will never learn, so you kind of just have to put things out there and see what happens. I think that it is hard sometimes for early educators to feel comfortable doing that because the materials feel so different than what you would often find in the classroom.

Technology in the early childhood classroom should encourage interaction, problem-solving, critical thinking, creativity and open up new doors for young children. It should also allow children to create and produce products to share with others. Children in all three classrooms were engaged, challenged, and excited to learn. This is the ultimate goal for integrating technology in a developmentally appropriate way.

The purpose of this study was to identify exemplary use of the integration of technology in the P-3 classroom in a developmentally appropriate way and add to the literature on how teachers can use technology effectively with young children. Chapters 4 and 5 showed three cases of developmentally appropriate practice that can be shared with other early childhood teachers so they can see more examples. Teachers who feel confident in their own technology skills and who possess a belief system that supports high expectations for all children are more equipped at developing an environment that allows children to explore and create. They also encourage students to reach an appropriate and deep level of understanding integrating technology in an appropriate way (Judge et al., 2006; Sarama & Clements, 2003).

Recommendations for Further Study and Policy Implications

Whereas, research is beginning to surface on the integration of technology in the primary classroom, much more is needed. Recommendations for future research include:

a) Because of the number of classes observed in this study, further investigations, and exploratory research to examine developmentally appropriate technology integration into the primary classroom should be conducted with more classroom teachers to determine what is needed and to also provide more examples for teachers.

b) In this study, teachers used grouping for many different purposes. Further research should be conducted on grouping of students and intentional planning when using technology with young children.

c) The teachers in this study were not observed using digital text, but in the literature digital text can be used to support literacy development. Further research is needed to explore how digital text supports literacy development and children's engagement with digital text (Burnett, 2010).

d) All three teachers in this study integrated digital tablets in their practice. Because teachers are using digital tablets with young children, more research is needed to examine how teachers integrate digital tablets and effective educational apps (Couse & Chen, 2010).

e) Computer games and programs were used by the teachers in this study to reinforce skill development. There is also a need to research and identify computer games that best facilitate developmental play and higher level thinking in young children (Verenkina, Herrington, Peterson, & Mantei, 2010).

f) This study focused on the teacher's practices, but other studies could be conducted focusing on the students. Specifically, focusing on student engagement and social interaction while using technology.

g) A longitudinal study about what happens to children who have technology integrated in the classroom as they grow up and enter the workforce would give insight on best practices for integrating technology.

h) Finally, the policy implication of how to train teachers of young children in integrating technology needs to be further studied.

Closing Comments

Research has shown that integrating technology in early education can yield many benefits. Studies also have shown that with technology use in the P-3 classroom, children grow in cognitive skills, social-emotional, reading, math, and school readiness skills (Brooker, 2003; Chantel, 2003; Clements et al., 1993; Haugland, 2000; Haughland & Wright, 1997; Judge et al., 2006; Kahkaanaranta & Kangassolo, 2003; Li et al., 2006; Mouza, 2005; NAEYC & Fred Rogers Center, 2012; Sheridan & Samuelsson 2003; Yelland, 2005). In observing developmentally appropriate technology use in the early childhood classroom, I found that children were interactive, engaged, and enthusiastic about their learning. This did not surprise me because children growing up in this digital society expect technology to be a part of their learning environment. Providing children with powerful learning tools can extend, enrich, and scaffold their learning in an exciting way. Including technology in the early childhood classroom should be integrated in a playful, interactive, and actively engaging way.

When I piloted my study, the teacher had many digital devices to use in her classroom, but there wasn't social interaction or play occurring because all the children wore headphones. They were engaging with the computer or tablet, but not with each other. This was an example of a kindergarten teacher trying to use technology, but not aware of the developmental research that has been conducted on integrating technology in a developmentally appropriate way. This teacher wanted to engage her students with digital devices, but didn't have the guidance on best practices to do this.

This study was also limited to three Colorado classrooms and to classrooms where either the classroom teacher reported the use of technology or was recommended by an administrator that the teacher was using technology. I expected to see technology use, but I was encouraged at

how these three teachers integrated in a developmentally appropriate way. In all three rooms, the children interacted with each other and adults when using technology. Often the technology served as a conversation starter as the children engaged in the programs or activities. These teachers used technology in a developmentally appropriate way that encouraged children to use higher-level critical thinking skills and engaged the child.

Unfortunately, this is not the norm. Because there is a dearth professional development for early childhood educators, there are few models illustrating for teachers how to use technology in DAP ways. Teachers who are using constructivist or a student-centered pedagogy create a learning environment for young children that promote learning and technology can fit in well. In the early grades, children encounter a variety of technologies but rarely do they have the opportunity to explore freely these technologies or create new technologies. Research showed that when children are engaged and not simply interacting with materials, but designing, creating and inventing them, they learn the best (Papert, 1980; Resnick, 2006). Each one of these teachers sought out opportunities to learn. Unfortunately, many early educators don't have experience with technology and are unaware of the possibilities. This study opened a window into three classrooms to provide examples.

Teachers in this study used computers and iPads as literacy centers, math centers and as free-choice center time to scaffold, reinforce learning, and meet learning standards. They also used Skype, Google, YouTube for Kids, and Twitter to open up doors to the outside world for their young learners. A robotics unit exposed young children to engineering concepts and stimulated problem-solving, collaboration, and communication. Older peers and classroom peers provided expertise and scaffolding in using technology. Finally, children were encouraged to play, create, and collaborate while using technology. These teachers all concurred that children

should be able to play with technology before they are expected to perform a specific activity. They all also agreed that technology in the classroom should be a learning tool like any other manipulative. The three teachers also offered the children tech and non-tech choices during literacy, math, and choice time. Finally, they saw technology as a way to open the classroom to the outside world and expose the children to different cultures and experts.

> Nevertheless if all children are to achieve their full capabilities as members of a society in which knowledge and communication are highly prized commodities, then all children need opportunities to become proficient or 'literate' in their uses of new media. It is essential for early years practitioners to be provided with the curriculum guidance and training they need to help them understand how this might be achieved most effectively. (Wolfe & Flewitt, 2010, p. 397)

Early childhood teachers need to have the resources and professional development to make this happen for all children.

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APPENDIX A: Checklist for Exemplarary Technology Integration

Selection (Intentionality, Developmental Appropriateness, Planning)	Yes	No	Comments
1. The use of interactive media and technology tools is intentional.			
• Supports the goals, early learning standards or curriculum areas of focus			
• A need is identified first, then an appropriate resource is selected			
2. Selective media and technology tools are developmentally appropriate. • Selected tools are age-appropriate, stereotype-free, provide clear instructions and prompts, are well produced, and are free of commercial messaging			
• Technology features are deliberately chosen to meet instructional goals for the developmental needs of the child, including distinct cognitive abilities, motor skills, social-emotional needs, and interests of the child			
• Interactions with technology are playful and open-ended, encourage creativity, pretend play, active play and outdoor activities			
• Gives children control of the medium; may offer scaffolding and reinforcement to children of different abilities			
• Is play present? What kind of play- isolated or mature/social play?			
3. Technology use is well planned. • Cost effectiveness is considered, including resource allocation, initial costs, costs of updating, upgrading or replacing software and hardware, and durability for active use by young children			
Use (Physical Environment, Collaboration, Connection to Non-Digital World, Family Engagement, Digital Equity)	**Yes**	**No**	**Comments**
4. The physical environment is configured to accommodate the specific technology tool.			
• Hardware availability and placement accommodate individual, small group, and whole group instruction so the physical environment is configured appropriately for usage by children (i.e. tablets, computers, digital cameras are better suited for individuals and small groups, while light tables and interactive whiteboards are better for whole groups.)			

• Technology is infused into multiple learning areas of the classroom alongside traditional materials			
5. Technology and interactive media offer opportunities for joint engagement, collaboration, information sharing, and conversation with peers, educators, parents, or other caregivers • May offer ability to access experts and peers in other locations			
6. Interactive media and technology tools are connected to the non-digital world			
• Educator uses technology tools to connect to the lives of students and world beyond the classroom			
• Technology is used to explore real-world issues			
• Technology supports learning and expands access to new content by complementing and supplementing current activities such as creative play, physical activity, outdoor experiences, conversation, or social interactions			
7. Technology tools and interactive media are used to strengthen home-school connections • Educator models appropriate interactive media and technology tool usage and creates opportunities to educate parents about home use; technology is used to connect and communicate with family members; educators and families share learning resources			
8. All children, including dual language learners, children with special needs, and others, have opportunities to use and learn from available technologies			
Integration (Professional Development, Support)	Yes	No	Comments
9. The educator has access to online or offline communities of learning around digital media literacy that may include formal courses, mentors, webinars, online courses, or in-service • Professional development offers opportunities to explore, create, and play with interactive media and technology tools.			
10. Senior leadership support use of technology in classroom and programs, and allocate staff, equipment, financial resources, and time appropriately. • Program has a clear technology policy that addresses appropriate selection of and access to technology, digital privacy and etiquette, and digital equity			
• Technical and training assistance is available for maintaining and using digital resources			

• Educators feel empowered by leadership to effect change in technology integration.			
Evaluation (Assessment, Reflection)	**Yes**	**No**	**Comments**
11. Educator assesses whether learners are meeting expected objectives. • Educator develops system to track the use and impact of technology.			
• Evaluation of technology in classrooms is integrated with ongoing assessments of learning and developmental outcomes.			
• Educator uses pictures, video, and other interactive media to provide meaningful documentation of classroom activity or child progress, which may be shared with parents or other caregivers.			
12. Educator reflects on activity, identifies areas of success and ideas for improvement. • Educator identifies what planning helped the success of the activity and what changes occur the next time			

APPENDIX B: Fourteen Guiding Principles for Integrating Technology From the NAEYC (2012) Position Statement

1. The use of technology tools and interactive media should not harm children.
2. Developmentally appropriate practices must guide decisions about whether and when to integrate technology and interactive media into early childhood programs.
3. Professional judgment is required to determine if and when specific use of technology or media is age-appropriate, individually appropriate, and culturally and linguistically appropriate.
4. Developmentally appropriate teaching practices must always guide the selection of any classroom materials, including technology and interactive media.
5. Appropriate use of technology and media depends on age, developmental level, needs, interests, linguistic background, and abilities of each child.
6. Effective uses of technology and media are active, hands-on, engaging, and empowering; give the child control; provide adaptive scaffolds to ease the accomplishment of tasks; and are used as one of many options to support children's learning.
7. When used appropriately, technology and media can enhance children's cognitive and social abilities.
8. Interaction with technology and media should be playful and support creativity, exploration, pretend play, active play, and outdoor activities.
9. Technology tools can help educators make and strengthen home-school connections.
10. Technology and media can enhance early childhood practice when integrated into the environment, curriculum, and daily routines.

11. Assistive technology must be available as needed to provide equitable access for children with special needs.
12. Technology tools can be effective for dual language learners by providing access to a family's home language and culture while supporting English language learning.
13. Digital literacy is essential to guiding early childhood educators and parents in the selection, use, integration, and evaluation of technology and interactive media.
14. Digital citizenship is an important part of digital literacy.
15. Furthermore, they include recommendations for early childhood educators. These are the ones that pertain to the ages of 3 to third grade.
16. Select, use, integrate, and evaluate technology and interactive media tools in intentional and developmentally appropriate ways.
17. Provide a balance of activities and programs for young children using technology and interactive media as an intentional learning tool to support active, hands-on, creative, and authentic engagement.
18. Discourage the passive use of television and other non-interactive media, for children two through five.
19. Carefully consider screen time recommendations from public health organizations for children birth through age five when determining appropriate limits on technology and media use.
20. Provide leadership in ensuring equitable access to technology and interactive media experiences for the children in their care and for parents and families.

APPENDIX C: Pre-Observation Interview Questions

1. Tell me about your background with educational technology.
2. What professional development have you had?
3. How do you integrate technology in your program?
4. Do you integrate technology on a regular basis? Daily, weekly, how often?
5. What subject or subjects will be observed and what technology is integrated? What are the learning goals of the lesson?
6. What activities will the students do with the technology? How were these chosen?

APPENDIX D**:** Post Observation Interview Questions

1. *What would you like to share about the lesson?
2. What information should I know to understand the situation more clearly?
3. What was the reason for_____?
4. Tell me more about _____
5. *How did you set this lesson up and what part of the lesson did I not see? How long did you spend on this lesson?
6. *How long have the students been working with this technology?
7. Did you teach this lesson before without technology? If so, did you notice any difference?
8. *Do your students have access to technology at home?
9. *How do you track the impact of the technology and if the students are meeting the learning goals?
10. *Are you supported by district and school leadership in using technology? Do you have the resources that you feel you need?
11. *Do you have the technical assistance you need?
12. *Are you encouraged by leadership to integrate technology?
13. *Does your school/district have a technology policy that guides selection, equity and privacy?
14. *Tell me how you define Developmentally Appropriate Practice?
15. *How do you integrate technology in a developmentally appropriate way?
16. *What steps will you take after the lesson? How do you reflect on a lesson?
17. *Anything else you would like to share with me?

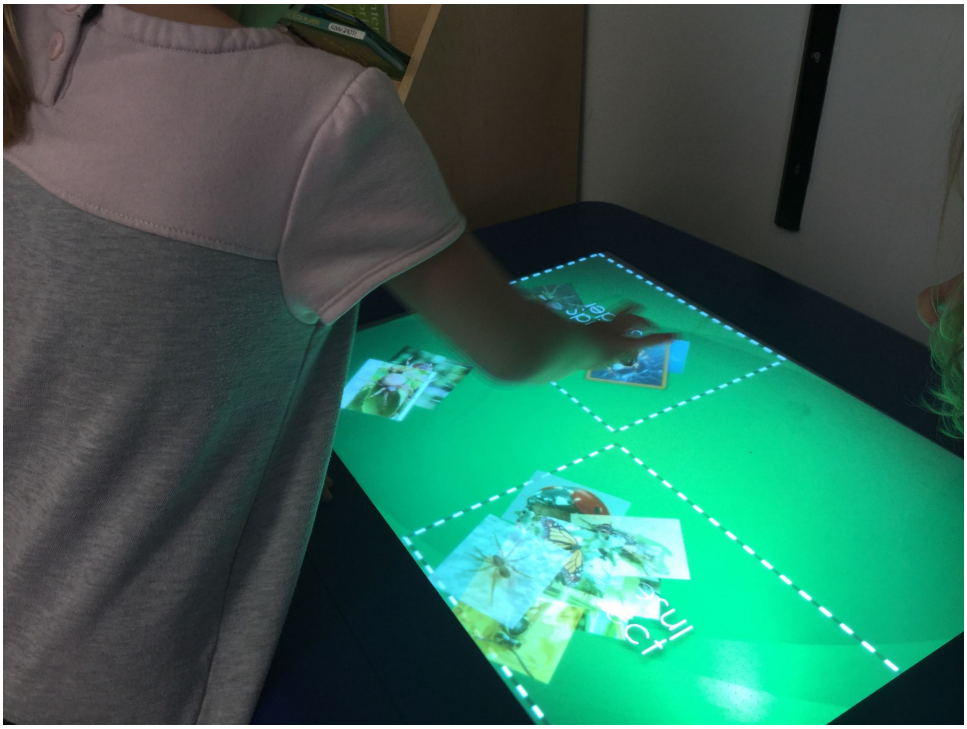
APPENDIX E: Empty Shell

Teacher's Educational Goals	Learning Environment	Classroom procedures
Role of the Teacher	Interactive use of media and tech. tools	Interactions and play
Tech. encourages collaboration and conversation	Technology well planned	Tech. equitable for LL and SPED. students
Assessment of learners meeting goals	Educators reflect of goals	Tech. connected to the non-digital world

APPENDIX F: Kindergarten Teacher differentiating on the White Board

APPENDIX G: SMART Table

APPENDIX H: Child on SMART Table



APPENDIX I: Beebot Game

APPENDIX J: IRB Approval Notice

PEPPERDINE UNIVERSITY

Graduate & Professional Schools Institutional Review Board

March 31, 2015

Amy Cameron

Protocol #: E0315D01
Project Title: Integrating Technology in the Preschool through 3rd Grade Classroom in a Developmentally Appropriate Way

Dear Ms. Cameron:

Thank you for submitting your application, *Integrating Technology in the Preschool through 3rd Grade Classroom in a Developmentally Appropriate Way,* for exempt review to Pepperdine University's Graduate and Professional Schools Institutional Review Board (GPS IRB). The IRB appreciates the work you and your faculty advisor, Dr. Fusco, have done on the proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations (45 CFR 46 - http://www.nihtraining.com/ohsrsite/guidelines/45cfr46.html) that govern the protections of human subjects. Specifically, section 45 CFR 46.101(b)(2) states:

> (b) Unless otherwise required by Department or Agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:
>
> **Category (2) of 45 CFR 46.101**, research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: a) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit a **Request for Modification Form** to the GPS IRB. Because your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the GPS IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the GPS IRB as soon as possible. We will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the GPS IRB and the appropriate form to be used to report this information can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* (see link to "policy material" at http://www.pepperdine.edu/irb/graduate/).

Please refer to the protocol number denoted above in all further communication or correspondence related to this approval. Should you have additional questions, please contact Kevin Collins, Manager of the

6100 Center Drive, Los Angeles, California 90045 ▪ 310-568-5600

Institutional Review Board (IRB) at gpsirb@peppderdine.edu. On behalf of the GPS IRB, I wish you success in this scholarly pursuit.

Sincerely,

Thema Bryant-Davis, Ph.D.
Chair, Graduate and Professional Schools IRB

cc: Dr. Lee Kats, Vice Provost for Research and Strategic Initiatives
Mr. Brett Leach, Compliance Attorney
Dr. Judi Fusco, Faculty Advisor