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A Case Study of Mobile Internet Technology in Bilingual Elementary Classrooms

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A Case Study of Mobile Internet Technology in Bilingual Elementary Classrooms

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Dedication

I dedicate this dissertation to my husband Jon, my daughter Allison, and my late grandmother, Lee Chalkley. Thank you for always believing in me and never letting me give up.

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I would like to thank my advisor, Dr. Min Liu for her guidance, patience, encouragement, and support through this process. In life, there have been only a handful of people who have a great influence on who I am as a person and as a professional. I consider Dr. Liu one of these people. She is truly an outstanding professor and mentor and I could not have completed this dissertation and program without her support and wisdom. I would also like to thank the other members of my committee: Dr. Paul Resta, Dr. Joan Hughes, Dr. Karen French, and Dr. Nancy Hartman. Thank you for your support and encouragement through this process.

A Case Study of Mobile Internet Technology in Bilingual Elementary Classrooms

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The University of Texas at Austin, 2013

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Research about the use of mobile Internet technology in education is increasing, but gaps remain in the literature. This study used a case study approach to understand how teachers in a bilingual English Language Learner (ELL) classroom used iPod touch devices in a Texas public elementary school. Unlike many other studies investigating the use of mobile Internet technology in education by motivated educators and researchers, this research focuses on an initiative where apprehensive teachers were mandated to integrate mobile Internet technology. It also has a relatively rare focus on the implementation process rather than learning outcomes. Research questions were designed to explore how teachers implemented the iPod touch devices, whether the implementation encouraged informal learning, and what implementation challenges arose. Data sources consisted of qualitative interviews with students, teachers, and a school administrator as well as classroom observations and an analysis of student artifacts. Data showed that many activities resulting from the implementation of the iPod touch initiative included elements of constructivist learning and encouraged student interaction. Another finding was that giving students full-time possession of the devices did lead to students using the device outside of school, but that most of their activities

involved practicing what they had learned in the classroom and not true informal learning. Overcoming teachers' hesitancy and lack of familiarity with technology were found to be major obstacles early in the program, but findings suggested that training, support, and student enthusiasm overcame teachers' initial reluctance. Implications of this research are that efforts to integrate mobile Internet technology with elementary-level ELLs need an active focus on informal learning to leverage the potential the devices offer. Also, successful implementation requires more than just the availability of the technology; it also requires training and support for teachers to increase their familiarity with the technology and to provide them with ideas that allow them to use the technology most effectively.

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Chapter 1 – Introduction

Mobile Internet devices like the iPod touch are becoming very popular and like most technologies, these devices clearly have applications in education (e.g. UNESCO, 2012, Vogel Kennedy, & Kwok, 2009, van 't Hooft & Vahey, 2007a) even though the most common uses of these devices are for communication and entertainment. Existing research about using mobile Internet devices in education is relatively sparse but is proliferating. The literature in the field of education identifies a variety of affordances that mobile Internet devices offer for education, suggests some useful theoretical contexts for optimizing these affordances, and provides some data to support the effectiveness of these devices.

Because the nature of this research is closely related to the context of a specific educational initiative involving mobile Internet technology, this chapter begins with background information about the context of this research. After providing the necessary background, the chapter continues with an explanation of the purpose of this research within this context. The chapter then presents the research questions followed by an explanation of why this research is significant. Next, the chapter defines key terms and concludes with an overview of remaining chapters.

BACKGROUND

This study explored a recent program that used iPod touch devices as a tool to improve English language learning and support learning in all academic subjects for fourth and fifth grade students in a Texas public school district. The study collected and

analyzed data about how iPod touch devices work in different contexts – as a resource for elementary education in general, as a tool for constructivist learning, as a resource for language learning, and as a way to facilitate informal learning. The program that is the focus of this research was an elementary bilingual education program. Because language is a major component of culture, the study used a sociocultural approach to explore how students can use iPod touch devices to acquire core language and literacy skills as well as a way to adapt to the dominant culture. This research has an implementation-level focus to identify the challenges that sometimes inhibit or prevent full realization of the technology's potential.

This research focused on a current-generation (as of 2013) mobile Internet device – the iPod touch. Mobile Internet devices are a relatively new and quickly evolving technology, meaning that even recent research sometimes focuses on nearly obsolete devices. As the power and capabilities of these devices increase, ongoing research is needed to make sure educators who use these devices have an understanding of their uses and potential.

Another key aspect of the context of this research is that it studied a program where the teachers were reactive rather than proactive in their use of the mobile Internet devices. Most programs using mobile Internet technology in education described in the literature are innovative. Many times, innovation is necessary because the devices and their applications are new and no standard best practices are available. Because mobile Internet devices are relatively new and relatively expensive, deployment of these devices in many educational settings and much research about these programs involves motivated

researchers, educators, and technologists who are comfortable with and excited about technology (Kukulska-Hulme & Shield, 2008).

In the school district that is the focus of this research, use of the iPod touch in ELL and bilingual education was a standard requirement set by the district administration. In contrast to most other situations studied by researchers, this research does not focus on mobile Internet technology used by highly motivated teachers and researchers but rather on the integration of this technology into classrooms where teachers had mixed and even negative reactions about it. Consequently, the quality of implementation may be lower than other efforts examined in the literature. However, these devices have potential to enhance education and more widespread use of them will need to involve teachers who have lower levels of knowledge and motivation and not just motivated early adopters (Norris, Shin, & Soloway, 2007; Tomasino, Doubek, & Orniston, 2007).

With a focus on English Language Learners (ELLs), this research investigated how mobile Internet devices can enhance learning in basic academic subjects, English language and literacy, and the cultural understanding that provides the background for academic success. In the initiative that is the focus of this research, students had continual possession of their iPod touch devices both in and out of school. Thus, there was the potential for some learning with the devices to happen outside the formal education setting, regardless of how effectively teachers used them in class. Providing ELLs with mobile Internet devices for at-home use may be a way for teachers to facilitate

and encourage informal learning to supplement what they are able to teach directly and formally.

This research used an approach that included perspectives from multiple stakeholders and that looked at multiple educational goals and outcomes associated with mobile Internet devices. It also considered both formal and informal learning as part of the broad range of learning that can occur via mobile Internet devices. This broad approach is not unique, but it allowed this research to comprehensively address multiple dimensions and to make a more fundamental contribution towards understanding mobile Internet technology that goes beyond the focus of a specific device in a particular setting.

PURPOSE OF THIS STUDY

The purpose of this study was to contribute to the body of literature about mobile Internet devices in education by exploring an initiative to use mobile Internet devices in a specific context with a unique combination of dimensions that is absent from existing research. These dimensions were:

1. The iPod touch as a tool.
2. The U.S. as the geographic setting.
3. Public K-12 education (specifically elementary) as the academic setting.
4. Teaching English language and literacy to ELLs
5. A sociocultural approach as the primary theoretical perspective.
6. An educational setting where the use of mobile Internet technology is an administrative requirement.

Other research has studied programs and initiatives that match several of these dimensions, but not all of them. In addition to contributing a better understanding of programs with this specific combination of dimensions, this research also explored how devices like the iPod touch combined with effective pedagogy can enhance instruction and learning experiences in both formal and informal learning environments.

Mobile Internet devices like the iPod touch will probably continue to diffuse in U.S. K-12 education. As this happens, use of these devices will more frequently occur in situations where teachers lack the knowledge, interest, and/or motivation needed to optimize the potential benefits of this technology. Through studying the use of the iPod touch in an educational situation lacking highly favorable pre-conditions, this research identified implementation challenges that educators will have to address to ensure that more widespread use of this technology is effective and beneficial.

Implementation is an important focus because the implementation process connects the theoretical potential of mobile Internet technology with learning outcomes. As discussed in Chapter 2, previous literature supports that using mobile Internet technology can enhance learning. However, there are many things that teachers, administrators, and students can do (or not do) that determine whether and to what extent this happens. This research provides a better understanding of the specific practices that affect the results of deploying mobile Internet devices as an instructional tool.

RESEARCH QUESTIONS

This research focused on answering three main questions about use of the iPod touch in K-12 education. The first question was designed to identify the process the teachers used to implement mobile Internet devices. The second question sought to determine whether the iPod touch facilitated informal learning. Like the first question, the third research question had an implementation focus and sought to determine the existence of implementation challenges and to identify any challenges that were present. To explore these dimensions, the specific research questions were:

1. What implementation practices do teachers use to integrate mobile Internet devices like the iPod touch into K-12 classrooms for fourth and fifth grade ELL students in bilingual classrooms?
2. Do student-defined activities and informal learning supplement formal teacher-defined activities when fourth and fifth grade ELL students in bilingual classrooms have continual possession of mobile Internet devices like the iPod touch? If so, what is the nature and extent of these student-defined activities and this informal learning?
3. Are there implementation challenges when integrating mobile Internet devices like the iPod touch for fourth and fifth grade ELL students in bilingual classrooms? If so, what are these challenges and how can they be met?

To answer these questions, this case study collected data from students, teachers, a school administrator, and from careful observation and analysis of classroom instruction and activities.

SIGNIFICANCE OF THE STUDY

Answering these questions will provide future researchers and those planning to integrate mobile Internet devices into K-12 educational settings with an improved understanding of the implementation process. This study identified and discusses both successes and challenges. Recognizing that benefits from the use of mobile Internet technology can extend beyond the classroom and beyond teacher-defined activities and instruction, this case study explored whether and how the nature of classroom implementation (whether successful or not) affected informal learning and student-defined learning activities.

ELLs are a significant and quickly growing population in U.S. schools (White & Gillard, 2011). Discussing the ELL population, White and Gillard argue:

> The integration of technology-based literacy instruction, specifically designed for this population, provides a logical means to assist teachers in the facilitation of second language acquisition (SLA) for ELLs. This integration has been slow and sporadic in the U.S., yet has proven to be effective. (p. 1)

Mobile Internet technology has potential to improve ELL education to meet the needs of this important and expanding student population. However, the fact that this technology is relatively uncommon in ELL education points to the existence of barriers. This research is significant because it identified possible implementation barriers so that this growing technology can benefit more students.

This study is part of a relatively small body of literature that has focused on late-generation (as of 2013) mobile Internet devices as a tool in the K-12 education setting.

A comprehensive review of academic literature on mobile learning in K-12 schools by Liu, Scordino, Geurtz, Navarette, Ko, and Lim (2013) examined 63 research papers published in journals from 2007 through late 2012. Of these 63 articles, only seven included research on mobile learning in the U.S. and just four of these seven included elementary school students. Of these four articles focusing on mobile learning in U.S. elementary schools, none investigated foreign language or second language learning (although four of these 63 articles focused on English or foreign language learning in Asia). While academic research on mobile learning is proliferating (Liu, Scordino, Geurtz, Navarette, Ko, and Lim, 2013; Hung & Zhang, 2012), very little research exists with a specific focus on understanding English language learning using mobile Internet technology in U.S. elementary education.

The growing popularity and declining costs of mobile Internet devices means that more students will have access to them and that providing these to students who lack them may be financially possible for many schools (e.g. Vogel et al. 2009). These devices are cheaper than traditional laptop and desktop computers and while mobile Internet devices have less computing power, they offer the advantage of portability (Caudill, 2007). An ELL student visiting a museum might easily touch an icon to launch an app on an iPod touch kept in a pocket or purse to understand the meaning of a new word or concept he or she encounters, but this student might be less likely to remove a laptop from a backpack, boot it up, and search the Internet in the same situation.

Researchers have identified affordances of mobile Internet devices and have assessed outcomes of the implementation of these devices in various settings, but there is

still an incomplete understanding of how U.S. elementary ELL students use this type of device and its features in ways that can extend learning beyond the classroom environment. Much research has focused on the technology, pedagogy, and outcomes of initiatives with mobile Internet devices. While some of this literature mentions the associated constraints and challenges, very little research has directly focused on implementation challenges at the K-12 classroom level. An in-depth understanding of these challenges and barriers is the first step towards removing them so that educational programs using mobile Internet devices can realize more of their potential.

Definition of Mobile Internet Devices and Other Key Terms

The specific technology tool that was the focus of this research is the iPod touch manufactured by Apple. However, previous research on other devices with some or all of the same characteristics is at least somewhat relevant, and some findings from this research are likewise applicable to initiatives using other similar mobile Internet devices. The term "mobile Internet devices" is somewhat unspecific. However, using a somewhat general term is useful because the capabilities and characteristics of these devices have changed and evolved quickly and this trend will likely continue. Because the literature about how these devices serve as educational tools is relatively diverse, a broad definition allows the inclusion of a range of devices that share at least some key characteristics and capabilities of the iPod touch that is the focus of this research. Some other mobile Internet devices offer a subset of the functions of the iPod touch while a few offer more. Because the specific mobile Internet device used as an educational tool has varied in

previous research and will likely continue to vary in future research, the focus should be on how the key functions and capabilities of any given devices enable the relevant affordances.

Some previous authors offer alternative terms for mobile Internet devices and explain the subtleties and nuances of their terms and definitions. Some use terms like "mobile technologies" (e.g. Mifsud & Morch, 2010; Looi, Seow, Zhang, So, Chen, & Wong, 2010) or "mobile devices" (e.g. Keengwe, Pearson, D, & Smart, 2009). Other terms such as "mobile learning devices" (e.g. Kim, 2009) and "Wireless Internet Learning Devices (WILDs)" (e.g. Roschelle 2003) focus on the educational aspect of these devices. Broader terms like "mobile devices" or "mobile technologies" are too inclusive and fail to emphasize the computer-like nature and connectivity of the devices. For example, these terms would include pocket calculators or portable CD players. Likewise, terms that include "learning" either restrict the definition to the small subset of devices specifically intended for learning or convey the incorrect impression that many popular devices are intended solely or even primarily for educational purposes.

For this research, I use the term "mobile Internet devices" operationally defined as wireless electronic computing tools with the following characteristics:

1. Easily carried in a pocket, purse, or in a case attached to clothing.
2. Near-instant access to the Internet and stored content without significant boot up or launch time.
3. Capacity to store data, electronic media, and programs or apps.
4. Computing capability.

My definition of this term for the purposes of this research specifically and deliberately excludes laptop and notebook/netbook computers because these devices are larger and are not easily carried and because they take time to boot up. This definition also excludes tablets such as the Apple iPad. Tablet devices offer many of the same affordances as smaller devices like the iPod touch in a school setting and their larger screen size offers significant advantages for visual content and text entry. However, the larger size and weight of tablet devices may cause people to carry them less often in non-school environments and this might limit informal learning opportunities with the device.

This definition is proposed just for the purposes of this research effort and is not intended as a comprehensive or global definition. This definition includes the key characteristics of the iPod touch as well as other devices. Chapter 2 discusses some of the varieties of mobile Internet devices studied in previous research and further discusses the features and capabilities of the iPod Touch. In the context of this research, the key characteristics and functions of the iPod touch are: (1) the ability to play and record audio files, (2) the ability to take pictures and to play and record video content, (3) wireless high-speed Internet access with common browser software, (4) the ability to download and run software applications (apps), and (5) small size to allow high portability.

Three other terms are central to the research questions of this study. First, the acronym ELL stands for English Language Learners. In the school district that was the focus of this study, ELL is a formal designation for students who had low scores on the standardized tests that measure English language ability and fluency. While the ELL designation applies regardless of a student's primary non-English language, the vast

majority of ELL students in this study spoke Spanish as their primary language. Second, the term "bilingual classroom" also has a specific meaning in the context of this research. To improve ELL instruction, the school district established bilingual classrooms for ELLs where teachers used both English and Spanish for instruction. Third, the term "student-defined activities" refers to learning techniques that students discovered or developed and used that are outside the classroom curriculum and that are not suggested or directed by teachers. These student-defined activities can happen either in the formal learning environment and/or outside of school in informal contexts. Further discussion of these terms appears in later chapters.

DISSERTATION STRUCTURE

The remaining chapters begin with Chapter 2, which discusses the theoretical perspectives that have been applied to the use of mobile Internet devices and to Second Language Acquisition (SLA) in education. Chapter 2 also reviews the research related to the use of mobile Internet devices in a variety of settings. Chapter 3 describes the research methodology, including the overall case study approach and the specific data collection strategies used. Chapter 3 also describes the techniques used to analyze the data. Chapter 4 presents the results of this research and summarizes the key themes and findings from data analysis. Chapter 5 offers the conclusions from this research and discusses how the data from this research answer the research questions identified above. It also identifies data-supported recommendations that educators can use to more successfully implement this technology.

Chapter 2 – Review of the Literature

INTRODUCTION

There is not a major theoretical framework specific to mobile Internet technology in education. Like other research in the literature, this research will apply broader educational theories to the specific case of these technological devices. As pointed out by Keengwe et al. (2009), "Technology is just a tool that supports learning" (p. 335). Others (e.g. Vogel et al. 2009; Comas-Quinn, Mardomingo, & Valentine, 2009) echo this point that understanding technology's role in education does not have and probably does not require a theoretical framework that is independent of other theories about learning.

This chapter begins with a discussion of the general education theoretical perspectives that are best suited to understanding the role of technology in education, with a focus on constructivism and the sociocultural approach. It continues with a description of the characteristics and capabilities of the iPod touch. Like any instructional technology, the iPod touch has affordances and constraints and this chapter reviews the affordances and constraints that previous authors and researchers have identified. Next, the chapter summarizes the literature that documents how mobile Internet devices have been used in educational initiatives and findings from research that has focused on these initiatives. The chapter concludes with an identification of the limitations of previous research and a discussion of how educational theories and previous research set the stage for this study.

PERSPECTIVES ON LANGUAGE LEARNING WITH TECHNOLOGY

This research will use the sociocultural approach to learning as both a broad theoretical perspective and as a context for constructivism as a specific pedagogical

framework. The sociocultural approach to learning considers learning as inseparable from other aspects of people's social and cultural experiences. The sociocultural approach recognizes that learning occurs within a culture and is a part of that culture, making this theoretical approach particularly relevant to this research that focuses on students who are trying to learn literacy and fluency in the English language as well as academic subjects.

Constructivist Pedagogy

Constructivism is a framework for understanding how students learn. Generally, the constructivist pedagogy advocates experience-based learning where teachers (and/or technology) guide and support learners as they discover information. While research supports that constructivist teaching approaches are very effective (Jonassen, 2006), they are not in widespread use because they challenge entrenched traditional approaches and because many teachers and school administrators lack the understanding and/or motivation to apply constructivist teaching.

The constructivist approach to education is based on John Dewey's idea of experiential learning discussed in his 1938 book *Experience and Education* (Comas-Quinn et al., 2009). While Dewey's book provides an extensive discussion of his ideas, one relatively short excerpt summarizes constructivism well:

> Once more, it is part of the educator's responsibility to see equally to two things: First that the problem grows out of the conditions of the experience being had in the present, and that it is within the range of the capacity of students; and,

> secondly, that it is such that it arouses in the learner an active quest for information and for production of new ideas. (1938, pp. 96-97)

From its introduction by Dewey as an approach to teaching and learning, the constructivist pedagogy has advocated that teachers provide students with learning opportunities that relate to learners' experiences and motivate learners to create their own ideas and knowledge. In the quotation above, Dewey includes the point that the learning experience must be "within the capacity of students" and this idea is reflected in Vygotsky's later ideas about the zone of proximal development (Vygotsky, 1978).

Though the constructivist approach to education has been articulated for decades, it remains a particularly relevant framework for exploring the educational potential of new technologies. Jonassen and Land (2000) state "constructivist principles and situated learning assumptions are at the heart of most current work in mobile learning" (p.97). Sandberg, Mardomingo, & Valentine (2011) state "new technologies are strongly associated with constructivist approaches to learning" and summarize the key principles of constructivism currently shared by most scholars as (1) construction, (2) authenticity, (3) elaboration, (4) social, and (5) self-regulation (p.1335). The construction principle is the name for the process by which learners construct their own knowledge using learning tools and resources and their own existing knowledge. Authenticity refers to the idea that people learn best from real-world tasks and experiences. Elaboration means that multiple perspectives and information sources allow more comprehensive learning with fuller understanding. The social principle states that learners benefit from peer interaction in

the learning process. Self-regulation refers to the idea that learners set their own goals and direct their own learning.

While constructivism is a learner-centered approach, it defines a specific, important, and (for many) challenging role for the teacher. Dewey (1938) writes, "When education is based upon experience and educative experience is seen to be a social process, the situation changes radically. The teacher loses the position of external boss or dictator but takes on that of leader of group activities" (p. 66). According to Keengwe et al. (2009), "constructivist learning environments are intended to provide multiple paths for students to learn meaningfully with teachers performing the role of guides, mentors, or facilitators" (p. 335). Sharp (2006) argues that this role involves mediation, modeling, coaching, and creating environments and experiences for learning. Sadker, Sadker, and Zittleman (2008) identify specific constructivist teacher tasks as asking questions, overseeing activities, mediating discussions, and using scaffolding to link new learning to previous experiences. Jonassen, Peck, and Wilson (1999) suggest that teachers can even teach effectively in areas where they lack expertise by modeling their own learning process for students. In addition to teachers performing these specific roles, constructivist pedagogy includes prescribed learning activities such as anchored instruction, problem-based learning, microworlds, cognitive tools, and simulations (Jonassen, 2006).

Mobile Internet devices can enhance constructivist pedagogy in several ways. The devices (through the software applications that they run) can supplement the role of the teacher by guiding learners through problem-based learning activities, though

Chinnery (2006) points out that these devices and their applications are not able to react to learners as well as a good teacher. Through their technological capabilities such as web access and multimedia access, mobile Internet devices can serve as platforms that host learning environments (Sandberg et al. 2011). These environments can be exclusively virtual or they can combine the physical space and direct social interaction with communication and experiences shared through a virtual network (Roschelle, 2003). Many effective constructivist efforts using mobile Internet technology situate students in real-world scenarios and provide them with online learning tools (Hwang & Chang, 2010).

While researchers and educators generally share a common idea of the core principles constructivism discussed above, there are two major schools of constructivism (Duffy & Cunningham, 1996). Each school has its own ideas about which parts of the learning process are most significant. Sociocultural constructivism is one of the two main schools of constructivism and focuses on the social processes involved with the learning creation process. Another major school of thought in constructivism is cognitive constructivism, which is based on Jean Piaget's work focusing on mental processes (Comas-Quinn et al., 2009). Cognitive constructivism focuses on the mental processes involved when people learn through creating their own knowledge rather than on the role of the social environment (Duffy & Cunningham, 1996).

Cognitive constructivism is a useful way to understand the thought processes students use to learn using mobile Internet devices. However, these devices have the potential to facilitate learning through social communication and collaboration as well as

through applications that cognitively engage learners individually. Because sociocultural constructivism concentrates on understanding of how ELLs learn elements of culture beyond the curriculum established in formal education settings, this literature review focuses on the sociocultural school of constructivism.

For elementary level ELLs, academic success requires an understanding of the dominant culture (particularly language) as the context as well as proficiency in subject matter areas. The consensus of current research on language and literacy learning is that language acquisition is a fundamentally sociocultural process (Lantolf & Thorne, 2007). Thus, teaching approaches that recognize this and use sociocultural instruction have the most potential for success.

Sociocultural Theory in Education

Many scholars recognize Vygotsky (e.g. Comas-Quinn et al., 2009; Mifsud & Morch, 2010; Wetsch, 1991) as the most influential proponent of the sociocultural approach in education. Vygotsky's (1978) idea of the "zone of proximal development" (ZPD) is central to the sociocultural approach. Reacting to traditional education practices, Vygotsky (1978) states: "over a decade even the most profoundest thinkers never questioned the assumption; they never entertained the notion that what children can do with assistance of others might be in some sense even more indicative of their mental development than what they can do alone" (p. 85). Vygotsky (1978) explains that the difference between a child's current developmental level and their potential developmental level is the zone of proximal development (ZPD). A key point about the

zone of proximal development is that it reflects the level of development and learning that a student can attain with guidance from adults and collaboration with peers, which is higher than what they can attain unassisted. Thus, the idea of the ZPD emphasizes the inherently social nature of learning and that assessment to determine the zone of proximal development should also be a social process.

Mediation is a key concept in the sociocultural approach and this perspective 'begins with the assumption that action is mediated and that it cannot be separated from the milieu in which it is carried out" (Wertsch, 1991, p. 18). Vygotsky's framework for the sociocultural approach emphasizes the role of both technical and psychological cultural tools as mediators of thought and action (Wertsch, 1991, Vygotsky 1978). Both types of cultural tools are important in the use of mobile Internet devices in ELL education. Both the device and the language and cultural norms of English-speaking public education mediate learning (though bilingual education leverages use of ELL's native language as an additional mediating psychological tool).

Recent research about the use of mobile Internet devices in education uses the sociocultural approach. Mifsud and Morch (2010) apply the sociocultural perspective to argue that in some contexts, students using mobile Internet devices for so-called "off-task" activities might actually be directing their own learning. They suggest re-framing these activities as "student-defined activities" (p.190) and feel future research efforts should work to understand the socio-cultural context of these activities to identify new learning opportunities.

Vygotsky's idea of the zone of proximal development (ZPD) also appears in research on seamless learning with mobile Internet devices. Using the sociocultural idea that cultural tools mediate learning, Looi et al. (2010) argue that mobile Internet devices make informal seamless learning possible. They believe that a traditional (non-sociocultural) view would significantly underestimate how much students could learn informally with the help and resources of these devices because these devices serve as a cultural tool to expand learners' ZPD. Failure to consider the benefits of mobile Internet devices from a sociocultural perspective could lead educators to decide against using these devices or cause educators to use the devices at a level of effectiveness that is well below the potential.

Roschelle (2003) does not explicitly refer to the sociocultural perspective, but uses it to understand the potential of mobile Internet devices as a learning tool by looking at how these devices promote social connections that enhance learning in three ways. First, mobile Internet devices can serve as classroom response systems that allow an immediate aggregated display of students' anonymous responses to questions. Second, mobile Internet devices allow participatory simulations (such as modeling the spread of an infectious disease). Roschelle (2003) identifies collaborative data gathering as the third type of social connectivity offered by mobile Internet devices. In all three types of learning, students use a cultural tool to access information and resources provided by their peers to acquire learning and answer questions that are beyond their reach individually and in isolation.

Because language is a significant part of culture and the basis for social interaction, the sociocultural approach is particularly useful for language learning (Wertsch, 1991). Mobile Internet technology expands the number of other learners and experts with whom a student can communicate and collaborate and provides new communication and collaboration channels. Within a sociocultural framework, this expanded communication is especially useful in language learning (Comas-Quinn et al., 2009).

Second Language Acquisition (SLA)

This research focuses on the use of the iPod Touch in the role of bilingual English Language Learner (ELL) education. An understanding of the process by which K-12 students learn languages and literacy is important because in most U.S. public schools, English is the primary language for instruction. Consequently, academic success requires ELL students to learn English for both conversational and academic purposes and to acquire proficiency in both language (speaking and understanding) and literacy (reading and writing). This section summarizes some of the key theories that have been used in language education and discusses some of the details of the sociocultural theory of language acquisition.

Specifically, this section will summarize and discuss major theoretical perspectives about how people initially learn their first language (L1 acquisition), how they acquire literacy, and how they learn second languages (L2). The overall goal is to understand and apply these theoretical perspectives in the context of research to evaluate

the use of mobile Internet devices as a way to enhance ELL education for elementary school students.

Understanding L1 acquisition is indirectly relevant to SLA because some of the processes through which people learn their first language are also part of second language acquisition (SLA). Also, understanding how people learned their first language offers insight as to what and how they must learn differently in the SLA process. Most scholars of language learning agree on four major theoretical traditions in this field and these are the Behaviorist, Innatist, Interactionist, and Sociocultural approaches. These approaches are not entirely exclusive, though each has its own emphasis on what is most fundamentally important in the language (L1) learning process.

While specific behaviorist theories differ, in general behaviorism is the theoretical approach that asserts that L1 learning is similar to other kinds of learning where people gradually acquire knowledge through positive reinforcement of desirable behavior and negative reinforcement of undesirable behavior (Lindfors, 1991). However, this approach has major limitations. One of these is that almost all children learn language regardless of their intelligence level, learning potential, and the characteristics of their environment and this would not be the case if language acquisition were heavily dependent on each child's level of learning ability and the reinforcement they receive in their specific environment (Lindfors, 1991).

The innatist view is largely a reaction to the limitations of the behaviorist view and it asserts that children are born with an innate ability to learn language and that almost all children learn language regardless of their learning capacity for other

knowledge and skills and regardless of their environment (the environment affects which language they learn but not whether or how quickly they learn language) (Lindfors, 1991). While the innatist view provides an important perspective for language acquisition, there is less evidence that humans' innate capacity for language is present for either literacy or second languages (Lindfors, 1991) and the innatist view has limited value for teaching ELL for middle school students who have passed the age window for the innate language acquisition.

While the behaviorist and innatist views focus on language learning as an individual cognitive process, the interactionist approach shifts the focus to the learner's role as a participant in a social network (Lindfors, 1991). While the sociocultural perspective adopted and expanded a lot of the interactionist perspective, the interactionist perspective initially recognized the uniquely and inherently social nature of language learning (as opposed to other learning).

The sociocultural theoretical perspective broadens the interactionist perspective. People learn language as a means to interact with others in a social context, but the sociocultural view asserts that language learning occurs not in a limited context of pure and unbiased interactions with others, but also in the context of the culture of the broader society. The broader sociocultural approach to learning (which was then applied to language learning) was heavily influenced by the work of Vygotsky. In describing Vygotsky's idea of the zone of proximal development as an example of how culture and interaction actively affect people's capacity to learn, Moll (1990) writes "the zone must be thought of as more than a clever instructional heuristic; it is a key theoretical

construct, capturing as it does the individual within a concrete social situation of learning and development" (p. 4). Sociocultural theory of language learning does not directly reject the behaviorist and innatist views on the rules and learner characteristics of formal language learning, but argues, "these just aren't fruitful foci" (Hawkins, 2004: p. 188). Regardless of the individual cognitive process people use to learn language, what they learn and the meaning of the words they learn is defined by the specific cultural context that surrounds them.

Sociocultural Processes in ELL

The sociocultural approach to language acquisition emphasizes that language learning is the result of general socialization as well as specific formal instruction. This view of language as an element of culture as well as knowledge subject area means that the sociocultural perspective recognizes that ELL students need to learn the social meanings that surround the English language as well as how the meanings of words translate into their native language.

In her efforts to propose an effective model for ELL education, Hawkins (2004), notes that there is a lack of "of ways to theorize about socialization into the language and literacy practices of school" and states that "these issues call for a framework for researching the language and literacy development of ELLs in classrooms that is predicated on a view of language development and classroom participation for learners as part of a socialization process" (p. 187). The sociocultural view recognizes that culture is

inseparable from language and literacy learning and Hawkins suggests that ELL education needs to be a process of socialization as well as instruction.

The framework Hawkins (2004) proposes is complex. One key idea Hawkins presents is that "no language exists as a general thing" (p. 189) and that there are multiple social languages within the overall English language and that everyone achieves proficiency or fluency in some but not all of these social languages. Hawkins also emphasizes the concept that each person has multiple identities suited to different situations and that each role we have has to an extent its own social language. She points out that it would be a daunting task to teach each student all of the social languages she or he might need to use for all of the communities she or he interacts with and suggests that "perhaps a teacher's primary goal is to support his or her learners to become participants in school (academic) communities" (p. 191).

In discussing the unique characteristics of ELLs, Hawkins (2004) points out that these learners often have a strong learning background that just happens to be from a different culture and asserts that we should "dispel the notion of ELLs as 'deficient' – that is, lacking in skills and knowledge that other children come with; they are simply socialized into different (but equally valuable) communities of practice" (p. 194). ELL educators can and should try to understand and respect the cultural background of ELLs as this will help them teach with a tailored perspective and help relate SLA instruction to concepts and cultural background that students find familiar.

While acquiring Basic Interpersonal Communicative Skills (BICS) in English (Cummins, 1979) is valuable, success in school depends on ELL students' abilities to

understand and communicate in the specific type of English used in school instruction. The goal of iPod deployment in the classrooms that are the focus of this research is to help ELL students more quickly and effectively attain what Rolstad (2005) refers to as Second Language Instructional Competence (SLIC) in their other classes.

SLIC is closely related to other terms such as "academic language" as used in Cummins' (1979) idea of Cognitive Academic Language Proficiency (CALP). However, the terms "academic language" and "proficiency" are limited. As pointed out by Smith and Edelsky (2005), the concept of "proficiency" can be artificial and tautological because "language proficiency is what language proficiency tests measure" (p. 2138). Likewise, Smith and Edelsky (2005) point out criticisms that focusing on the dichotomy between BICS and CALP can inappropriately de-emphasize the value of non-academic language skills. SLIC refers to a relatively specific ability to "understand the language of instruction sufficiently well at that moment, in that context, to participate in that lesson and learn from it" (Rolstad 2005, p. 1998). The concept of SLIC is also more flexible because it applies to specific situations, meaning that students can acquire SLIC in some academic subjects or even some units within academic subjects but not others.

A 2006 article by Gee focuses on the cultural context of language and in this article, Gee uses the term "vernacular style" to describe everyday language for conversation and that is "equal for everyone" (Lankshear, Knobel, Bigum, & Peters, 2006, p. 106) and the term "specialist style" for language people use to speak about special technical topics (Gee, 2006). Literacy demands at the early levels of K-12 education largely rely on the vernacular literacy but at around fourth grade, the demand

for specialist style literacy increases and causes a "fourth grade slump" in reading level assessments. Gee argues that specialist-language lessons (both informal at early ages and also formal throughout schooling) are the key to maintaining continued growth and learning. Specialist-language lessons are activities that deliberately introduce specialist style communications by relating specialist style terms and ideas to more familiar vernacular style concepts.

Learning and understanding English used in elementary school instruction to achieve SLIC is not just a matter of proficiency with vocabulary and syntax; it must include a broader education that includes understanding the social interactions and activities in which English is used. Gee (2001) writes: "Language is not about conveying neutral or objective information; rather, it is about communicating perspectives on experience and action in the world" (p. 716). Language and literacy skills have little meaning or utility in the absence of activity to describe or ideas to convey. Gee (2001) also points out that within an overall language (e.g. English), there are many social languages used by people who share experiences and socially situated identities and that most of these social languages "are clearly not acquired by direct instruction" (p. 719), which emphasizes that effective language teaching should include informal learning components.

Gee (2001) continues to suggest that social languages are acquired by socialization and that social languages are part of a broader shared social identity called Discourses. He writes: "social languages are embedded within Discourses and only have relevance and meaning within them" (p. 719). Being a successful middle school student

in central Texas public schools is a Discourse that requires SLIC in most academic areas, but learning language and literacy in the English language is a necessary but not sufficient background to joining this Discourse. To understand the social language, students must also understand the activities and ideas that members of this Discourse share.

While no reliable data about cell phone ownership rates among elementary age children are readily available, recent data show that mobile communication devices are very popular among teens and that about 78% of American teens age 12-17 have cell phones and 47% of these teens have "smart" phones that allow Internet access as well as voice and text communication (Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U., 2013). From personal observations, even some elementary school students have smart phones. The possession of mobile Internet devices and the understanding of common activities and terminology related to these devices is becoming a more important part the K-12 student Discourse. Just having a device like the iPod touch – independently of how they specifically use the device to learn language and literacy - promotes socialization that may help ELLs acquire familiarity with the Discourse that will help them succeed.

Promoting and facilitating socialization to acquire the Discourse of an academically successful student should not and need not come at the cost of diminishing other ongoing Discourses to which ELLs belong. Smith and Edelsky's (2005) work shows an example of how students in a bilingual program blended English and Spanish into memoir writing assignments that resulted in more compelling and interesting writing

than they could have created using either language exclusively. This is a powerful idea that ELL teachers and students have already discovered and applied to some extent (Liu, Wivagg, Maradiegue, & Navarrete, in press). This research will explore how this integration of languages, literacies, and Discourses can make ELLs successful in English-speaking classes and also allow them to leverage their other Discourses into a richer and more diverse learning experience.

Digital Literacy

In a 1999 article, Gee articulates the "New Literacy Studies" sociocultural perspective that "sees literacy as integrally part and parcel of sociocultural practices" (p. 359). Recently, researchers have begun to apply the idea of literacy to technology as well as language and other elements of culture. Some ELLs have less familiarity with mobile Internet devices than other students. Even those ELLs who are as familiar or more familiar with these devices than other students may not fully understand how these devices contribute to the Discourse they are trying to attain.

Gilster (1997) initially popularized the idea of digital literacy and used the term to describe the ability to use computers to find, read, and understand information. With the advancement of technology, this concept has expanded to include other technological devices and their applications. As stated by Lankshear and Knobel (2008), "If we extend this argument from literacy to digital literacy it involves thinking of 'digital literacy' as a shorthand for the myriad social practices and conceptions of engaging in meaning making

mediated by texts that are produced, received, distributed, exchanged, etc., via digital codification" (p.5).

Many researchers point out that digital literacy is more than the knowledge and ability to operate computers and other technological devices. Digital literacy refers to "ideas and mindsets" (Bawden, 2008, p. 19) and the ability to synthesize information from multiple sources as well as the ability to communicate using technology. Because of the variety of devices and applications included under the umbrella of digital technology, researchers have argued that it is more appropriate to use the plural version of the term and discuss digital literacies (Lankshear & Knobel, 2008).

Some argue that using technology extensively during childhood development causes innate changes in the ways people think. Prensky (2001) describes people who have grown up using technology extensively as "Digital Natives" and characterizes them as people who expect to receive information quickly, expect instant gratification and rewards, and are comfortable multi-tasking. Prenksy characterizes members of older generations who use technology as "Digital Immigrants". He relates his concept of Digital Natives/Digital Immigrants to language by pointing out that second languages acquired later in life are not part of people's initial socialization (regardless of how proficient someone may become).

While Prensky points out that younger people have grown up in an increasingly technology-influence world, the term Digital Immigrant could also apply to someone who is relatively young but who has not been subject to the pervasive influence of technology. ELLs in Texas are disproportionately likely to be economically disadvantaged, giving

them less access to technology and making them Digital Immigrants as well as geographical immigrants. The concept of technology as a language means that ELL education should include instruction in both English and in the use of the technology that is ubiquitous in modern U.S. society.

Summary of Relevant Theoretical Perspectives

For this research, the sociocultural approach and the constructivist perspective (independently and together as sociocultural constructivism) provide the theoretical context. The sociocultural approach is important because this study focuses on a bilingual program that teaches ELLs language as well as academic subjects and the sociocultural approach provides a framework for holistically understanding the language acquisition process. The related New Literacy perspective extends the scope of this research and prompts an exploration of how students (especially through the use of the iPod touch) acquire the broader cultural context that allows them to fully understand what they learn.

This research is about technology as well as language learning. Therefore, the idea of digital literacies provides the impetus to investigate how proficiency in the use of the iPod touch is worthwhile for its own sake – independently of how it is used to facilitate other learning. In U.S public education, many ELLs have comparatively less access to mobile Internet technology and fewer opportunities to learn about how to use these devices. While using mobile Internet technology for its own sake may have

benefits, the primary reason driving its implementation is often its potential to enhance the learning process.

MOBILE LEARNING

Mobile Learning Background

As mentioned in Chapter 1, this research uses the term mobile Internet devices to describe the technology. In addition to explaining and justifying the terminology used to describe the physical device, it is important to understand the term used to discuss the type of learning associated with this technology.

Many researchers refer to learning with mobile devices as mobile learning or "m-Learning" (Caudill, 2007; Kukulska-Hulme & Traxler, 2005). While various researchers have proposed a variety of nuanced definitions of m-Learning, these definitions share the basic idea of using mobile technology to facilitate learning (Caudill, 2007; Hwang & Chang, 2011; Sandberg et al., 2011; Kukulska-Hulme & Traxler, 2005). Comas-Quinn et al. (2009) contend that more recent definitions of m-Learning "focus on the learner rather than the technology" (p.98) and support a definition of m-Learning proposed by O'Malley, Vavoula, Glew, Taylor, Sharples, & Lefrere (2003) as "any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies'' (Comas-Quinn et al., 2009). This definition acknowledges two separate and independent characteristics of m-Learning – that it happens when the learner is mobile (regardless of whether the learner is specifically using a mobile technology

device) and/or that it happens on a mobile device (regardless of whether the learner is in or outside of a formal classroom setting). This dual-faceted definition is the one used for this research.

Description of iPod touch and Other Devices

Early research (from the 1990's and early 2000's) usually focused on a variety of devices generally called Personal Digital Assistants (PDAs) (Banister, 2010). The specific features of PDAs varied considerably, but in general PDAs offered the ability to create and read documents, relatively slow Internet connections suitable for email or reading or posting text on the Internet (but not suitable for easily downloading or streaming audio or video content), and the ability to run custom programmed education-related applications. Research conducted on the use of older PDAs is useful because late-generation devices (as of 2013) like the iPod touch can replicate almost any task performed by PDAs. However, newer devices that are more powerful and versatile offer additional capabilities.

The predecessor of Apple's iPod touch was the iPod. The predominant feature of the original iPod is its ability to store, play, and record sound files. Higher end versions of the iPod devices also have the ability to store and play video content. The original iPod is not able to directly access the Internet but does have the ability to "sync" with a laptop or desktop computer to upload and download files to and from the Internet through Apple's iTunes software.

Though the name sounds similar, the iPod touch is considerably more versatile than the original iPod (Banister, 2010). In addition to the touch-screen interface, the iPod touch offers direct wi-fi access to high-speed Internet (when a network is available) with a standard browser and touch-screen keyboard. It also has an operating system that allows it to download and run a wide variety of custom software applications (apps). The selection of apps includes electronic book readers, educational games and exercises, educational tools such as probes and calculators, as well as general-purpose apps like audio/video capture and editing that have educational uses. The newer iPod touch devices (the ones used in the initiative that is the focus of this research) have built-in still and video cameras as well as microphones and speakers. The iPod touch is about 2.5 inches by 4.5 inches and about 0.25 inches thick and weighs about 4 ounces, making it very portable. The 3.5-inch screen is relatively small but allows an easy and intuitive zoom feature. To summarize, the key characteristics and functions of the iPod touch in the context of this research are its ability to:

1. Play and record audio files
2. Play and record video content
3. Internet access with browser
4. Ability to download and run apps
5. Small size to allow high portability

The results of this research will be most directly applicable to other initiatives that use the iPod touch or devices with similar characteristics and capabilities.

Apple also makes the iPhone, which is similar to the iPod touch but with the additional ability to serve as a cellular phone (including cell-based text messaging capabilities). In addition to the iPhone, other smart phones (such as those that use Blackberry, Android, or Windows operating systems) offer similar capabilities as the iPod touch (Godwin-Jones, 2011). However, smart phones are generally more expensive than similar devices that do not have cell capabilities. These additional and often significant costs make the iPod touch a more cost-effective tool for K-12 schools to provide. However, students who own iPhones could use them to perform any tasks done on the iPod touch.

Mobile Internet devices also include tablets, notebook computers, and laptop computers. Tablets such as Apple's iPad are generally more expensive than the smaller phone-sized devices and offer the same functions as the iPod touch. Their larger size makes them easier to use and gives them more affordances (larger images, easier display and entry of text). Tablets are becoming increasingly popular and tablet makers such as Apple are creating specific apps for education for these devices. Despite some advantages, the larger size of tablets also makes them less portable, which could lead students to carry them fewer places and thus limit informal learning opportunities. Laptop computers are more powerful and have close to the full functionality of a desktop computer, but are less convenient and portable. Laptop computers are generally even more powerful and can match the capabilities of a desktop computer. While laptops are technically mobile, they are much less portable than handheld devices like the iPod touch

and require much longer start-up times to turn on and use and require keyboard and mouse navigation rather than touch-screen (Caudill, 2007).

Affordances

With any technology used in education, researchers and potential users of the technology must understand its affordances (Gibson, 1986) and constraints (Norman, 1999) to make the best decisions about when and how to best use it (Mifsud & Morch, 2010). Mobile Internet technology offers a unique combination of affordances for educators and students. Mobile Internet devices share some affordances with other computer-type devices but also have other affordances that make them different from, and in some cases superior to, more traditional computing and Internet devices. Research about Internet technology in general shows that the affordances of boundaries, authority, stability, pedagogical context, disciplinary context, are intertwined with challenges when compared to more traditional sources of information and teaching frameworks like textbooks (Wallace, 2004).

Existing research and literature on mobile Internet devices identifies 8 general types of affordances:

1. Collaboration and Communication
2. Access to Media and Internet
3. Use of Learning Tools and Instructional Apps
4. Media Capture and Creation
5. Situated Learning and Student-defined Activities

6. Engaging and Desirable Device and Interface
7. Cost-Effective Computing
8. Mobility and Informal/Anywhere Learning

This list is a compilation of affordances identified in the specific literature discussed below, though not all sources identify or emphasize all of these affordances and some refer to these with different labels. This list is similar to a list of affordances complied by Liu, Geurtz, Karam, Navarrete, C. & Scordino (2013) summarizing the affordances identified in the literature of mobile devices in adult education. The following subsections explore each of these affordances as identified in the academic literature on the topic of mobile Internet devices in education. As discussed later in this section, the final affordance of easy informal learning by combining the other affordances in a portable unit gives mobile Internet devices unique potential in education.

Collaboration and Communication

One key affordance of mobile Internet devices is their potential to facilitate communication and collaboration. Even when the capabilities of the devices were considerably more limited, communication and collaboration were key features of these devices (Roschelle, 2003). Researchers have found that the ability of mobile Internet devices to offer immediate feedback from teachers and peers motivates students to do their assignments better (Norris & Soloway, 2004). Others point out that these devices support both individual and collaborative learning (van 't Hooft & Vahey, 2007a). As an example, Hegedus (2007) described how communication on mobile Internet devices

makes the SimCalc Mathworlds software effective in helping students understand math functions. Another example showed how the benefits of collaboration on these devices also apply to writing where research has shown that collaboration activities lead to students spending more time writing (Yarnall, Carriere, Stanford, Manning, & Melton, 2007). Others have observed that many research efforts about mobile learning have concentrated on their capabilities to support communication and collaboration (Botha, Vosloo, Kuner, & van den Berg, 2009; Gedik, Hanci-Karademirci, Kursun, & Cagiltay, 2012; Liu & Hong, 2007; Lin, Wong, & Shao, 2012; Looi, Wong, So, Seow, Toh, Chen, Zhang, Norris, & Soloway, 2009; Rau, Gao, & Wu, 2008; Shih, Chu, Hwang, & Kinshuk, 2011; Thomas & Orthober, 2011; Zurita & Nussbaum, 2007) and that these affordances are particularly valuable in language education (Comas-Quinn et al., 2009) and a key part of what researchers have called Mobile Assisted Language Learning or MALL (Kukulska-Hulme & Shield, 2008; Hashemi & Ghasemi, 2011).

Access to Media and Internet

As the term implies, the ability to access the Internet is fundamental to mobile Internet devices and this is a key affordance for the educational potential of these devices. While the speed and memory of early devices allowed limited Internet access to and limited display/playback of audio, image and video content, current generation devices have the ability to store a considerable amount of content and have sufficient speed to "stream" audio and video content stored remotely. In discussing the iPod touch specifically, Banister (2010) mentions these capabilities and points out that these devices

have a built-in speaker that allows users to share content in a group setting. Banister (2010) also points out that "a plethora of pre-made educational media are available for K-12 classroom use, including podcasts, audio books, and video clips" and that these are available in a "'just in time' fashion" (p. 123).

Sandberg et al. (2011) also mention this affordance and state that the ability to access media and other Internet content promotes the development of constructivist learning activities. Mayer (2003) proposed the dual-channel hypothesis, stating that people learn from multimedia channels in parallel. Sandberg et al. (2011) assert that the affordance of mobile Internet devices to combine various media channels supports more effective learning and memory of what people see and hear.

The iPod touch comes with the Safari Internet browser, and most other mobile Internet devices have a similar browser available. Banister (2010) believes that this "provides limitless possibilities for classroom use' (p. 124) and points out that students can integrate web content into their own classroom learning activities.

Learning Tools and Instructional Apps

Playback and display of existing multimedia content and the ability to access the web via a browser are important affordances, but instructional tools and software applications (apps) afford interactive learning opportunities. Tools and apps fall in the middle of the spectrum between one-way consumption of pre-defined media content and unfocused access to the unstructured and nearly unlimited resources of the Internet.

Some tools and apps are general-purpose with the potential for integration into learning activities, while other tools and apps are specifically intended for educational purposes.

Some general tools and apps available on the iPod touch and many similar devices include clocks (with timer and stopwatch), calculators, maps, and weather information (Banister 2010). Banister (2010) also discusses a variety of age-specific and academic subject-specific apps available for the iPod touch such as *Flash Math* (PalaSoftware Incoporated, 2012) that provides arithmetic drills, *Earth3D* (3Planesoft, 2012) that provides graphic representations of the earth's rotation, and *Molecules* (Sunset Lake Software, 2012) that shows images of DNA. Roschelle (2003) identifies probes, such as a handheld instrument that collects water quality data and stores the data on the mobile Internet device, and the apps that allow them to work with mobile Internet devices as an important set of learning tools. Others have identified activities using temperature probes to measure and then predict changes in skin temperature (Tinker, Horwitz, Bannasch, Staudt, & Vincent, 2007).

Media Creation and Capture

As mentioned above, most mobile Internet devices have the ability to store and display images or store and playback audio, and video content. Another important affordance is the microphone and camera functions on many devices that allow users to capture sounds, images, and video and the software that allows users to edit and share this content. One type of media specifically developed for mobile technologies is the podcast. Researchers have found that K-12 students enjoy learning activities centered

around creating and sharing podcasts because they know that others may access their work and that the voice recording feature of MP3 players like the iPod are effectively used in language learning (Kukulska-Hulme & Shield, 2008). Others point out that the camera feature of mobile Internet devices like the iPod touch is helpful because it allows students to create and share images as a basis for discussion and dialogue (Looi et al., 2010; Churchill & Churchill, 2008).

Situated Learning and Student-defined Activities

Because mobile Internet devices are easily portable and function as learning tools, they are particularly useful for situated learning experiences. In describing the ideal tools for situated lifelong learning Sharples (2000) identifies three characteristics – highly portable, individual, and unobtrusive. Mobile Internet devices are an almost perfect fit for this type of learning. Naismith, Lonsdale, Vavoula, and Sharples (2004) identify support of situated learning as a key benefit of mobile technologies.

With mobile Internet devices, Looi et al. (2010) argue that "while learning can be facilitated or scaffolded by teachers or peers, at other times it could be student-initiated, impromptu, and emergent" (p. 157). Comas-Quinn et al. (2009) feel the idea of student-defined learning is in line with Vygotsky's sociocultural approach because learners ultimately learn best when they take ownership of their learning. Banister (2010) points out student-defined learning in the form of student-created media is a powerful affordance of the iPod touch. Others assert that activities that are considered "off-task"

sometimes have positive outcomes and that researchers can usefully re-frame these activities more neutrally as "student-defined activities" (Mifsud & Morch, 2010).

The advantages of mobile Internet devices like the iPod touch as tools for situated learning are particularly beneficial of English Language Learners. Lave and Wenger proposed the idea of legitimate peripheral participation as a framework for understanding how newcomers to an educational setting are able to participate in situational learning (1991). From their study of apprenticeship, they found that newcomers learn successfully when they have access to the benefits of community membership, are involved in the community, learn the discourse of the community, and when the community is open to investing in the newcomers' potential (Lave & Wenger, 1991). For elementary ELL's, the iPod touch promotes all of these conditions for effective situated learning.

Engaging and Desirable

Mobile Internet devices like the iPod touch are useful and popular among students for non-educational purposes. Students are very familiar with digital devices (e.g. Norris & Soloway, 2004; Caudill, 2007) and many use mobile Internet devices (sometimes integrated into cell phones) to share pictures and video, communicate through text and instant messaging, create and view blogs and social media updates, and access the Internet (Looi et al., 2010). Unlike learning-specific tools and devices (translators, dictionaries, etc.), there is no stigma (and possibly favorable status) associated with possession and use of these devices both in and out of school (Patten & Craig, 2007, Seisto, Federley, Kuula, Paavilainen, & Vihavainen, 2011). The device itself and its core

capabilities appeal to most students, and interactive and entertaining software apps further engage students.

Hwang and Chang (2011) assert that "compared with traditional instruction or information from textbooks, mobile learning seems to be a more attractive way of learning that can trigger the interest and motivation of the learners." (p. 1024). Some of the characteristics that make these devices and the apps they support interesting and engaging are integration into the user's life, control over learning goals, enjoyment, the ability to learn in context, the status associated with having the device, instant sharing, privacy, and portability (Jones, Issroff & Scanlon, 2006). However, Comas-Quinn et al. (2009) caution, "some of these are powerful concepts which are not always fully understood" (p.98).

Other researchers have found that mobile Internet devices work well as a platform for game-like learning activities. Sandberg et al. (2011) use the term "serious games" (p.1336) to describe these games that have a goal beyond pure entertainment. Sandberg et al. (2011) also point out that serious learning games based on a mobile device allow learners rather than teachers to direct the pace and nature of learning and this enhances the appeal of device-based learning. Schwabe and Goth (2005) found that learning games augmented with a "mixed reality" (p. 214) experience that combines the digital world of the software and device with the real physical world were particularly effective in engaging students. A comparative study of a history game about medieval Amsterdam also showed higher engagement among game-playing students than students receiving alternative instruction, but found that this engagement did not extend beyond the specific

topic (Huizenga, Admiraal, Akkerman, & ten Dam , 2009). Research by Klopfer, Sheldon, Perry, and Chen (2012) showed increased student engagement and interest resulted from playing a game related to weather and climate. Liao, Chen, Cheng, Chen, and Chan (2011) found that a game requiring elementary students to learn multiplication in order to care for a virtual pet successfully engaged students and encouraged collaboration. Seisto, et al. (2011) reported that elementary-aged students found hybrid books (printed materials combined with mobile phone apps) more engaging when they included game-like attributes. Other research has found that gender may play a role in the appeal of game-based learning. Gwee, San Chee, and Tan studied a social studies game called *Statecraft X* (LearnXscape, 2010) in ninth grade classes (2011). They found that while ninth grade boys played the game more often, students of both genders played the game enough to achieve the learning goals.

Gee (2007) discusses how video games are effective in socializing players into the story and culture of the game by creating situated learning experiences. Gee points out that "while video games actively encourage such situated and embodied thinking and doing, school often does not" and that "in school, words and meanings usually float free of material conditions and embodied actions" (p. 84). With "serious games", teachers, students, and iPod software applications can use the iPod touch as one platform to create these types of learning experiences.

The versatility and capabilities of mobile Internet devices and related technologies makes them popular in areas outside of formal education. Caudill (2007) describes how mobile Internet devices offer major advantages to facilitate lifelong learning. Norris &

Soloway (2004) state "technology pervades essentially every aspect of our daily lives" (p. 293). They point out that learning to use mobile Internet technology is by itself a valuable way to prepare students for future careers, independent of how they use the device to learn about other things.

Cost-effectiveness

Powerful late-generation mobile Internet devices can cost several hundred dollars per unit (at the time of this writing, the iPod touch devices used in the school that is the focus of this research cost approximately $250 per unit). However, these devices can be cost-effective considering their capabilities and the cost of alternative technologies. Roschelle (2003) recognizes that many learning tools previously available on larger and more expensive desktop computers are becoming more widely available on less expensive handheld devices and that this shift will have a large scale impact on learning. Norris and Soloway (2004) estimated that mobile Internet devices cost about 25% of a laptop and current pricing at the time of this research was about this same percentage (approximately $250 per iPod touch vs. approximately $1,000 per laptop at current prices in the school district).

The relatively low cost and the versatile capabilities of these devices offer a variety of opportunities. Looi et al. (2010) see the potential for more students to have and use these devices in classrooms and informal learning. Norris and Soloway (2004) believe that lower-cost mobile Internet devices will allow many schools to achieve a 1:1 student to computer ratio and feel the focus should shift towards a "handheld-centric

classroom" (p. 282) that emphasizes the use of the technology rather than just its availability. To help reach this goal, they suggest that schools use the savings of replacing laptop or desktop purchases with mobile Internet devices toward support and professional development. From a global perspective, Kim (2009) believes the relatively low cost and minimal infrastructure requirements of mobile Internet devices gives them the potential to address educational inequalities in isolated and disadvantaged areas around the world.

Mobility and Informal Learning

In addition to costing less than laptop and desktop computers, the fact that mobile Internet devices are small, mobile, and easy to use gives them an affordance that is unique among currently available technologies. This affordance is the capability to provide most of the resources and functions of a computer at almost any time and in almost any location, and this affordance significantly expands informal learning opportunities (Sandberg et al., 2011; Lin, 2007). Caudill (2007) recognizes that "the prime characteristic of mobile devices is that they are carried on a regular, if not constant basis" and that these devices "will start up almost instantly, as opposed to the boot process that is required for a larger computer' (p.6). Norris and Soloway (2004) echo this sentiment: "Laptops are simply not as mobile, not as easy to use, and not as forgiving as handhelds" (p. 292). Clark, Logan, Luckin, Mee, & Oliver (2009) found mobile technology was effective in blending formal and informal learning.

Scholars consider mobile Internet devices like the iPod touch to be "highly mobile devices" that share the following key traits: (1) small enough to hold in one hand and not impede face-to-face interaction, (2) sufficient computing power to handle relatively large amounts of data, and (3) capable of supporting sharing and collaboration (van 't Hooft & Vahey, 2007a). With high mobility, "wireless mobile devices diminish boundaries imposed by brick and mortar spaces and the school day" (Swan, Kratcoski, & van 't Hooft, 2007: p.10) by bringing the outside world into the classroom via the Internet and by allowing students to the learning resources with them outside of school.

Several recent research studies have explored how mobile Internet devices can enhance formal instruction by interacting with the outside world. In one example, students used devices to help identify plants (Huang, Lin, & Cheng, 2010). In another, elementary students in Taiwan used concept maps on devices to plan field observations of a butterfly ecology garden (Hwang, Wu, & Ke, 2011). A U.S. study of elementary students showed how students were able to access satellite maps via mobile Internet devices to enhance their observations of geological formations (Bannan, Peters, & Martinez, 2010). Research by Ekanayake and Wishart (2011) also showed the effectiveness of using mobile Internet devices outdoors to enrich science learning. In this study, high school students used mobile phone cameras to explore organisms in their environment. Other research has shown that using mobile Internet devices for additional media can improve learning outcomes when used to supplement museum experiences (Guazzaroni, 2012; Sung, Hou, Liu, & Chang, 2010).

Mobile Internet devices facilitate the integration of outside experiences into formal instruction, but the mobility and capabilities of these devices also offer the important opportunity for enhanced informal learning. While mobile Internet devices have considerable potential as a tool to assist independent and student-initiated learning, the preponderance of research focuses on structured formal learning activities. While learning activities that occur without the involvement or even awareness of teachers are difficult for researchers to investigate, informal learning is an important affordance of mobile Internet devices. Seisto et al. (2011) recognized that "mobile phones can be seen as culturally new but important artifacts, which are interwoven into the everyday lives of the students, and thus are part of their social interaction and informal learning (p.44)."

Constraints

Understanding the characteristics and affordances of the iPod touch and similar devices is very important to identify how this tool can support learning in unique and effective ways, but understanding the constraints of these devices is just as important. Few examples of the literature focus on constraints, but several are mentioned. These are:

1. Need for support
2. Teacher resistance
3. Access control and inappropriate use
4. Obsolescence
5. Focus on technology over pedagogy

There are ways to minimize or overcome these constraints, but these can add effort, costs, and/or complications. An understanding of these constraints can help users and potential users of mobile Internet devices prepare for successful implementation.

Many researchers highlight the need for administrative support in the form of teacher training and in-service workshops (Keengwe et al., 2009; van 't Hooft and Vahey, 2007b). They also mention the need for a technician or other technology expert. Effective support consists of training teachers on the technical operation of the devices and also on effective ways to integrate the technology into their curricula though in many cases, professional development is either broadly motivational or software-specific (Zhao, Pugh, Sheldon, & Byers, 2002). Depending on the pre-existing skill level of teachers, administrative support and professional development efforts aimed at both technology proficiency and innovative teaching approaches using technology are necessary (Zhao, et al., 2002) and can require a considerable investment. School administrators also need to provide technical support to assist teachers and students with problems using the device and its software applications. The maintenance and replacement of the devices requires further support to fix or replace devices that are lost, damaged, or stolen.

Researchers point out that teachers' perceptions of mobile Internet devices can be a constraint. Because the devices can provide instruction and learning opportunities outside the classroom, Sandberg et al. (2011) believe some teachers will view the devices as a threat to their position. Short of viewing these devices as a direct threat to job security, teacher perceptions can also be a lesser constraint if teachers are reluctant to use

the devices because they view them as not useful or if teachers fail to combine the use of the devices with appropriate teaching activities. Tomasino, Doubek, and Ormiston (2007) acknowledge the reality that " some teachers are phobic about technology and exhibit the 'you go first' philosophy, some are very savvy with technology but have limited instructional expertise, and others are just plain skeptical about making any changes" (p. 31).

Because most mobile Internet devices are designed for all ages and for many non-educational purposes, they often contain features and applications that can be distracting and/or inappropriate for students. By default, many devices have unrestricted access to anything available on the Internet. If schools provide mobile Internet devices or condone their use for school activities, many will want to ensure that the devices only allow approved content and access. Even features that have both educational and non-educational uses may need to be monitored. Roschelle (2003) reports that schools have considered banning text messaging to prevent cheating and distractions.

Mobile Internet devices seem to follow the trends seen in other computer-related technologies where capabilities increase dramatically in relatively short timeframes. Looi et al. (2009) discuss "the rapid obsolescence of personal digital assistants and cellphone models" (p. 163) and suggest that many devices are outdated and unpopular after a period of no more than 2 years. Costs of newer model devices are not always significantly higher. Writing in 2004 (3 years before the debut of the iPod touch), Norris and Soloway estimated the cost of handheld computers at $250 and this was the same cost of late-generation iPod touch devices in 2012. However, replacing the devices with

newer models (even if unit costs do not increase) can be a significant expense - especially if a school has a 1:1 ratio of devices to students.

Finally, another constraint is the potential for users to over-emphasize or over-rely on the technology. Caudill cautions "with such an intense focus on the capabilities of the new technology available to integrate into a learning environment it is far too easy for a designer or instructor to put all of their time into the technical aspects of an environment" (2007, p.5). The power and versatility of the device allow levels of technical sophistication that may interfere with or inhibit effective teaching strategies.

Results from Research on Mobile Learning

As mentioned above, this research effort focuses on a unique combination of dimensions (iPod touch as a device, U.S. as the location, K-12 as the level, ELLs as the learners, a sociocultural approach, and a setting where mobile technology use is a requirement). While any previous research about mobile Internet devices that includes some of the key dimensions is potentially informative for this research, the dimension of academic level (K-12 versus higher education) is particularly important because the learners and instructional models are considerably different between these levels. Therefore, this section separates research findings from mobile Internet device implementation efforts based on the academic level. Because research presenting empirical findings about the implementation of mobile Internet technology is relatively limited, this discussion does include selected research from higher education settings where other key dimensions are addressed. However, the application of these findings

from higher education settings to inform this research is much more tentative. For research conducted at the K-12 level, this section separates examples related to language learning and examples related to learning general academic subjects. Both language and general learning at the K-12 level using mobile Internet devices are relevant to this research, but these are distinct goals.

Overall, research shows that mobile learning is effective in K-12 learning. In a meta-analysis of recently published research, Liu, Scordino, Geurtz, Navarrete, Ko, and Lim (2013) found that nine out of twelve comparison studies of mobile learning showed positive learning outcomes. The other three studies showed neutral outcomes and no published research suggested that learning outcomes were negative or inferior to other approaches.

Mobile Internet Devices in K-12 Language Education

One study in the U.S. investigated a situation similar to the focus of this research and looked at the use of iPods (though not the newer and considerably more versatile iPod Touch) among K-12 ELL students (Patten & Craig, 2007). This research analyzed two projects implemented by elementary school teachers and two projects implemented by middle school teachers with the goal of improving reading, writing, and listening skills. In this study, each of the four teachers used iPods differently, though all involved allowing ELLs to listen to books in English on the iPod. The researchers measured test scores (Accelerated Reader and state writing assessment tests), evaluated student writing, observed classroom activities, and conducted interviews with teachers and students.

Patten and Craig (2007) found that the ELL students in these four classes had successful learning outcomes as measured by test performance. While no control groups existed as a baseline for comparison, achievement levels were higher than previous years when iPods were not available and interviews with teachers and students suggested that the iPods motivated students and helped them learn. Also, the researchers found that many ELL students were excited and proud to have the iPods, which were seen as desirable.

Other research has also focused on the use of the iPod touch in ELL classes. Lacina (2008) conducted observations and interviews in another Texas school district that began using iPods in 2005. The research focused on a sixth grade class consisting of newcomer ELLs who had been in the U.S. for less than a year. In this classroom, the teacher designed tailored podcasts for homework assignments. Class activities included assignments where students created video podcasts to tell their stories about coming to the U.S. The production of these podcasts involved writing, developing a storyboard, integrating pictures, video, and background music, and providing narration.

Lacina (2008) observed that the ELL students in the class were very engaged and motivated and that the iPods allowed students to acquire vocabulary and other language skills in a structured audio format both inside and outside the classroom. Interviews with the teacher supported the observation that students found the iPods more engaging than the previous traditional curriculum. From this experience, the teacher provided the researcher with some implementation recommendations that included making sure that support and training are available from the district, providing dedicated instruction for

ELL students about how to use technology, sharing ideas with other teachers, starting slowly with technology integration, and making learning relevant to students' lives outside the classroom.

Research in the Netherlands studied 85 fifth graders learning English as a second language (Sandberg et al., 2011). This study used three groups – traditional instruction, instruction with mobile devices, and instruction with mobile device the students were allowed to take home. All three groups were learning English vocabulary related to animals. While the students were not randomly assigned, the first class represented the control condition with just classroom instruction. The second and third classes visited the zoo to provide an engaging context for learning and also were give handheld devices with a custom app designed to teach the English animal-related vocabulary words. While students in the second group were given a mobile phone with the app for the duration of zoo trip, the third group was allowed to take the device home for two weeks.

This research (Sandberg et al., 2011) found that the third group allowed to keep the mobile devices for two weeks had higher post-test scores for learning vocabulary and facts about animals while the post-test scores of the second group who visited the zoo but only had access to the app for that day did not differ significantly from the classroom-only group. Further analysis of the results revealed that the higher scores among students who took the device home resulted from the additional time they spent learning, suggesting that full-time possession of the mobile devices encourages informal learning.

Hwang and Chen (2013) conducted research in Taiwan to evaluate the effectiveness of situated learning for helping students learn English language and

listening skills. In the experimental group, students used PDA's at lunch with pictures of food-related items and recordings of their peers pronouncing the associated English word. After hearing the word, students recorded their own pronunciation of the word. Thus, students were able to hear and speak these words in familiar situations. The evaluation of this program found that practicing English with peers through the devices significantly improved learning. Follow-up interviews with students revealed that students in the experimental group extended their learning at home.

In 2008, another study in Taiwan looked at the use of short message service (SMS) via mobile phone as a way to improve students' English vocabulary (Lu, 2008). This research found that students who used the SMS lessons had improved vocabulary when compared to students who were assigned to the more traditional print material. Interviews with the students discovered that the students who used SMS had a more positive attitude toward vocabulary learning, but also found that students' unfamiliarity with the devices and activities could prevent them from reading the SMS lessons.

Particularly relevant are two research efforts I conducted with my colleagues that studied preceding years of the iPod touch initiative (Liu, Navarette, Maradiegue, & Wivagg, in press; Liu, Navarette, & Wivagg, 2013). Both studies were conducted at the same district. The first study (Liu, Navarette, Maradiegue, & Wivagg, in press) focused exclusively on ELL students and teachers in sixth, seventh, and eighth grades, where the iPod touch initiative began in 2009. The second study included some of the same information, but also included data from the fourth and fifth grade classrooms that are the focus of this research.

The first of these studies (Liu, Navarette, Maradiegue, & Wivagg, in press) found that the iPod touch devices offered both technological and pedagogical affordances. The technical affordances were language learning, content learning, multimodal learning support, extended learning time, and home-school connection. Pedagogical affordances were differentiated instructional support, collaborative learning support, and access to Internet resources. The second study (Liu, Navarette, & Wivagg, 2013) found many of these same affordances and focused separately on the middle school environment (grades 6-8) and the elementary school environment (grades 4-5). The study noted lower enthusiasm for the initiative among the elementary teachers and found that the affordance of extended learning time was not prevalent in the elementary classes.

Both studies (Liu, Navarette, Maradiegue, & Wivagg, in press; Liu, Navarette, & Wivagg, 2013) also identified constraints. Teachers mentioned that integrating the devices took a significant amount of time because they had to figure out appropriate lessons and learn how to use the devices. Other constraints were technical problems and students losing and breaking the devices. The elementary teachers also identified the issue of inappropriate use, though the middle school teachers did not mention this.

These studies (Liu, Navarette, Maradiegue, & Wivagg, in press; Liu, Navarette, & Wivagg, 2013) also analyzed survey data collected from students at the middle and at the end of the school year to understand the frequency and nature of their iPod touch use both at school and at home. The middle school students generally reported using their iPod touch devices less at the end of the school year, while usage patterns varied among the elementary students. At the end of the school year, elementary students tended to use

some tools like the calculator and voice recorder less often, but they tended to use the calendar, Internet, maps, and video camera more.

Mobile Internet Devices in K-12 General Education

Other research has looked at the use of mobile Internet technology for enhancing instruction in general academic areas at the K-12 level. One recent effort conducted cross-national comparisons and looked at the use of PDAs by sixth and seventh grade students in the U.S. (Michigan) and in Norway in 2003-2005 (Mifsud & Morch, 2010). The researchers studied two classes in each country where students were allowed to keep PDAs for the whole school year and they conducted classroom observations and interviews and focus groups with students. The focus of this research was on how students and teachers used the PDAs rather than whether or not the devices directly improved learning outcomes.

Data from observations and interviews found that while teachers in each country provided different instruction using the PDAs, students in both countries tended to use the PDAs for their own activities in similar ways. While many of the student uses of the PDAs did not directly relate to the teacher-defined activities, the researchers use sociocultural theory to frame these uses as "student-defined" activities rather than "off-task" activities (Mifsud & Morch, 2010). The main types of student-defined activities were personalization and exploration. The students personalized their PDAs (with folders, etc.) and used software that was not part of the teacher-defined activities such as spreadsheets, virus simulation, games, and quizzes for exploration (p. 193).

In Taiwan, a quasi-experiment with two fifth grade classes showed the effect of tailoring pedagogy to maximize the benefits of mobile Internet devices (Hwang & Chang, 2010). Students visited a temple to learn about culture and the control group used PDAs with traditional tour-based applications that told students where to go and provided information about each location. The experimental group had PDAs programmed with the Formative Assessment-based Mobile Learning (FAML) model, in which "individual students are situated in a real-world learning environment with personal supports or guidance from the learning system" (Hwang & Chang, 2010: p. 1024). With the FAML app, students in the experimental group were asked questions about each location or feature of interest and based on their responses, were guided to additional information or resources. The control group also visited the temple with PDAs, but their PDA app was a traditional tour-based app (where the device told students where to go and prompted them with questions about each location or feature and immediate feedback as to whether their response was correct).

Based on pre-test and post-test data, Hwang and Chang (2010) found that students in the experimental group had significantly higher learning achievement. While both groups had about the same increase in their interest, only the experimental group showed an increase in their learning attitude. The researchers concluded that by only providing hints and resources, the FAML approach created a more problem-based learning experience that motivated students to learn on their own. Other research about this same activity focuses on the cognitive load measured by student questionnaires (Shih, Chuang, & Hwang, 2010). This research shows that while the more problem-based FAML

approach improves outcomes and attitudes, it has the same level of cognitive load for students. These results suggest that the combination of mobile Internet technology with appropriate pedagogy can yield improved learning outcomes and improved attitudes toward learning without changing the level of effort required from learners.

Other research from Taiwan has looked at the use of mobile Internet devices in the natural sciences using an app called the Mobile Knowledge Constructor (MKC) to teach plant identification and classification (Chu, Hwang, & Tsai, 2010). The researchers conducted pre-test and post-test with two fifth grade classes. Both classes had the assignment of observing and comparing 12 plants with the goal of correctly identifying and classifying them. The control group class was guided by the teacher and documented their findings on an information sheet while the experimental group used the MKC app that provided prompts, hints, and questions to assist with identification.

The researchers found that students in the experimental group using the MKC app with mobile devices scored significantly higher on the post-test. Specifically, the post-test scores were higher on items related to the observation and classification of plants whereas the test scores were not significantly different between the groups on the fundamental knowledge of the plants (Chu, Hwang, & Tsai, 2010).

Research from Australia has a relatively rare focus on the implementation decision-making process by looking at how Australian schools with iPods worked to develop a plan to deploy them in two fifth grade classrooms (Reid, Kervin, Vardy, & Hindle, 2006). This study in 2006 looked at the original iPod that lacks many of the features of the iPod touch, most notably Internet access (meaning these technically are

not mobile Internet devices). The first step taken by these teachers was deciding which area of the curriculum would most benefit from use of the iPods. Because the English curriculum area (which is the native language of most students and the language of instruction) is a particular emphasis mandated by the administration and includes instruction on talking and listening as well as reading and writing, the teachers decided to use the iPods in this area.

After determining the focus on English talking and listening skills, the next step was for the teachers to decide how the functions and affordances of the iPod would be useful. Researchers observed that the teachers identified the potential for the iPods to assist students with special needs (such as one student who was almost blind) and came up with suggested activities such as recording interviews and experiences, deconstructing audio texts and podcasts, creating a podcast radio show as a final project, and (for the teachers themselves) maintaining audio reflective journals. As the researchers observed this process, they remarked on the excitement and motivation the teachers showed about using this technology. While not all teachers will always necessarily share this motivation, their proposed process of teacher-determined implementation planning may alleviate negative teacher attitudes.

Research from U.S. K-12 education has explored the use of mobile Internet devices to improve writing. One Oklahoma City-area school district acquired Palm OS handheld devices with the goal of facilitating an initiative called "writing across the curriculum", which emphasizes writing as a way to improve learning across all subjects (Yarnall, et al., 2007). Yarnall, et al. (2007) discuss four findings from research on this

initiative. First, they found that the screen size of handheld devices made them useful for taking notes, but not extended writing efforts. Second, they found that teachers using handheld devices developed more collaborative and creative writing activities than other teachers. Third, data from teachers indicated that increased student engagement as a result of using these devices did not persist but that these devices remained a useful way to take notes. Fourth, they found that writing quality did not improve as a result of using the devices compared to results from traditional classroom activities (Yarnall et al. 2007). This research suggests that efforts to deploy mobile Internet technology can have secondary positive outcomes even if they fail to meet the intended goals. These findings from Yarnall et al. may also reinforce the idea that the pedagogy and learning activities need to change to realize the potential of mobile Internet technology and that just adding the technology within an existing framework has limited benefits.

Another U.S. study by Kiger, Herro, and Prunty (2012) looked at the use of a mobile learning intervention (MLI) used in third grade math. The students in the experimental group used a variety of math apps on iPod touch devices rather than flash cards for daily practice. Controlling for a variety of factors, Kiger et al. found that students who used the iPod touch for practice had moderately and significantly higher post-tests. Shin, Sutherland Norris and Soloway (2012) also examined math games used in U.S. elementary education. This study used a quasi-experimental design with second graders and also found that students who used the math games had positive effects on students' arithmetic learning. Bannan et al. (2010) conducted exploratory research on the use of mobile Internet technology to help elementary and middle school students in the

U.S. learn geology. Like other studies, Bannan et al. found evidence that the affordances of the device led to improved learning outcomes.

Summary of Mobile Learning

To summarize, most literature across countries, grade levels, and learning goals recognize the relatively low cost of mobile devices in comparison to traditional computers. Beyond low cost, the devices also have strong potential to foster informal learning because they are portable and socially acceptable (even desirable) to carry in and out of the school environment. Most literature emphasizes that the devices themselves offer some inherent benefits and that maximizing the effectiveness of these devices requires integrating them with constructivist pedagogy. Studies show that long-term possession of the devices (including outside school) can encourage informal learning.

In the environment of mobile learning, mobile Internet devices like the iPod touch have a unique combination of affordances and constraints. While individual affordances are shared with other technologies and other tools that support mobile learning, mobile Internet devices are versatile, portable, and desirable. This combination of affordances gives these devices particularly high potential for informal learning. As with affordances, many of the constraints of mobile Internet devices are also common to other tools and technologies. However, mobile Internet devices are particularly prone to loss, theft, and damage – especially when they leave the school environment to support informal learning.

Previous research on the use of mobile Internet devices in education shows them used in a variety of ways. With the rapid growth in the capabilities of these devices, even relatively recent research sometimes focuses on technology and devices now considered obsolete. In general, research evaluating mobile Internet devices shows that using these devices yields better learning results than more traditional approaches. This benefit seems particularly evident when the instruction combines these devices with constructivist-oriented teaching practices. Much of the research has studied innovative pilot programs where teachers, students, and administrators are enthusiastic about using the technology and different teaching approaches and activities.

LITERATURE GAPS AND IMPLICATIONS

Gaps

The academic literature about the use of mobile Internet devices in education exists and seems to be growing. The available literature does identify the key affordances and constraints of mobile Internet devices and this list seems comprehensive and well developed. It also connects mobile Internet technology to relevant theoretical approaches (sociocultural) and pedagogy (constructivist) to create a useful context for understanding the educational applications of this technology.

However, there are some key limitations of the existing literature for informing this specific research effort to understand the use of the iPod touch in U.S. K-12 ELL education. Research with empirical data about the implementation and outcomes is relatively limited and comes from a wide variety of situations. Much of the literature is

from outside the U.S.; much of it focuses on education goals other than ELL; much of it focuses on grade levels other than K-12; also, the research evaluates a variety of devices other than the iPod touch.

Perhaps most importantly, most literature examines programs and initiatives where teachers and researchers are excited about and motivated to use mobile Internet technology. Consequently, research must also seek to understand how to successfully deploy mobile Internet devices in situations where teachers might have neutral or negative attitudes towards the technology and/or low levels of knowledge about how to operate the devices or leverage the affordances of the devices.

Implications of the Proposed Research

This research effort will contribute to overcoming these gaps in the current literature by focusing on implementation efforts and challenges in a situation where the implementers have varying levels of motivation and knowledge. Recent trends have shown that mobile Internet devices are becoming more ubiquitous in society on general and more common in educational settings. If these observed trends continue (as many researchers project), the use of mobile Internet technology will likely increase in schools where teachers are not ready or are not receptive. Thus, one main purpose of this research is to provide information that will help advocates of this technology understand the implementation challenges that must be addressed to allow it to become successful on a broader scale.

From the literature and related theoretical perspectives, good implementation of the iPod touch will include (1) maximizing affordances, (2) proactively counteracting and compensating for constraints, (3) a sociocultural approach that recognizes the importance of social interaction in learning, (4) constructivist learning experiences, and (5) encouraging and supporting informal learning. These five dimensions will comprise the "yardstick" for measuring the effectiveness of the iPod touch implementation, which will in turn help specifically identify the challenges that future implementation efforts will need to address. Another main purpose of this research is to understand how teachers and administrators implement programs using mobile Internet devices. Some aspects of good implementation may deliberately and proactively accompany the deployment of the technology, other aspects may occur somewhat naturally because of the nature of the devices, while others may not be present or may be present in lower than optimal levels because the characteristics of the device, teachers, administration and/or students inhibit good implementation.

The review of the literature shows that research aimed at understanding the role of mobile Internet technology in education is fairly broad but not very deep. Also, the fast evolution of mobile Internet devices means that the technological capabilities of current-generation devices far exceed those of devices that may have been cutting-edge just a few years ago. Consequently, new research about mobile Internet technology is important to understand its role more fully and in different education settings. Until the power and capabilities of these devices reach a plateau and remain relatively consistent for a significant period of time (if they ever do), research efforts like this one must be ongoing

so that researchers and educators can stay current and leverage the potential that these devices have for education.

Chapter 3 – Methodology

Overview

This chapter describes how I conducted the research to answer my questions. It begins by describing the overall case study approach and explaining the history and context of the iPod initiative. The chapter then describes the participants who provided data and continues with an explanation of the specific data sources. It continues with a discussion of the procedures used for qualitative data collection and a discussion of the data analysis. As a case study based on qualitative data, trustworthiness is a key consideration and this chapter addresses how this study achieves the several major dimensions of trustworthiness. Finally, the chapter puts forth my position statement as the researcher and describes the measures used to protect human research participants.

This research used a case study methodology to explore an initiative to use iPod touch devices in fourth and fifth grade public school classrooms in central Texas. The research questions for this study focused on understanding some specific aspects of this initiative. As presented in Chapter One, the research questions were:

1. What implementation practices do teachers use to integrate mobile Internet devices like the iPod touch into K-12 classrooms for fourth and fifth grade ELL students in bilingual classrooms?
2. Do student-defined activities and informal learning supplement formal teacher-defined activities when fourth and fifth grade ELL students in bilingual classrooms have continual possession of mobile Internet devices like the iPod

touch? If so, what is the nature and extent of these student-defined activities and this informal learning?

3. Are there implementation challenges when integrating mobile Internet devices like the iPod touch for fourth and fifth grade ELL students in bilingual classrooms? If so, what are these challenges and how can they be met?

These questions did not center around identifying relationships between variables but rather on understanding different aspects and dimensions of a complex education initiative in a specific context. Therefore, the case study approach is appropriate because this research focused on "what some phenomenon means as it is socially enacted within a particular case" (Dyson & Genishi, 2005, p. 11) and because it "is an in-depth description and analysis of a bounded system" (Merriam, 2009). The program that is the focus of this research and the nature of the research questions also meet Yin's (2009) three criteria for selection of the case study as an appropriate research method because (1) the research questions generally focus on "how", (2) the researcher does not have and does not require control over behavioral events, and (3) the focus is on contemporary events.

For case study research, five research design components are particularly important. These are (1) the study's questions, (2) its propositions, (3) the unit(s) of analysis, (4) the logic linking data to propositions, and (5) criteria for interpreting findings (Yin, 2009). The research questions for this study contain mostly questions about "how" things work. The propositions for this study are:

1. Mobile Internet technology combined with constructivist pedagogy enhances language learning and this applies to ELLs in K-12 education.

2. Mobile Internet technology has unique potential for facilitating informal learning and informal learning expands language learning into a variety of environments so that ELLs can better learn different literacies within the English language.
3. Barriers exist that prevent mobile Internet technology from diffusing in K-12 education and there are means to remove or overcome these barriers.

As described above, the unit of analysis (the "case") consisted of the teachers and students in two ELL bilingual fourth and fifth grade classrooms in a central Texas school district. The data collected from observations, interviews, and content analysis were linked to the theoretical propositions above and data were used as evidence showing whether and how the data supported or failed to support these propositions. The criteria for interpreting the findings focused on implementation, specifically whether or to what extent teachers used constructivist teaching activities and whether or to what extent students used their iPod touch devices for informal learning.

Description and Background of the iPod touch Initiative

The district began using mobile Internet technology in 2009 to address a substantial gap between the test scores of ELL students versus other students in the district. The chart below compares the overall rates of students passing the Texas Assessment of Knowledge and Skills (TAKS) test (the primary standardized test used for K-12 public education in Texas).

Table 3.1

Percentage of All District Students and Limited English Proficiency Students Passing TAKS Test by Year (All Grades)

Year	All District Students	LEP Students
2008	83%	61%
2009	84%	61%
2010	85%	60%
2011	85%	67%

As shown in the chart above, passing rates for limited English proficiency (LEP) students trailed the district rate by 22 percentage points in 2008. In 2009, the upper administration with the approval of the school board implemented a program to provide all ELLs in district middle schools (grades 6-8) with iPod touch devices available for continuous use. While 2011 rates suggest that passing rates among LEP students have increased, a variety of factors make it difficult to establish a direct link between the iPod touch initiative and higher standardized test scores for ELL students in the district. However, recent research has found other anticipated positive outcomes resulting from the middle school iPod touch initiative including: connecting families to the school, providing engaging ways to learn content, promoting informal learning, and allowing teachers to better tailor instruction to students' grade levels and English proficiency levels (Liu et al., 2013). As of the 2011-2012 school year, the middle school program expanded through grade 10 and all district ELLs in grades 6-10 (approximately 250 total students) had iPod touch devices as of the 2011-2012 school year.

Prior to the 2009 middle school program, the district considered several options to improve test scores for ELLs. Based on observations conducted in neighboring school districts that used older generation iPods (without Internet access) in ELL programs, upper administration decided to move forward with mobile Internet technology that would offer the media capture and playback advantages of the classic iPod as well as expanded possibilities such as Internet access, learning tools (such as translators, dictionaries, encyclopedias, etc.), and educational games. At the time of this decision in the summer of 2009, the iPod touch was the only widely available device with these capabilities.

This research focuses on a pilot program that began in 2011-2012 to expand the middle school iPod touch program into elementary grades 4 and 5. In 2011, the 41 ELL bilingual students in grades 4 and 5 from one of the district's bilingual schools received iPod touch devices. As of February 2012, there were 24 fourth graders and 17 fifth graders participating in the pilot program. Two teachers were also involved with the program. One teacher taught math and science at each grade level and the other taught language arts and social studies for each grade level.

As of 2013, the district planned to expand the program to all fourth and fifth grade ELLs (approximately 200 total students), including those who are not attending a bilingual school, if this pilot program showed positive outcomes and was deemed sufficiently cost-effective. While the district was likely to expand the pilot program to all fourth and fifth grade ELL classes if administrators decided that the iPod touch devices

cost-effectively contribute to better English language learning, the district had no plans for other mobile technology initiatives due to limited support staff.

At the district administrative level, the implementation and support of the iPod touch initiative involved the Instructional Technology and Bilingual/Dual-Language Education support areas. During the 2011-2012 school year, these departments provided 3 full days of training as well as in-class support to the teachers in the pilot program. In addition to formal training, teachers had access to campus instructional facilitators whose primary role is to train teachers in the use of technology. If a teacher needed additional support in the classroom with technology, she could schedule one of the campus instructional facilitator to come and assist in the classroom. Bilingual teachers also had access to online technology training materials and training opportunities offered through the district's "Tech2U" videoconference professional development training sessions, which are offered every Tuesday and Wednesday.

This research uses the second year (2012-2013 school year) of the iPod touch initiative pilot program implemented in the fourth and fifth grade ELL classes as the case study. The case study includes both teachers who were part of the pilot program when it began in 2011 and many of the 2012-2013 fifth graders participated in the program as fourth graders in the 2011-2012 school year.

As with any technology used in education, effective implementation combines appropriate use of the technology's capabilities with a pedagogy that fits the technology. Understanding the program requires both a discussion of the device and the teaching approach. This section lists and describes the nature of the apps that students had on their

iPod touch devices during the 2012-2013 school year as well as the nature of the curriculum the district defined to maximize the benefit of mobile Internet technology.

The teachers in this district were allowed flexibility on how to teach the required district curriculum. The required curriculum was written in broad terms so that teachers had the flexibility to teach according to their own individual teaching philosophy or to work within their grade level team to build lessons. The district did not prescribe set activities for each curriculum objective but did provide a list of suggested activities and lessons. Because of this philosophy, the onus was on the teacher as to how to incorporate the iPods in the curriculum. District level staff provided teachers with recommended apps and lessons using the iPod but the teachers made the final decisions on how and when to use the iPods.

Because this was a district initiative, teachers were expected to use the iPods with their students. However, the ways in which the iPods were used was left to the teachers' discretion with the exception of two apps that the district required to be installed on each iPod. The two required apps were the *Merriam Webster Dictionary* (Merriam-Webster, Incorporated, 2012) and the *English-Spanish Reference Dictionary* (Word Magic Software, 2012). These two specific apps were required to be installed on the iPods because students can use them when taking the state standardized tests and these apps do not require an Internet connection to work.

Besides having access to a dictionary and translator, students also had access to the native apps located on the iPods. These include; a voice recorder, calendar,

calculator, note taking app, weather information app, maps app, Internet browser and photo, music, and video app. The iPods also have a built in video and still camera.

In addition to the native and required apps, the teachers installed an additional 49 apps onto the student's devices. The types of applications ranged from creation tools such as *Keynote* (Apple, 2012b), a presentation builder, *Pages* (Apple, 2012d), a word processor, and *Comic Touch* (plasq LLC, 2011) a comic strip maker, to apps that enhance memory such as *Spelling City* (Spelling City, 2012), *Times Tables* (Digital Brainwash, 2012), an app that drills students on multiplication facts, and *BrainPOP*, (BrainPOP, 2012) which presents students with a different educational video each day. A full list of apps is included as Appendix E.

Preceding Technology Initiatives

In addition to the iPod touch initiative, there have been other district-wide efforts to use mobile technology. All secondary school libraries had iPod touch and iPad devices available for student checkout. In 2009, the district purchased iPod Nano devices (that have no Internet access capability) for middle school science classrooms as a way to hear and watch science-related media. However, the iPod Nano program for the science classrooms was not particularly successful and was mostly discontinued as of the time of this research. Besides district-level initiatives, specific schools and programs acquired mobile Internet devices for educational use. All district schools and offices offered wireless Internet access allowing students to use mobile Internet devices (either those provided by the school or those belonging to students). To limit Internet use to

appropriate activities, the district used custom filtering software. Also, the school commissioned an app downloadable from iTunes that allowed students, parents, and staff to have mobile access to district web content.

As of the 2012-2013 school year, there were several other technology initiatives at this school district. Since 2008, all teachers had been issued a laptop computer for use both at home and at work. Also, all classrooms were equipped with overhead projectors and document cameras. All secondary teachers and students were also required to use the district's learning management system (LMS). Teachers used this system to upload and post assignments and resources. Students used the LMS to turn in assignments and store their files using either a computer or mobile device. Parents could also login to their child's account to check their assignments and calendar.

In 2012, the district began an iPad initiative for teachers. The district offered iPads to all teachers and required them to complete a three-hour training session on instructional strategies using the device. The training included having teachers watch other teachers and demonstrate their own lessons. This iPad initiative was an initial step towards a possible one-to-one device initiative for students. However, the arrival of a new superintendent in the district and the unexpected departure of the district's Chief Technology Officer (who led the initiative) effectively ended this program. While teachers kept the iPads, there was no longer any structure or support for the program.

Although teachers were not required to attend professional development sessions that focus on technology, the district offered both online and face-to-face training opportunities throughout the school year. One program that was successful was the

implementation of training sessions via desktop videoconference. On Tuesdays and Wednesdays, teachers could attend trainings that focused on technology integration during their conference periods via videoconference.

PARTICIPANTS

To answer the research questions using this case study, this research used data collected directly and indirectly from multiple stakeholders. Key stakeholders providing direct data in the form of interview responses included teachers, administrators, and students involved with the ELL iPod touch initiative. Indirectly, the teachers and students provided data through classroom observations and student artifacts and these indirect data sources are described further in the following section.

The two teachers in this study were certified English as a Second Language (ESL) teachers and taught in a bilingual class setting where the teachers taught in both Spanish and English. The language choice was left to the discretion of the teacher with the expectation that teachers would use the language that best met each individual student's need for language instruction. The goal for the teacher was to transition students from their first language to English by using a gradual process of increasing English language instruction.

Table 3.2

Key Characteristics of Teacher Participants

Teacher	Subjects	Years Experience in District	Total Years Experience
Allison	English Language Arts and Social Studies	13	23
Michelle	Science and Math	12	21

The fourth and fifth grade classes that were the focus of this research consisted of all English Language Learners in bilingual classrooms (bilingual ELLs) during the 2012-2013 school year. The purpose of this Bilingual Education program has been to develop English Language Proficiency in English Language Learner (ELL) students for a positive impact on future success both in school and after graduation. Students whose first language is not English and who score low on the TELPAS (Texas English Language Proficiency Standards) test are classified as English Language Learners. In this district, ELL students in grades K-5 are placed in bilingual classrooms. In sixth grade they transition away from bilingual classrooms into mainstream regular education classroom with support from English as a Second Language (ESL) teachers.

This mobile learning initiative was in a district where Spanish is the primary language spoken at home for about 97% of ELL students, with 95% of ELLs coming from Mexican descent. All fourth and fifth grade students in the iPod touch initiative were Spanish speakers. In the district, ELL status is strongly associated with low socioeconomic status with 85% of ELL students classified as economically disadvantaged (versus 32% for the district as a whole).

There were nine students who participated in the student interviews. Both genders grade levels were represented and the level of English proficiency for the participants varied and was representative of the overall distribution. For proficiency, I used teacher-estimated levels of each student's academic English proficiency based on a rating scale of 1 to 5, with 1 being no English and 5 being completely fluent in English. All interviewed students were at least level 3, but this generally reflected the composition of the classes.

Table 3.3

Sample for Student Interviews by Key Characteristics

		Level of English Proficiency		
Grade/Gender	Total	Level 3	Level 4	Level 5
Grade 4 - Male	1		1	
Grade 4 - Female	2		1	1
Grade 5 - Male	3	1	1	1
Grade 5 - Female	3		3	

The administrator who participated in the interview was the Bilingual Coordinator for the school district. A Mexican-born native Spanish speaker, this administrator's educational experience included four years as a bilingual teacher, two years as a Bilingual Instructional Specialist, and two years in the Bilingual Coordinator position.

DATA SOURCES

Data sources consisted of classroom observations, interviews, and analysis of student work. Because this is a case study of a pilot program, qualitative interviews allowed an in-depth understanding of teacher, student, and administrator attitudes about and experiences with the iPod touch initiative. Classroom observations provided a summary of the events and interactions that occurred in the learning environment. Content analysis of learning activities complemented student and teacher interview data with data that show how students and teachers actually used iPod touch devices. This multifaceted approach used all of the major qualitative methodologies (Merriam, 2009) and multiple data sources to allow triangulation of findings.

Interviews

Qualitative interviews with students, teachers, and a school administrator were important data sources. The table below identifies the three stakeholder groups that provided interview data and summarizes the key viewpoint and perspectives that they offered.

Table 3.4

Stakeholder groups for qualitative interviews

Stakeholder Group	Number of Interviews	Key Contributions
Teachers	2	Direct knowledge of implementation practices and challenges. Observation of student-defined activities in the classroom setting. Possible indirect awareness of informal learning.
Students	9	Direct knowledge of informal learning and student-defined activities. Reporting of interest and engagement levels regarding the iPod touch. Identification of successful implementation practices.
Administrator	1	Objective assessment of teacher attitudes towards the initiative. Identification of program successes in achieving broad district goals. Evaluation of costs vs. benefits.

The sections below provide further details about the interviews conducted with each stakeholder group.

Teacher Interviews

Both teachers involved with the pilot project participated in individual interviews. Because the nature and extent of iPod touch implementation depends highly on the attitudes of the primary teachers, the interview began with questions that assessed teachers' motivation (e.g. "When initially told about the iPod touch initiative, what was your reaction?") and attitudes about the program and how their feelings have changed since the start of the initiative (e.g. "How have your feelings about the initiative

changed?"). Teachers' knowledge and proficiency with the iPod touch and its educational potential were also likely to have an impact on implementation and the interviews included questions asking teachers about their technology background (e.g. "describe your familiarity and comfort level using technology") and comfort level as well as asking them to formatively assess the level and effectiveness of training and preparation provided by the district.

Teachers were also asked to identify what they perceived as the goals and advantages of the program (e.g. "What are the benefits of using the iPod touch in your teaching?") and also what they perceived as the challenges and disadvantages of the program (e.g. "What are the disadvantages or problems using the iPod touch?"). As literature suggests that constructivist-oriented teaching strategies tend to be the most effective approach to integrate mobile Internet technology, the interview included questions that asked teachers about their teaching philosophy and how their philosophy matches constructivism. Teacher interviews continued with questions about teaching activities with the iPod touch, including questions about which apps they use and questions about student-defined learning activities (e.g. "What have students told you about how they use their iPod touch outside of the classroom?"). Finally, the interview asked questions about affordances and constraints that teachers have experienced using mobile Internet devices. A full list of the Teacher Interview Questions is included as Appendix A.

Student Interviews

Data sources also included qualitative interviews with nine students. Interviews asked what students generally liked and disliked about having the iPod touch assigned to them throughout the year. To establish context, the interview asked questions about their technology background and what other technology they have and use ("Other than your iPod touch, what other technology devices do you use?"). Most interview questions focused on how the students used their iPod, including questions about how they use the iPod outside of school and whether and how they share the device with their families (e.g. "How often do you use the iPod touch outside of school?" and "What apps do you use and how do you use them?"). These questions probed to identify learning activities that students have discovered on their own or learned from peers and whether they engage in these activities in school, out of school, or both. Interview questions concluded by asking students about their favorite apps and asking them which classroom activities using the iPod touch they like and dislike and why ("What are your favorite class activities using the iPod touch?"). A full list of the Student Interview Questions is included as Appendix B.

Administrator/Staff Interview

This interview asked about the goals for the iPod pilot program for fourth and fifth grade and how to define success (e.g. "What would success of this program look like?"). Questions also assessed Juan's perspectives on teacher attitudes about the program and whether or how these have changed (e.g. "How would you describe the

teachers' attitudes towards the iPod touch program?" and "Have they changed over time?").

Because most constraints associated with mobile Internet technology relate to direct costs (purchase, maintenance, and replacement of devices) and indirect costs (support, training, etc.) that are usually incurred at the district level (e.g. Keengwe et al., 2009; van 't Hooft and Vahey, 2007b), the administrator interview focused on the constraints of the devices and problems associated with the program implementation (e.g. "What are the problems or drawbacks associated with the iPod initiative?"). Based on goals, the definition of success, and constraints, the interview concluded by asking the coordinator to rate the costs versus the benefits of the program and how he would rate this iPod touch program compared to other programs that are available (e.g. "How do the benefits of the iPod touch program compare with the costs?" and "What other programs would be more cost-effective?"). A full list of the Administrator/Staff Interview Questions is included as Appendix C.

Classroom Observations

First, classroom observations looked for how often and in what ways the teachers used the iPod touch devices. Specifically, observations looked for planned versus ad-hoc use and teacher-directed versus student-initiated use. Classroom observations documented classroom activities (and pre-class activities in one observation) that involved social interaction and learning that occurred from the social context. Finally, classroom observations documented instances where teachers and students leverage the

affordances of the iPod touch and instances where they counteract its constraints. Subsequent analysis assessed the nature of the classroom learning activities to evaluate whether they had traits associated with constructivism.

To standardize classroom observation, documentation used an observation form designed to measure constructivist learning using technology adapted from a previous study (Liu, Wivagg, Geurtz, Lee, & Chang, 2012) to record specific student and teacher behaviors as well as classroom characteristics. In addition to completing the form, I also used extensive field notes to document classroom activities as well as my comments and insights.

Student Artifacts

Data collection included a content analysis that analyzed student assignments. From the examples teachers provided, Keynote presentation files and some pictures showing in-class math work along with an explanation of how the pictures were used in class provided the most usable content for this analysis. From these assignments, content analysis focused on evidence of how iPod touch devices were used and which apps were involved. The content analysis specifically looked to identify elements of assignments that show innovative student-defined tasks and evidence of constructivist learning.

Participant-Observation

In this case study, I was both a researcher and a practitioner. In addition to conducting the research, I was also employed as the district's Instructional Technology

Coordinator and the implementation of the iPod touch initiative was one of my job responsibilities. Thus, the formal interviews, observations, and artifact analysis I formally conducted specifically for this research comprised a relatively small part of my overall involvement with the program. Though being a participant in the program allowed me a deeper understanding based on personal experience and extensive interactions with other key program participants, this also led to some bias.

To limit this bias, my findings, conclusions, and recommendations are based almost exclusively on data I formally collected from the data sources described below. I deliberately excluded my own personal experiences as a separate data source so that the voice of other participants and the activities and assignments that stemmed from the initiative would be the focus. However, my experiences as a participant serve as a context that provides a deeper and richer understanding of the context of the data I collected from these sources. Also, my position statement below summarizes my professional background in order to identify the nature of my personal bias.

Position Statement

I began my professional career in 1996 as a sixth grade teacher in a small Texas school district where I was also very involved with acquiring and implementing technology within the district. Since then, I have worked in two other Texas school districts and one of Texas' regional Education Service Centers as a technology specialist and technology coordinator.

During the course of this research, I was the district Instructional Technology Coordinator for the school district that is the focus of this research. In this position, part of my job was to initiate and manage the iPod touch program and I believed that this program has the potential for success. Also, I was aware of the challenges and barriers that inhibit the program and because it was my job to deal with these challenges, I put a strong emphasis on this in my research questions.

In 2001, I earned a master's degree in Educational Technology and I began work on my Ph.D. in Learning Technology in 2005. This dissertation and the supporting research are in partial fulfillment of this Ph.D. With my education and experience, I have a strong belief in the potential for technology to improve education.

PROCEDURES

The research activities described above took place during the 2012-2013 school year, with most data collection occurring during October 2012 through April 2013. Specifically, the timeline is shown in the following table.

Table 3.5

Timeline for Research Activities

Research Activity	Began	Completed
Teacher Interviews	March 22, 2013	April 12, 2013
Student Interviews	December 20, 2012	March 22, 2013
Classroom Observations	December 5, 2012	February 1, 2013
Administrator Interviews	April 12, 2013	April 12, 2013
Student Artifact Analysis	February 2, 2013	April 30, 2013

Data analysis was ongoing during data collection and through May of 2013.

Teacher Interviews

I conducted teacher interviews with both ELL teachers who teach fourth and fifth grade at the school where the iPod touch initiative is in place. These teachers were selected because they are the two teachers who implemented the program, making their interview data essential to this research. This discussion refers to them as Allison and Michelle to keep them anonymous. Both teachers were very willing to participate.

The interview with Allison lasted about 8 minutes and the interview with Michelle lasted about 12 minutes. While longer interviews with these teachers would have been desirable, the environment of the school district made this difficult. I conducted these interviews shortly after the arrival of a new superintendent who was making significant changes in the district. During the timeframe of this research, the district experienced over 20% turnover among the district's 1,150 teachers. A new policy

of administrative walk-throughs made the teachers anxious. While I believe the teachers continued to see me as a helpful resource for technology issues rather than as someone enforcing accountability, the work environment encouraged these teachers to minimize time spent away from their formal job responsibilities.

Though the interviews were relatively short in duration, both teachers were asked all questions and gave thoughtful and informative answers to most questions with minimal probing. Also, these interviews were only a small part of my interaction with these teachers. Throughout the iPod initiative, I worked with these teachers closely to help them implement the program. I regularly interacted with them by phone, text messaging, videoconferencing, and in-person visits on a weekly basis. Thus, the information they formally provided in the interviews added to information from many other conversations that helped me understand the issues I asked them about in the interviews.

Student Interviews

A careful process for selecting student participants allowed data collection from a diverse group of students based on characteristics that may affect their experience to increase the variety of perspectives obtained from the interviews. The selected students included students in both fourth and fifth grade, students with a variety of English proficiency levels, socioeconomic statuses (to the extent this can be determined), lengths of time in the U.S., academic achievement, and familiarity with technology and the Internet. Student interviews occurred in December of 2012 and March of 2013.

I conducted interviews with nine of the 41 total students in the program. This purposive sample included a good representation of the key dimensions of gender, grade, and level of English proficiency as described in Chapter Three. Interviews took place on December 20, 2012 and March 22, 2013. To conduct the interviews, I pulled students aside to a quiet area and explained that I would ask them some questions about how they use their iPod touch and how they feel about having it. I informed them that I would record their responses.

While students generally appeared comfortable during the interviews, most of them tended to give relatively brief and general responses. Interviews ranged in duration from about 2 minutes and 15 seconds to about 5 minutes and 30 seconds, with most interviews lasting between 3 and 4 minutes. Students seemed to understand the eight questions from the interview guide, but I found that I often needed to probe or suggest examples to get more in-depth responses.

Administrator Interview

I attempted to interview both the district-level coordinator who oversees bilingual education and the principal of the school where the program is in place. Other than myself, these were the two administrators who worked most closely with the program and had the best understanding of the program's costs and goals. However, the principal left the district before I was able to schedule an interview and the only administrator interview was with the bilingual coordinator. To maintain his anonymity, this administrator will be referred to as Juan. The interview Juan occurred in April of 2013

and was about 8.5 minutes in length. As with the teacher interviews, the administrative changes in the district likely discouraged Juan from taking time away from his formal job responsibilities and the formal interview I conducted for this research was just a small part of my ongoing collaboration and communication with him.

Classroom Observations

Classroom observations occurred on seven different sessions during December 2012 and February 2013 and were split between the two classes (social studies/language arts and science/math classrooms). The observations included a variety of subject areas with a focus on science and also included observation of some pre-class behavior where students used their iPod touch devices. Observations occurred on typical instruction days and each observation session lasted between 30 minutes and one hour. The observations are shown below. To maintain confidentiality, the two teachers are referred to as Allison and Michelle.

To allow peer debriefing through validation by a second observer and more intense analysis through repeated viewing, one full observation and one partial observation were video-recorded. Due to logistical constraints, the other sessions were documented only with notes. To minimize intrusion and reduce non-typical teacher and student behavior that might result from heightened awareness of the recording process, recording used a single small camera and two small microphones. Classroom observations looked for specific actions, comments, and events that relate to the key dimensions of using mobile Internet devices identified by the literature.

Classroom observations occurred in December of 2012 and February of 2013. In total, I conducted 6 observations of classroom activities (3 from Allison's class and 3 from Michelle's class) plus one observation of some pre-class activities in Allison's class, as shown in the table below.

Table 3.6

Classroom Observation Sessions

Session	Classroom	Teacher	Date
1	Grade 4 Social Studies	Allison	December 5, 2012
2	Grade 5 Science	Michelle	December 5, 2012
3	Grade 4 Pre-class behavior	Allison	December 6, 2012
4	Grade 5 Science	Michelle	December 6, 2012
5	Grade 4 Social Studies	Allison	December 7, 2012
6	Grade 5 Science	Michelle	December 11, 2012
7	Grade 5 English Language Arts	Allison	February 1, 2013

Artifact Analysis

When asked to provide examples of student work, the teachers provided a number of pictures and presentation files with no particular organization or explanation of how these files related to student projects. To select projects for analysis, I filtered through these files to find ones where the context of the assignment was readily evident from the images and files. In some cases, the files clearly related to assignments that were described in teacher and/or student interviews or assignments that I had directly observed either through the formal classroom observations described above or through casual observations while performing my job.

As shown above in Table 3.4, the artifact analysis was the final data source I collected, allowing me to select the artifacts based on a better understanding of the program. Ultimately, I selected two types of artifacts for analysis. I selected these because they had sufficient material for analysis and because I had sufficient background information about the assignment that led to these artifacts.

DATA ANALYSIS

The goal of this case study was to provide an in-depth understanding of the processes associated with the implementation of a program using iPod touch devices in ELL education. As mentioned in the previous section, original data about the program came from a variety of sources and data collection techniques.

As recommended by Merriam (2009), qualitative analysis began during data collection where field notes documented not only observational data but also documented how interview responses provide answers to the research questions. To standardize and facilitate the classroom observation process, observers used the observation form shown in Appendix D along with their own field notes taken during the observation and their preliminary analysis written immediately after the observation or viewing of the recording.

The data analysis for the interviews followed the phases identified by Brenner (2006), which are: transcription, description, analysis, interpretation, and display. I used extensive notes based on my original interview and based on listening to the audio recording of each interview multiple times in addition to partial text transcriptions. This

helped preserve characteristics of the oral experience (such as length of pause, tone of voice, etc.) that do not fully come across in pure text format.

For the description phase of analysis, I summarized the responses for each interview question or group of related interview questions. This allowed me to identify and code themes that emerged from responses to questions. Table 3.6 shows examples of specific interview responses and how I classified themes based on these comments.

Table 3.7

Theme Coding of Interview Responses

Source	Interview Response(s)	Theme
Students	"play math games" ""I use it for math when I'm bored" "math sometimes"	Uses iPod touch to practice math.
Students	"projects" "pictures and writing in *Skitch*" "*StoryKit*" "Energy science videos" "Chemical energy project"	Favorite activity is class project using multimedia apps.
Teachers	"I was concerned that I wasn't going to know what to do." "At first, I was scared – not sure what to expect	Initial hesitancy to implement the iPod initiative.
Teachers	"mine learn by doing and they learn better if they work in pairs or partners or small groups"	Students learn best working collaboratively.
Teachers	"I think they learn by just trying to figure it out themselves; they figure it out by themselves on their own through their iPod, through their research."	Students learn best by constructing knowledge.

Table 3.7 (cont.)

Theme Coding of Interview Responses

Teachers	"I thought the kids would love it so I thought it was worth trying"	Positive student reaction motivates teachers to use technology.
Administrator	"once they [teachers] saw the benefits that the students were getting from that technology, they became more familiar, more used to, more comfortable using the technology.	Positive student reaction motivates teachers to use technology.
Administrator	"they are more comfortable speaking to the device than speaking to the teacher or another person"	Recording and capabilities of the iPod touch help language learning.

Some themes were important because multiple respondents within a stakeholder group mentioned them, some because they were mentioned by more than one stakeholder group, and others because they made a particularly important point or a raised a particularly interesting perspective. For student interviews, I grouped and counted similar responses and quoted and paraphrased a few specific comments. For teacher interviews, I provided quotes and summaries of each response and reported whether the two teachers agreed or whether their responses differed. The description of the administrator interview includes quoted comments and a summary of his interview responses. The descriptions in Chapter Four include direct quotes from respondents that expressed in-depth perspectives or reflective comments and summary data for more objective factual responses.

The analysis phase looked for relationships in the data for each stakeholder group. The analysis placed the interview responses in the context of the overall iPod touch initiative and within the context of other interview responses. This analysis allowed an understanding of how respondents' environment and perspectives might have affected their reported actions and beliefs. The interpretation linked interview responses to the literature discussed in Chapter Two to determine whether and to what extent topics identified in the literature were mentioned (either directly or indirectly) in the interviews.

In Chapter Four, the analysis and interpretation phases for the interview analysis are both included in the Discussion sub-section for each stakeholder group. This is a consideration based on the display phase of analysis. Because the analysis and interpretation phases are closely related, I chose to integrate these for a more coherent discussion.

Data analysis for the classroom observation followed a similar process. Rather than audio recordings, notes taken during the observation (guided by the observation form shown in Appendix D) and video recordings of some observations provided documentation for analysis. The description of these observations in Chapter Four presents an objective summary of activities observed and continues with analysis and interpretation to connect the observations and to identify key themes and relate these themes to the literature.

Data analysis for classroom artifacts was an inductive approach. Erlandson, Harris, Skipper, and Allen (1993) define an artifact as "almost any physical evidence that gives insight into the culture's technology, social interaction, and physical environment"

(1993, p. 100). Lincoln and Guba (1985) point out that artifacts are a permanent and unchanging source of data, unlike interviews or observations where specific details change each time the method is attempted.

The artifacts selected were driven by what teachers made available. Teachers provided over 100 image files and presentation slides with examples of student work. Many of these lacked context and did not obviously relate to a specific activity or topic, so I selected examples that seemed fully developed and where the nature of the assignment was fairly clear from the artifact or where I knew or could obtain the background of the assignment. Once the artifacts were selected, I examined these carefully to determine what the content of these artifacts demonstrated about the underlying assignments and learning activities. As presented in Chapter Four, most artifacts were photographs that were part of student assignments, Keynote slide presentations, and screen shots of iPods taken while students were engaged in class activities.

TRUSTWORTHINESS

The nature of qualitative research allows an in-depth analysis of peoples' thoughts and actions and the qualitative approach is well suited to this case study. However, analysis of qualitative data requires the researcher to actively filter and interpret data, making it susceptible to bias. To minimize this potential bias, appropriate research design and careful data analysis provide trustworthiness for the findings of this research

on the dimensions of credibility, dependability, transferability, and confirmability (Miles & Huberman, 1994; Merriam, 2009; Lincoln & Guba, 1985).

Credibility

Credibility means that a researcher accurately represents the viewpoints of research participants. Erlandson et al. (1993) identify techniques to enhance credibility and these are (1) prolonged engagement, (2) persistent observation, (3) triangulation, (4) peer debriefing, (5) referential adequacy, and (6) member checking. I used all of these techniques. My position as the Instructional Technology Coordinator for the district allowed prolonged engagement and I directly interacted with the students, teachers, and administrators in the iPod touch initiative beginning at the program's inception. This allowed me to understand the context of the classroom observations and student artifacts and ensured that I had a thorough understanding of the environment and program before I interviewed the stakeholders. My direct experience also allowed persistent observation. I formally observed six classroom sessions, but my involvement also included dozens of informal observations that helped me understand the background.

To maximize credibility, the analysis includes an extensive discussion of the context and a comprehensive presentation of findings, regardless of whether these findings are expected or intuitive. Multiple methods and measurements of multiple stakeholders allowed triangulation of findings (Erlandson et al., 1993). The data analysis process deliberately considered possible explanations of results that might minimize, negate, or contradict the presumed interpretation of the findings.

Prolonged engagement and persistent observation allow the researcher a deep understanding of the environment and research participants. However, this deep understanding can influence the researcher's perceptions. To add another researcher's perspective, I used a peer debriefing process. My peer debriefer was a Ph.D. in Sociology who is a professional researcher and who has extensive experience in the research process. Though a knowledgeable researcher, the peer debriefer had no direct involvement with the iPod touch initiative and his analysis of recorded interviews and analysis of classroom artifacts helped ensure that my analysis and conclusions were validated.

Audio recordings of interviews established referential adequacy. I conducted member checking with all of the adult participants (administrator and both teachers). I sent them the sections from Chapter 4 below that summarize their interview data and asked them to confirm whether my summary accurately reflected their views and asked if they had anything to further explain or clarify. All three participants confirmed that my descriptions of their interviews were accurate as presented. I did not conduct member checking with the student interview respondents for three reasons. First, the student interviews yielded mostly brief and factual responses with minimal potential for misrepresentation or distortion. Second, the nature of my summary may have been difficult for them to comprehend. Third, I wanted to avoid burdening them further.

To further enhance credibility, the proposed research protocol for this study was reviewed and approved by a 5-person Dissertation Committee holding doctorates in the field of education, including experienced and published researchers. This external expert

review assured that the research questions were well conceptualized and that the methodology was appropriate to answer the questions given the available data sources. This approval process included an initial approval of the research plan and final approval of the analysis, results, and conclusions. The members of my Dissertation Committee (whose names appear on the Signature Page at the beginning of this document) provided thoughtful guidance, suggestions, critiques, and other input based on their extensive learning and experience that broadened my perspective and reduced the influence of my personal bias on the design and analysis of this research.

Dependability

In qualitative research, dependability refers to whether a similar methodology applied in a similar research context would yield similar consistent results if conducted by another researcher at another time (Erlandson et al., 1993; Merriam, 2009). Replicating this study would likely yield somewhat different results because the participants and iPod touch implementation will change and evolve over time (Lincoln & Guba, 1985). However, this does not necessarily threaten the dependability of this research if the methodology would yield findings that are similarly accurate in measuring and identifying issues related to iPod touch implementation. The extensive description of the research activities and the explicit identification of my potential biases as a researcher are discussed below as part of transferability and confirmability, but would also serve to help future researchers assess this case study or a similar one with the same degree of reliability.

Transferability

Transferability is a particular concern for qualitative case study research. By its nature, this research effort is not fully applicable to other contexts and the best way to address this limitation is to make it explicit. Providing the specific context that produced these research findings will allow other researchers and educators to judge which conclusions may apply to other contexts and to what extent they may apply. While the specific findings from this research do not necessarily apply or fully apply to other situations, the findings include thick description (Lincoln & Guba, 1985) that explains processes and stakeholder perspectives that may support trends identified in other research and thus strengthen current ideas and theories (Schwandt, 1997; Erlandson et al., 1993). Also, the theoretical framework and methodology used for this research can serve as a starting point and template for other researchers seeking answers to similar questions in other environments and contexts.

Confirmability

Confirmability is the extent to which research findings are attributable to the data sources rather than biases of the researcher. Enhancing confirmability requires researchers to recognize their own position, perspectives, and biases (Birks & Mills, 2011) and to frame their conclusions within this context (Hall & Callery, 2011).

My position statement above provides context and discloses my background as the primary researcher/analyst and identifies potential biases that might bias the analysis or conclusions. This section addresses the need identified by Brenner to describe the role

of the interviewer (2006, p. 368) Also, the documentation of this research includes a complete description of the processes that other parties can use as an audit trail to identify any further potential biases. All research data (stripped of personally identifiable information) will be maintained for a reasonable amount of time (at least 3 years) to be available for re-analysis if any significant biases or shortcomings are identified in third party critiques.

With any research, bias results from the perspective and position of the researcher, making it important to frame the research within the context of the researcher's experience (Hall & Callery, 2011; Mruck & Günter, 2007). As the primary researcher, my own background, attitudes, and expectations had an impact on the questions, design, approach, data interpretation, and conclusions of this research. As mentioned in my position statement above, my educational and professional backgrounds give me a strong pro-technology perspective as a context for my research and its results.

PROTECTING PARTICIPANTS

Before data collection activities began, all aspects of this research had full approval from the Institutional Review Board (IRB) at the University of Texas at Austin. Additionally, this research had full approval from the administration of the Texas school district where the research will take place. All interview respondents signed IRB-approved consent documents. Parents of students who participated in interviews signed consent forms in either English or Spanish (based on their preference) and students signed assent statements. No names or other uniquely identifying information appear in

any research results and any existing records with specific respondent names were stored on the school district's password-protected computers or in locked cabinets and will be destroyed upon completion of the research.

Chapter 4 – Results

This chapter looks across the different approaches and data sources to answer the research questions. To identify implementation practices and answer the first research question, the analysis combined data from teacher interviews, student interviews, observations, and artifact analysis. The use of multiple data sources allowed an exploration of all aspects of classroom learning including how activities are planned, how they are actually implemented, and how the teachers and students interacted with the curriculum to create the actual learning experience.

To address the second research question about informal learning and student-defined activities, the analysis combined direct data from students about how they use their iPod touch devices on their own time and in their own ways as well as indirect data from teacher interviews based on their observations of and interactions with the students. The teacher and student interview data are also supported by an ad hoc observation conducted before one of the class sessions.

Answers to the third research question about implementation challenges came from responses to teacher interview questions that directly identified the challenges they reported. Teachers' responses to questions about their teaching philosophy and attitudes toward the iPod touch program indicated whether and to what extent the teachers' limited knowledge and/or low motivation were challenges to implementation. Data from an interview with the district administrator directly identified logistical challenges associated with costs, maintenance, and support of the technology. Data from student interviews suggested other limitations and validated conclusions from the other interview

sources. Classroom observations detected areas where program implementation is difficult.

While the data collection approaches did not allow development of an exhaustive list of all implementation practices, student-defined activities, or implementation challenges, results of this case study did identify some key examples of each of these items as well as extensive data to help understand the context and processes involved. The remainder of this chapter answers the research questions and provides data to support these answers. Chapter Five includes further discussion of these data in the context of the theory and literature presented in Chapter Two.

RESEARCH QUESTION 1 – IMPLEMENTATION PRACTICES

Overview

Research Question 1 asked: What implementation practices do teachers use to integrate mobile Internet devices like the iPod touch into K-12 classrooms for fourth and fifth grade ELL students in bilingual classrooms? Table 4.1 below lists the key implementation practices identified from the analysis. This crosswalk shows which data sources mentioned or revealed these practices. Because the administrator interview did not ask about implementation details, this data source is not included in this table.

Table 4.1

Implementation practices identified by data source

Implementation Practice	Teacher Interviews	Student Interviews	Classroom Observation	Artifact Analysis
Games/Practice	X	X		
Media Creation/Editing	X	X	X	X
Internet Search			X	X
File Sharing			X	
In-class work sharing (Apple TV)	X		X	X

Based on data from teacher interviews, student interviews, classroom observations, and artifact analysis, implementation of the iPod touch as a learning tool was pervasive. Teachers reported using the device frequently in all subjects and all observed classroom sessions included significant time using (or trying to use) the devices. Implementation occurred in a variety of ways. The following sections discuss each specific implementation practice identified in Table 4.1 above and summarize the relevant data that support the presence of each practice.

Games and Practice

The uses of the iPod touch included games, both for learning and for pure entertainment. In the teacher interviews, both teachers mentioned math and multiplication games as assigned classroom activities. Six of the nine students interviewed said that they like the iPod touch because it helps them learn, and those that mentioned learning all identified math as a subject where the iPod helps them learn and most of them said that they use it specifically for learning multiplication. Three of the

nine mentioned using the iPod touch at home for math games, with one student saying "I use it for math when I'm bored." Several students specifically mentioned using the iPod touch to practice multiplication tables.

Most of the students who mentioned learning also identified spelling as an area where they find the iPod helpful and three mentioned the *Spelling City* (Spelling City, 2012) app. Two students reported playing the iPod version of *Scrabble* (Electronic Arts, 2012) – a board game where players earn points by creating words from randomly drawn letters – and said that they played with other students. Three students reported that their friends had introduced them to the *MineCraft* (Mojang, 2012) game.

Media Creation and Editing

Media creation and media editing with the iPod touch devices were very prominent types of implementation. The teachers identified several media-related apps that they often used and provided some examples of how they used these apps as part of class activities. Allison mentioned using the camera and recordings as common activities, and said that class activities "gravitate" towards using the *StoryKit* (ICDL Foundation, 2012) app (an app that allows users to create an eBook with images, text, audio, and video to tell a story). She also said they enjoyed *Skitch* (Evernote, 2012) and use it a lot.

Michelle initially identified the *Keynote* (Apple, 2012b) app – a presentation software app used to create slideshows similar to PowerPoint – and the web browser as frequently used. With probing, Michelle also mentioned the *DoodleBuddy* app (Pinger

Incorporated, 2012), *Skitch* (Evernote, 2012), and *Screen Chomp* (TechSmith Corporation, 2012). *DoodleBuddy* (Pinger Incorporated, 2012) is an app that allows users to draw and save their own pictures, *Skitch* (Evernote, 2012) is an app that allows users to put together text, images, and audio in a collage-like electronic file, and *Screen Chomp* (TechSmith Corporation, 2012) is an app that lets users record both their voice and what they draw on the screen to create an movie file. Michelle also provided a detailed example of how she and the students have used these apps for class projects. In this example, she described an assignment where the students used the web browser to learn facts about migration patterns of various animals and used *Keynote* (Apple, 2012b) to create a presentation as part of a lesson on adaptations.

When asked about favorite class activities, students mentioned these media-related apps and the classroom activities that involved these apps. Six of the eight students who mentioned a favorite activity mentioned either the *StoryKit* (ICDL Foundation, 2012) app or the class activities related to the study of energy. Responses from a couple of students revealed that the class used the *StoryKit* (ICDL Foundation, 2012) app as part of the projects on energy, so some of the students who just mentioned *StoryKit* (ICDL Foundation, 2012) may have been referring to the energy project. Another component of the energy project was the class topic for one of the classroom observations, and this involved creating video presentations using the iPod touch devices (this is discussed further below). Other responses included using the *Skitch* (Evernote, 2012) app to write and create pictures.

During classroom observation #5, the class activity was to create a mini-book using *StoryKit* (ICDL Foundation, 2012) based on an historical figure that each student recently portrayed during a wax museum activity. This activity required media creation both with the original pictures of students dressed as their historical figure and creation of the book. It also involved media editing to integrate the pictures into the story.

In observation #6, the class topic was learning about different types of energy. Michelle began the class with a review of previous classes by asking the class questions like "what do we use electric energy for?", "what are other forms of energy?" and "what can you tell me about thermal energy?." After the review, Michelle used the classroom SmartBoard to divide the class into small groups (2-3 students each) and assigned each group a type of energy. She explained that their assignment was to create a video (using the built-in video camera on the iPod touch) to teach the rest of the class more about that type of energy, with an emphasis on how each type of energy is used in the real world. She told the groups that they would need to come up with a script and then film a short documentary-style video. She told the students that the entire group would work on the script and then 1 or 2 students would be the actors and the others would be the producers.

After receiving instruction, the students worked in their groups to construct scripts and film their videos. Figure 4.1 shows an example of a script the students developed using the *Notes* (Apple, 2012b) app on the iPod touch:

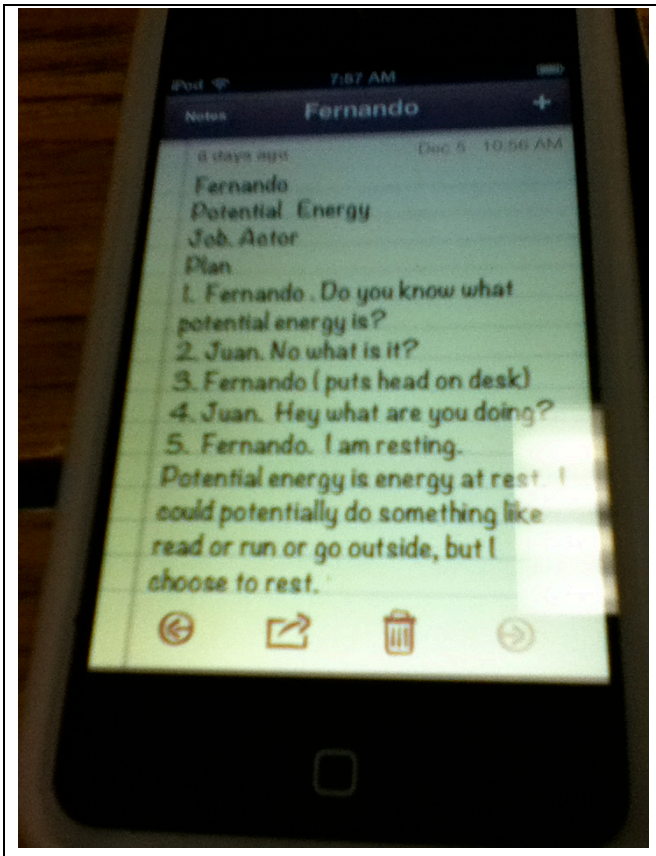


Figure 4.1. Energy Video Script Using *Notes* (Apple, 2012b) App

During the video creation, the teacher moved around to spend time with each group asking questions, providing ideas, and offering them pointers on using the video cameras. Towards the end of the class, each group shared their presentation and filmed it. The presentations included a description and explanation of the type of energy, some examples of that type of energy, and a visual aid such as a poster or live example of the energy. While presenting, the teacher asked questions that prompted students to offer details or further explanation where she thought it was needed.

Observation #7 also highlighted media creation and editing as key implementation activities. The topic of this class was teaching English words relating to emotion. The

classroom activity was having students create three photographic flashcards containing the English word for the emotion, the Spanish word, and a picture of one of the students displaying the emotion. The students used the camera on their iPods and the *Skitch* (Evernote, 2012) app to add words onto the pictures. An example of the original picture and the finished flashcard modified with *Skitch* (Evernote, 2012) appear below in Figure 4.2.

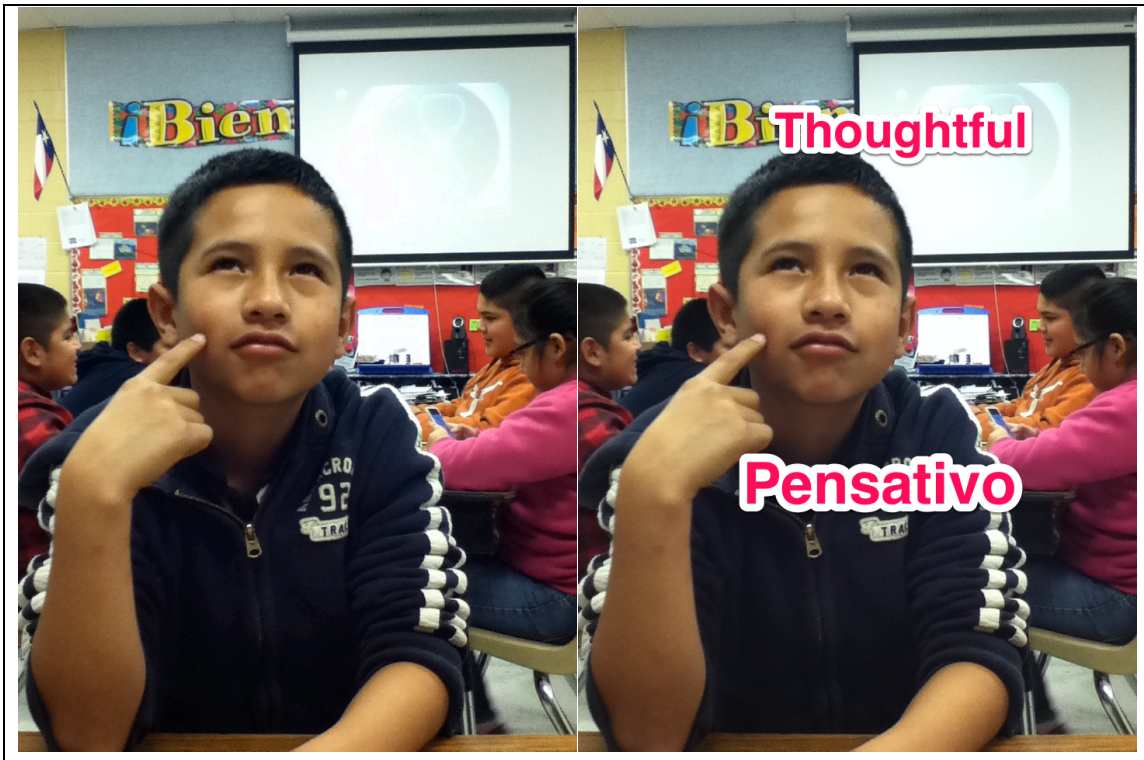


Figure 4.2. Example of Emotion Word Flashcard Activity from Observation #7

These media creation activities were good examples of classroom projects. In interviews, the teachers were asked about the role of activity-based learning. In probing, I also used the term "project-based learning." Both teachers gave relatively brief responses to this and both indicated that they did use this type of learning frequently.

Allison provided the example of a fall semester biography project and stated that the students used the classroom computers and the iPod touch devices for research. Michelle said "project-based learning is basically what we mainly do" and that the "iPod is basically all we use to get our projects done in class."

The prevalence of media-related projects was related to the teachers' beliefs about how to teach effectively. When asked how they thought their students learned most successfully, the teachers gave similar but slightly different responses. Allison said "mine learn by doing and they learn better if they work in pairs or partners or small groups; even with the technology, if they're working together, they help each other." Michelle reported "I think they learn by just trying to figure it out themselves; they figure it out by themselves on their own through their iPod, through their research." Allison further commented, "it [the iPod touch] gives the kids a chance to work on their own or to work together in groups, and it helps them become computer literate and comfortable with technology; they have no fear of the technology and that's good."

Michelle's responses focused on the potential of the iPod touch to bring in content and experiences beyond her knowledge and made the comment:

> I think it [the iPod touch] opens up possibilities of what else they can do – things that I never would have thought of – and how it broadens their horizons. I could only teach so much with my understanding. With the iPod touch, the Web is out there. They can learn so much more instead of just my knowledge.

Both teachers agreed that the iPod touch devices enhanced learning by providing access to information that allows students to discover their own knowledge.

Internet Searching

Classroom activities also involved using the iPod touch devices to access the Internet. In her teacher interview, Michelle described an assignment where the students used the web browser to learn facts about migration patterns of various animals and used *Keynote* (Apple, 2012b) to create a presentation as part of a lesson on adaptations.

The assignment for the class in observation #4 was to create a packet where the students identified, illustrated, and colored five examples of renewable energy and five examples of non-renewable energy. Each student worked alone and used the iPod touch to search for examples of renewable and non-renewable energy. Their iPod touch devices provided two sources of information – one was the Internet and the other was PDF files of their curriculum notes stored on the iPod touch devices.

Throughout this class, Michelle circulated among the students. As needed, she helped students by suggesting search terms to help them find examples of the different types of renewable and non-renewable energy. Figure 4.3 below shows examples of the results of some of the Internet searches that students conducted on their iPod touch devices for this activity.

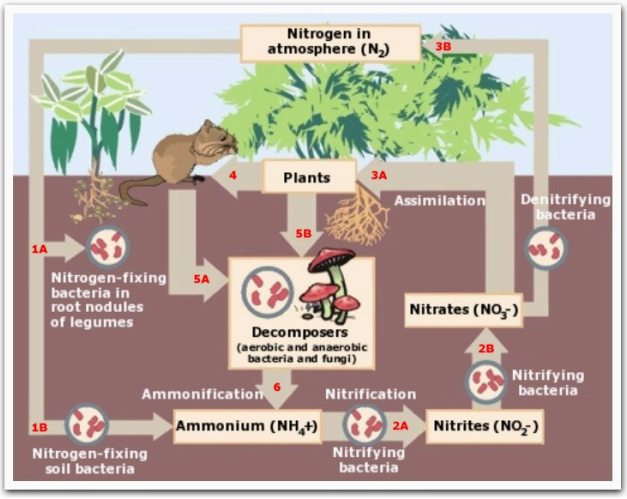
Figure 4.3. Search Results for Renewable and Non-Renewable Energy Examples

This process continued for the remainder of the class period. Students identified examples of renewable and non-renewable energy and found images that they could draw and color to complete their packets.

The Internet search activity was also evident from the student artifacts. The slides from various *Keynote* (Apple, 2012b) presentations include graphics and information

students found on the Internet about the food chain, rock classification, nightingales, and forms of energy. While these presentations showed that students did demonstrate the important skill of finding relevant information on the Internet and copying into their own media, some of the examples suggested that students did not always assimilate the information during the process of finding and transferring it.

Figure 4.4 below shows an example of two slides from the food chain *Keynote* (Apple, 2012b) presentation.



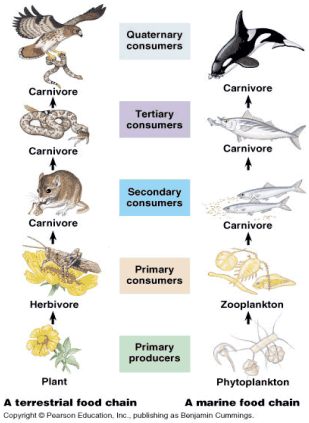


Figure 4.4 Examples of Slides from the Food Chain Presentation

While these slides show well-illustrated diagrams explaining the food chain, another slide added by the students explaining the food chain reads "The plant that all animals that eat plants get the energy from the plants and the plants energy goes animal to animal because soon the animal that eat the plant is going to get eaten." While the students' description

of the process seemed essentially accurate, there was a discrepancy between their description and the text of the diagrams they found on the Internet referencing "quaternary consumers" and "nitrification". Even though students were able to locate relevant information, they probably understood just a small part of the information from some of the diagrams they found and included.

Other examples show that students sometimes include irrelevant or incorrect pictures, indicating that the process of finding information and media does not necessarily result in the construction of knowledge. The picture of the bird shown on the slide in Figure 4.5 appeared on all eight slides of a *Keynote* (Apple, 2012b) presentation about nightingales. However, this picture is not a picture of a nightingale. As slide 7 of the presentation (shown below as Figure 4.5) describes, nightingales are brown and tan.

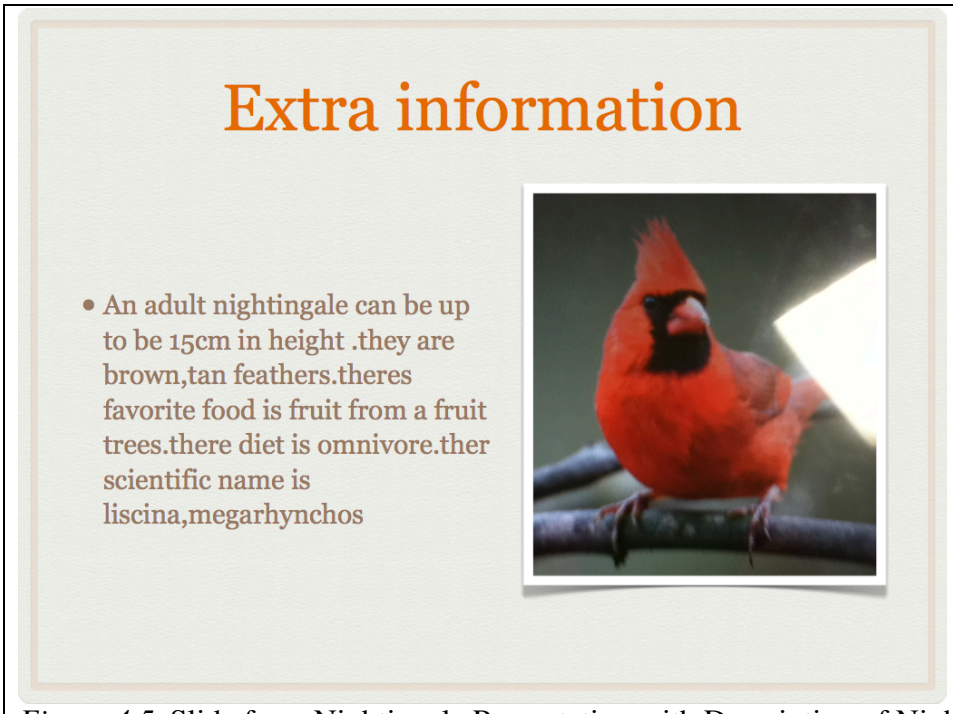


Figure 4.5. Slide from Nightingale Presentation with Description of Nightingale's Colors

In the nightingale presentation, the students either failed to understand the description of the nightingale or chose to use a picture of a different bird (even though an Internet image search of "nightingale" would have easily found a variety of pictures of an actual nightingale). Likewise, the slide about thermal energy from the energy presentation included a picture that seems unrelated to the topic of the slide as shown in Figure 4.6.

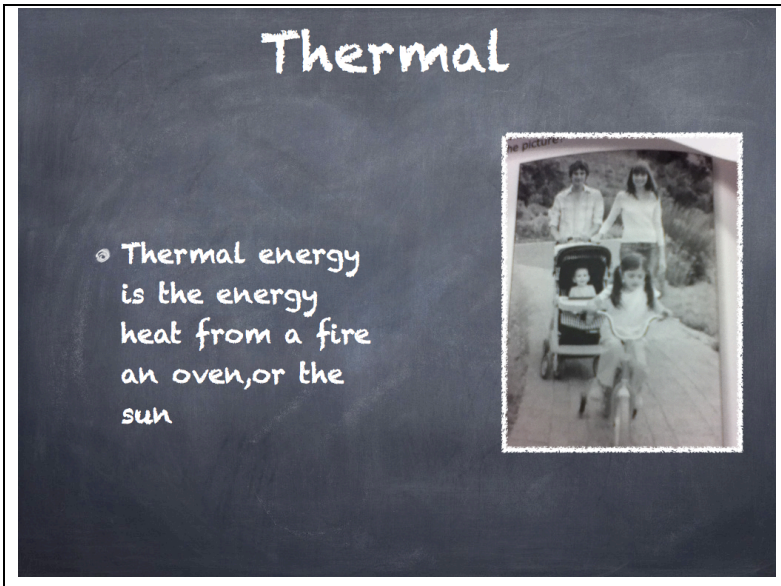


Figure 4.6. Thermal Energy Slide from Energy Presentation

The picture associated with the description of thermal energy was a black and white photograph of a family taking a walk, with no clear indication of how this might relate to thermal energy. The implications of the partial disconnect between finding information on the Internet and using this information to learn is discussed in Chapter Five.

File Sharing

While the implementation practice of file sharing was not mentioned in interviews, the importance of this became evident through classroom observations. Both

teachers used *DropBox* (Dropbox, 2012) – an online service that provides web-accessible disk space on remote servers – to distribute files to students and to allow students to share each other's files. While the district provided a Learning Management System (LMS) with file-sharing capabilities, teachers preferred the more intuitive and simpler functionality of *DropBox* (Dropbox, 2012), which allows users to save shared files through the same process as saving to a hard drive folder.

Even though *DropBox* (Dropbox, 2012) is relatively easy to use once set up, observation #1 revealed that all users need this app properly installed. The challenges associated with *DropBox* (Dropbox, 2012) installation are discussed further as part of the results of research question #3, but even initial technical challenges did not deter the teachers from using this as their preferred file-sharing system. In observation #5, the students completed the activity that was originally scheduled for observation #1 and used *DropBox* (Dropbox, 2012) to access pictures that Allison had taken of the students dressed like historical characters.

The usefulness of using *DropBox* (Dropbox, 2012) was also evident in observation #6. After filming the class presentations on energy, Michelle instructed students to upload all of the movie files to the class *DropBox* (Dropbox, 2012) folder. All students were familiar with *DropBox* (Dropbox, 2012) and were able to do this quickly. Michelle then explained that all of the videos would be available to the entire class as a way to help them study and review the material.

Observation #3 showed a more direct type of file sharing. This observation session was not originally planned, but I had the opportunity to observe students prior to

the 8:00 a.m. start of Allison class. During this unstructured time, I observed students preparing for school and showing each other pictures they had taken on their iPod touch devices. One student showed me a picture of her puppies and another student showed me pictures of her new cousin. The students seemed to really enjoy sharing pictures and this impromptu observation let me get a direct glimpse of how students use the iPod touch outside of formal classroom learning.

Classroom observations #2 and #4 also included file sharing with *DropBox* (Dropbox, 2012). In observation #2, Michelle showed the students how to take a screenshot of their notes on their energy research and how to upload these notes to her *DropBox* (Dropbox, 2012) folder for her to review and grade. Observation #4 occurred the following day. As described above, the students used PDF files available on their iPod touch devices as well as the Internet to find energy-related information and images for their project. The teacher used *DropBox* (Dropbox, 2012) to share the PDF files with the students.

Work Sharing

Another implementation practice was the real-time sharing of student work. During her interview, Michelle explained a class activity she developed to practice for the STAAR test (the recently implemented major standardized test for Texas public schools). In the activity, she divided the class into groups of four. Michelle then gave an example of a test question and one person from the group answers the question using the *Skitch* (Evernote, 2012) app to show their work. The students' shared their *Skitch* (Evernote,

2012) content via Apple TV (a device that allows students to project their iPod screen onto the class presentation system so the whole class can see) to allow other students in the class to comment on their work and make suggestions. The activity continued with three additional problems for each of the other three members from each group.

The artifacts I analyzed also included an example of this work sharing. Figure 4.7 below shows the original picture of the student's work on a basic division problem and then the picture with notes from *Skitch* (Evernote, 2012) added.

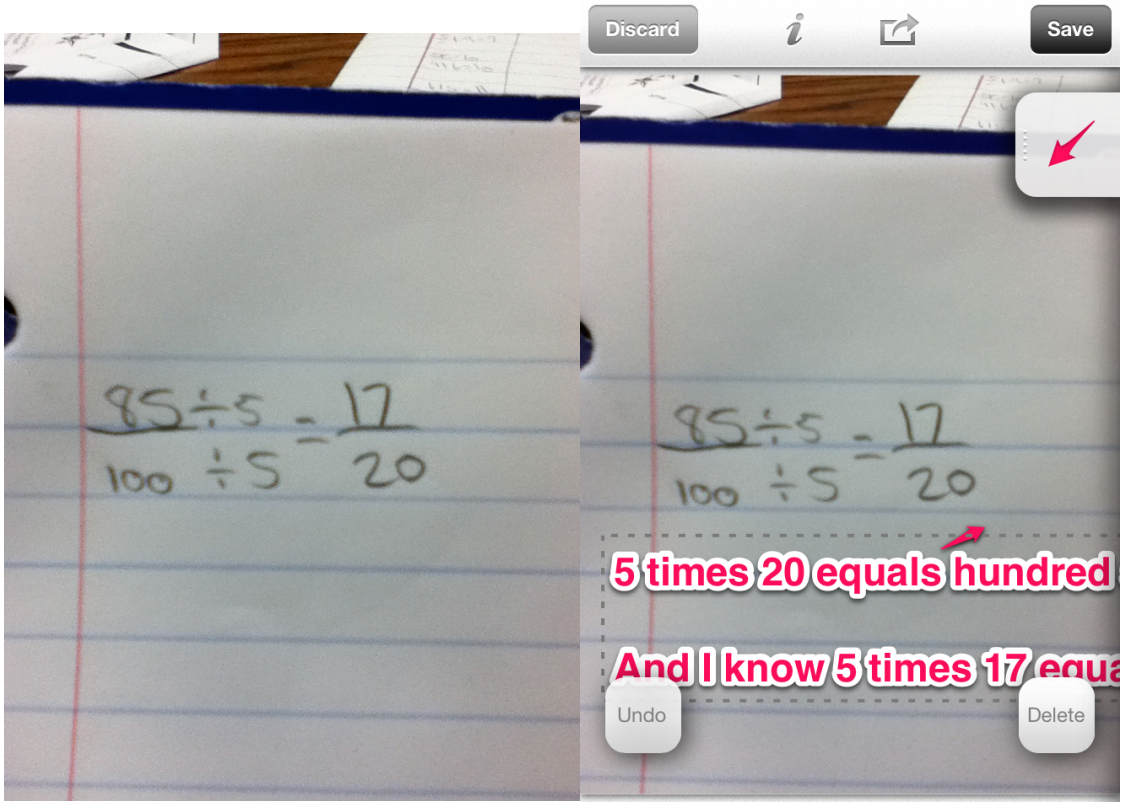


Figure 4.7. Example 1 of Math Problem with *Skitch* (Evernote, 2012) Notes

Figure 4.8 below shows the original picture of the student's work on a fraction reducing word problem and then the version with the *Skitch* (Evernote, 2012) notes.

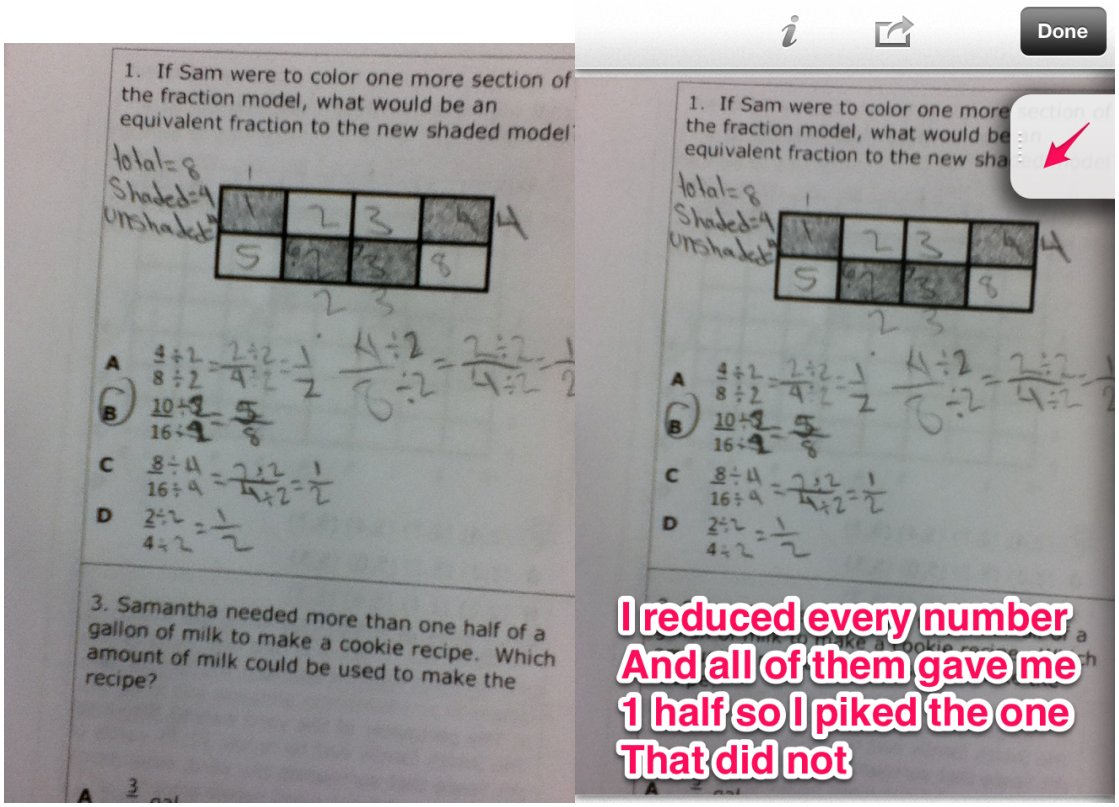


Figure 4.8. Example 2 of Math Problem with *Skitch* (Evernote, 2012) Notes

In both examples, the picture on the right is what the student shared with the class on the main classroom monitor.

I also saw the sharing of student work via the Apple TV monitor in observation #7. Once each student pair had taken their pictures demonstrating emotions, the IF (classroom instructional facilitator) gave a demonstration using an iPad linked to the classroom projector (through Apple TV) showing how to import the pictures into *Skitch* (Evernote, 2012) and how to use *Skitch* (Evernote, 2012) to add the English and Spanish

word to the image file. During this instruction, the IF asked all of the students to put their iPod touch devices face down on their desks so they would not be distracted or try to do the activity before she showed them how. For the remainder of the class period, Allison had the groups take turns displaying their flashcards by transferring the images from their iPod touch to the main classroom projection screen. The students seemed animated and engaged during this sharing and seemed to enjoy seeing each other's pictures.

RESEARCH QUESTION 2 – STUDENT-DEFINED ACTIVITIES AND INFORMAL LEARNING

Research Question 2 asked: Do student-defined activities and informal learning supplement formal teacher-defined activities when fourth and fifth grade ELL students in bilingual classrooms have continual possession of mobile Internet devices like the iPod touch? If so, what is the nature and extent of these student-defined activities and this informal learning? Based on the data collected for this case study, student-defined activities and informal learning stemming from the iPod touch initiative were present but limited. Data to answer this research question primarily came from student and teacher interviews. The administrator mentioned some ways he envisioned students using the iPod touch for informal learning, but he did not report any direct knowledge of how students actually used the device. Classroom observations did not reveal any significant student-defined activities. The artifacts available for analysis did not directly indicate whether these artifacts involved student-defined or informal learning. However, observation and interview data also mentioned some of the activities that led to these

artifacts and there was no evidence of any significant presence of student-defined or informal learning.

Student-defined Activities

This section discusses student-defined activities that occurred in the classroom setting. Student-defined learning activities occurring outside the classroom are discussed below in the section on informal learning. The teachers did report some uses of the iPod touch that came from student ideas and suggestions and that occurred during formal classroom learning.

Allison reported that her students suggested using *Skitch* (Evernote, 2012), *StoryKit* (ICDL Foundation, 2012), and the iPod camera for assignments in which she originally envisioned as audio recordings. She also said that the fifth graders tended to be more creative with these types of ideas and believed that this was because they have had their iPod touch devices longer. Michelle provided an example in which the students figured out how to record science experiments using the classroom iPads (though the iPod touch would also have this same capability) and transfer the content from the iPads into a *Keynote* (Apple, 2012b) presentation. Michelle also described a student who was preparing a *Keynote* (Apple, 2012b) presentation on how plants become fossils:

> One little girl really surprised me. She was doing a *Keynote* (Apple, 2012b) presentation and wanted to insert a video but she couldn't find a video she wanted, so she drew her own sketch on *DoodleBuddy* (Pinger Incoporated, 2012). She drew a plant and then how her plant died and then after the plant died. After

> many years, it was buried under layers of dirt and then how it became a fossil. All this through *DoodleBuddy* (Pinger Incoporated, 2012), and she inserted all those slides into her *Keynote* (Apple, 2012b) presentation. I was very, very impressed.

This example shows that students were able to show some initiative in using the apps for classroom assignments. While teachers encouraged the location and integration of existing relevant content, this student showed the initiative to create her own media.

Informal Learning

This section discusses informal learning activities that occurred outside of the formal classroom environment. Student interviews revealed that students used their iPod touch devices outside of school for education-related activities, though these activities were primarily games to practice math or spelling. While teachers admitted limited awareness of students' activities with the iPod touch outside of school, their perception that informal learning activities mainly consisted of spelling and math games was largely correct based on data from student interviews. Allison said that students used the iPod touch for reading and for playing games, including math games. Michelle said that the students "don't say much" about their outside use, but she did pick up that they play a popular game called *MineCraft* (Mojang, 2012) – a simulated world where players construct buildings.

Students reported varying levels of use of the iPod outside of school, though one student said she did "not really" use hers outside of school. Five students gave vague

answers such as "sometimes" when asked about the frequency of their use, though two students provided specific answers ranging from about one day per week to about one hour per day.

In addition to using the math and spelling games provided by the teachers, other personal activities reported by students included watching videos in the car, using the camera and video camera, and using the Internet browser. Seven students reported that they had discovered apps on their own that they used outside of school. One student played a game called *Monster Squeeze* (McGraw-Hill School Education Group, 2012) – a math game app in which students practice number line concepts. Two students reported playing the iPod version of *Scrabble* (Electronic Arts, 2012) – a board game where players earn points by creating words from randomly drawn letters – and said that they played with other students. Three students reported that their friends had introduced them to the *MineCraft* (Mojang, 2012) game. Another student said he had learned about the free version of the *Skyview* (Terminal Eleven LLC, 2012) app – an app that takes a picture of the night sky and identifies stars and constellations – from a friend.

RESEARCH QUESTION 3 – CHALLENGES AND EFFECTS OF IMPLEMENTATION

Research Question 3 asked: Are there implementation challenges when integrating mobile Internet devices like the iPod touch for fourth and fifth grade ELL students in bilingual classrooms? If so, what are these challenges and how can they be met? In this case study, the primary challenges were need for support, teacher reluctance, inappropriate use, and file management. The need for support manifested in three

different dimensions – infrastructure, technical, and training. Infrastructure support includes the network and staff needed to maintain it; technical support refers to in-class assistance using the mobile Internet devices and their applications (troubleshooting); and training refers to formal instruction provided to teachers outside of the classroom environment. Table 4.2 below lists the challenges identified from the data sources as discussed, with the exception of the artifact analysis where implementation challenges were not directly evident.

Table 4.2

Implementation challenges by data source

Challenge	Teacher Interviews	Student Interviews	Administrator Interview	Classroom Observations
Support - Infrastructure				X
Support - Technical		X		X
Support – Training			X	X
Teacher Reluctance	X		X	
Inappropriate Use	X			X
File Management			X	X
Budget			X	

Infrastructure Support

The need for infrastructure support was most evident in the classroom observation #1. At the beginning of this class, Allison asked students to clear their desks and get their iPod touch devices ready. She explained that the class activity would be using *StoryKit* (ICDL Foundation, 2012) to create stories as a follow-up to a previous class activity. The previous activity was a living wax museum where students dressed up as historical figures (George Washington, etc.) and posed around the classroom with a poster

describing who they were. Allison had taken pictures from the living wax museum and stored these on *DropBox* (Dropbox, 2012). During this activity, the class started having network problems. The download speed was very slow and some devices could not download at all. I noticed that many iPod touch devices were changing from the Mobile network (the network available to district-purchased devices) to the Free network (the public network with limited bandwidth and strict Internet restrictions). When I tried to switch the iPod touch devices back to the Mobile network, they displayed the error message: "Could not connect to the Mobile network."

Realizing this was a network issue rather than an issue with the iPod touch devices, I stopped my research and assumed my role as the Instructional Technology Coordinator. I called the district network engineer and described the problem. He checked the Internet access point that serves Allison's classroom and said that it was overloaded with too many devices connecting to it. The multiple simultaneous downloads in Allison's class combined with activities in Michelle's classroom that were also using the network exhausted the available network bandwidth.

The network engineer restarted the access point and made some changes. While things worked somewhat better after this restart, further technical issues related to setting up *DropBox* prevented the class from completing the planned activity and Allison rescheduled it for later in the week. After class, I followed up with the network engineer and he was able to install an additional access point by the following day.

Observation #5 occurred when Allison was resuming the class activity initially planned for observation #1. While students were able to progress with the activity, the

Internet connectivity became slow and some students were limited in the amount of research they were able to do. I called the network engineer, but he was unable to address the issue until later in the day. After investigating, the network engineer reported that the activity in Allison's class coincided with a peak in the use of the district's overall bandwidth use. The slowdown that occurred during observation #5 could only be addressed by district-wide policy changes on bandwidth use and/or an expensive major upgrade to the district's network access.

These observations show the need for infrastructure support. The teachers and students faced implementation challenges with bandwidth at both the micro level (sufficient access points in the two classrooms) and at the macro level (district-level bandwidth availability). The support provided by the network engineer was able to quickly overcome the micro-level challenge, but the macro-level of district bandwidth capacity and management remained a challenge to the implementation of the iPod touch program.

Technical Support

The need for technical support was evident in the classroom observations discussed above, as well as in other classroom observations and student interviews. For the purposes of this research, technical support refers specifically to troubleshooting specific technical problems with the iPod touch devices and helping teachers and students use the devices and the apps installed on them correctly.

The infrastructure challenges with observation #1 and observation #5 were discussed in the previous section, but these observations also showed the need for technical support. At the beginning of observation #1, I saw that many students did not have *DropBox* (Dropbox, 2012) installed on their iPod. Those students who did have the software installed did not have it configured. Because Allison did not have the technical background to fix the problem and because there were 21 kids in the class who needed their iPod touch devices updated, I stopped passively observing and started fixing the problem. I loaded *DropBox* (Dropbox, 2012) to the rest of the devices and helped Allison configure the *DropBox* (Dropbox, 2012) software on each iPod touch.

One further technical problem evident in observation #1 was that *DropBox* (Dropbox, 2012) asks the user for access to the photos on the iPods. The kids enabled this feature and everybody started seeing each other's photos. This made the assignment more challenging because students had to sort through many more photos and it was also distracting. I worked with the teacher to change the settings on all of the student iPods so students would just see their own pictures.

During observation #5, the class actually conducted the activity that was intended for observation #1. While the major network issues were resolved, there were still some individual problems at the start of the class. One student did not have *DropBox* (Dropbox, 2012) installed and was unable to access the photographs. The campus IF helping the class was able to get *DropBox* (Dropbox, 2012) installed, but another student forgot to bring her iPod touch to school and was unable to participate in the class activity. Several students were having trouble connecting to *DropBox* (Dropbox, 2012).

While Allison and the IF were helping make sure students could access *DropBox* (Dropbox, 2012), students were engaged in a variety of activities. Some were already starting to work in *StoryKit* (ICDL Foundation, 2012), but others were exploring other apps while waiting. Once all students were able to access *DropBox* (Dropbox, 2012), Allison began giving instructions and telling students to write about their experience in the wax museum activity and to create a book about their assigned historical character using *StoryKit* (ICDL Foundation, 2012). After her instructions, students began working on the assignment.

While students were working on the assignment, Allison, the IF, and the teacher's aide walked around the room helping students by giving them ideas and suggestions for their stories. They also worked to troubleshoot other minor issues such as showing a student how to put photographs into the *StoryKit* (ICDL Foundation, 2012) app. The student then showed other students at her table how to do this. The IF showed another student how to use *Safe Browser* (Mobicip, 2012) – the Internet browser installed on the iPod touch devices – to search for information. One student did not have *Safe Browser* (Mobicip, 2012) installed, so the IF quickly installed it. While most students were working on the assigned task, one student was using a different app for another activity and Allison corrected him. One student wanted to switch her iPod touch language settings to Spanish and another student showed her how.

While my role was as an observer, one student asked me how to spell "George Washington." I instructed him to use the Internet on his iPod touch to figure it out. He did use the Internet to get the correct spelling and seemed proud that he was able to do so.

I also intervened when one student could not access his photos because of an incorrect setting on his iPod touch. I changed the setting and showed Allison what was wrong and how to correct it.

Observation #7 also showed the need for technical support. The class began with the IF showing the students how to download the *Skitch* (Evernote, 2012) app in preparation for the activity. Most students downloaded the app quickly, but a handful had some trouble because they were logged in to the wrong network. While the IF helped the students download the app, Allison was using her iPad to practice the class activity using the *Skitch* (Evernote, 2012) app to create examples for the students.

Student interviews also suggested need for technical support. Two of the three who mentioned dislikes about the iPod touch had specific and correctable technical complaints. One of these complaints was a technical issue where the *DoodleBuddy* (Pinger Incorporated, 2012) app needed to reload when the student used it at home with her sister. The other correctable complaint was that the iPod touch did not have any songs or videos.

Training

The bilingual coordinator was responsible for providing support and training for bilingual teachers, including Allison and Michelle who are involved with the iPod touch initiative. Juan strongly felt that training was important and that "the training needs to focus on connecting classroom strategies with the technologies". He also said he felt that teachers needed ongoing training throughout the school year. One particular area he

identified was helping teachers find and learn apps that can help learning, especially new apps. He also felt training needed to concentrate on adapting the use of the apps for the specific needs of the students.

Based on their interview responses, neither teacher seemed especially proactive about learning new technologies and both suggested that they needed time and experience with new technologies before they were comfortable using them in their teaching. Allison felt much more comfortable, saying, "I've learned a lot and I'm a lot more comfortable with it [the iPod touch] and I'm comfortable that I can learn what I need to learn." She commented on how training was a factor in her change of attitude:

> I'm pretty comfortable with it when I've learned the app ahead of time. I feel we've gotten real good training in the program. I don't think I'd gotten quite as good training before and I think once I've gotten more training, I'm more comfortable with trying new things.

Michelle expressed a similar perspective and stated, "my comfort level just depends on if it's something I've used before and just how familiar I am with something. If I'm not familiar with something, I'm not comfortable with it but if I'm familiar with it, I'm okay with it."

Teachers often mentioned increased levels of comfort and familiarity without specifically relating these to training. While some of their improved comfort and familiarity came from their experience using the iPod touches, I believe that one reason that teachers may not have specifically mentioned training is because they knew I was already very familiar with their training experience. I conducted much of the training

they received on how to use the iPod touch and many of the apps. I also recommended, coordinated, or attended most of the training that I did not conduct myself. From my experience with their training and from informal conversations with these teachers, I know that they found training to be important and valuable.

Classroom observations indicated some needs for further training. The fact that campus IF's were present and involved during several of the classes (particularly observations #2, #5, and #7) showed that teachers did not have full confidence in their knowledge of using the devices. Most of the IF tasks related to helping students and teacher correctly set up and configure the devices and apps, suggesting that teachers might have benefited from further training in this area.

The results from Research Questions #1 and #2 also suggested areas for further training. Specifically, these findings showed that more training on how to use mobile Internet technology to foster constructivist learning and informal learning could have enhanced the benefits of the initiative. Further discussion of these potential training needs is included in Chapter Five.

Teacher Reluctance

Both teachers said they were initially apprehensive about the iPod touch initiative. Allison expressed "I was concerned that I wasn't going to know what to do." Michelle expressed similar unease and said, "at first, I was scared – not sure what to expect." Despite their personal reservations, both teachers said they wanted to implement the initiative because they felt it would benefit the kids. Allison made the comment "I

thought the kids would love it so I thought it was worth trying" when describing her initial reaction to the program.

Both teachers reported that their attitudes have changed since the program began the previous year. Allison stated "I think it's been all positive – especially for the kids. It's given them a chance to learn more about technology and become more of an expert and a lot of times they get to teach me – and they like that." Michelle also differentiated her initial feelings in the first year from the more recent start of the second year and stated, "after last year and working with them, I knew my kids were excited and I thought it was going to be easier this year after last year – going in blind." Michelle also remarked that the initiative has been challenging at times, but stated:

> It's been an eye opener. It's been a learning experience for both the students and myself. It's been a challenge at many times. I think it's a great initiative and hopefully it will continue and go on to both the upper levels and lower levels.

When explaining why their feelings about the initiative changed, both teachers' responses were similar in that they both mentioned how much their students enjoyed and benefitted from the program and their increased comfort level based on their training and experience. She elaborated that she was willing to try new technologies even if she felt scared and said, "I jumped in blindfolded with this [iPod touch] program – I didn't know how to use an iPod before."

The administrator's perspective on teacher attitudes largely aligned with what the teachers reported about themselves. He said that the teachers (Allison and Michelle, whose interviews are summarized above) did not immediately embrace the technology.

He commented, "Since they [teachers] are not Digital Natives – they are Digital Migrants – so, I think they were apprehensive." He did seem to recognize the change in teachers' attitudes when he continued, "once they [teachers] saw the benefits that the students were getting from that technology [iPod touch devices], they became more familiar, more used to, more comfortable using the technology." He pointed out that many students were probably more familiar with mobile Internet technology than the teachers. Interestingly, he used Prensky's terminology and described the students as Digital Natives and the teachers as Digital Migrants – similar to Prensky's term Digital Immigrants (Prenksy, 2001).

Inappropriate Use

Both teachers felt that the iPod touch device's ability to access inappropriate content was a significant disadvantage. Allison said that the small size and personal nature of the device made it challenging and time-consuming to determine whether content that a student was accessing or downloading in class was appropriate. She also mentioned that the time it took to determine whether or not students' activities were appropriate was a concern.

Michelle said that some of students' outside activities were problematic. She said she had 3-4 parents contact her and ask that their children keep their iPod touch devices at school because their children were using the iPod touch to engage in inappropriate text-messaging using the *iMessenger* (Apple, 2012a) app (an app that allows text-messaging over the iPod touch's Internet connection rather than via cell service using cell

phone numbers). Michelle followed up and said that inappropriate content and communication is currently much less of a problem than it was earlier in the initiative. Allison also mentioned inappropriate text messaging as an issue when asked about disadvantages of the iPod touch initiative. Despite these issues, both teachers indicated that the benefits are worth it and that they still wanted to use the iPod touch devices.

As discussed earlier, the iPod touch was not designed primarily as an instructional tool. It has many communication and entertainment features and my observations showed that these features could be a distraction. In observation #7, the IF had students put their iPod touch devices face-down as a way to keep students on-task. In observation #5 most students were working on the assigned task, but one student was using a different app for another activity and Allison had to correct him.

File Management

When asked about problems related to maintenance and management, the Bilingual Coordinator immediately identified file management as a challenge. Juan explained that efforts to individualize instruction meant that each student received their own take-home reading assignments and that this resulted in massive amounts of file downloading. He said that the reaction was to try to standardize groups of apps and files and assign each student to a group based on their current language proficiency as an alternative to completely individualized files and apps.

The classroom observations and the findings from Research Question #1 also showed the need to manage and share files related to classroom activities. While the use

of *DropBox* (Dropbox, 2012) provided an effective way to do this, the required bandwidth for file sharing overloaded the access point. Even with an additional access point, the speed of the file sharing process via *DropBox* (Dropbox, 2012) was significantly slowed when overall network demand was high.

Budget

When asked about overall problems with the initiative, Juan mentioned the budget. He explained that the funding for the iPod touch devices is not available in the bilingual budget and the initiative is only feasible because of the technology budget. While the funds ultimately come from the overall district, the technology budget is enhanced as a result of a bond passed by the community specifically technology initiatives. Without this bond funding, the initiative would not have had sufficient funding. While he agreed that the iPod touch initiative was cost-effective, the limited resources of the district and competing priorities made it difficult to count on continued funding.

Chapter 5 – Discussion and Conclusions

Overview

Chapter Four answered the research questions based on an analysis of the data I collected. This chapter connects these results to the relevant theoretical perspectives and literature. It also uses the results of this case study to identify implications for other school districts that want to implement this type of technology, including the identification of conditions that seem to be necessary for effective implementation. It continues by summarizing the contributions of this research to the wider literature and concludes by discussing the limitations of this study and the needs for future research.

Implementation of Mobile Internet Technology

This section discusses the theoretical context of the findings from Research Question #1. Chapter Four identified games and practice, media creation and editing, Internet searching, file sharing, and work sharing as prominent implementation practices present in this case study. The sections below explore how these implementation practices align with ideas about language proficiency, constructivist learning, known affordances of mobile Internet technology. It also discusses the particular context of mandatory implementation and how implementation affected digital literacy for students and teachers.

Language Proficiency

One effect of learning reported by the bilingual coordinator but not mentioned in other interviews or observed in classes or artifacts was students interacting with the iPod touch to develop their language skills. While the data collected do not show how this happens, the fact that students may feel comfortable practicing language using their device rather than with other people may be an important but hard to investigate and understand application of the devices. This is consistent with the observations of Hwang and Chen (2013).

While observations revealed that some students spoke a lot of Spanish, interview data from teachers and students indicated that they did not generally use the iPod touch as a way to directly improve English language skills. While some uses of the iPod touch were specific to language, the iPod touch was more often a tool used to enhance instruction in the overall curriculum (presented mostly in English). In other words, the mobile Internet technology most often supported language skill acquisition indirectly by facilitating and expanding classroom activities conducted in English. While the administrator interview data confirmed that the iPod touch initiative had the specific goal of improving academic achievement among ELLs, the implementation was mainly focused on regular academic subjects taught in English rather than on English language learning specifically. While use of the iPod touch devices with English-language instruction indirectly helped ELL students learn and practice academic English, the fact that English was predominant suggests that many findings of this case study are not specifically limited to bilingual education or ELL situations.

While observations and analysis of artifacts showed that much of the implementation focused on academic subject areas rather than English language proficiency, one observed class activity did focus on English vocabulary for words that describe emotion. During observations, classroom instruction was almost completely in English. However, many students spoke Spanish to each other when working in groups and several had Spanish as the default language on their iPod touch devices, suggesting a preference for or higher level of comfort with Spanish. The teachers were fully bilingual, so their use of English was likely an intentional effort to promote Second Language Instructional Competence (SLIC) (Rolstad, 2005).

Results from teacher interviews showed that they were very consciously trying to teach the students the language skills related to their academic subject areas. When asked to provide ratings of each student's proficiency as the context for the student interviews, teachers rated three of the nine interviewed students differently for conversational English proficiency and academic English proficiency. In interviews, teachers did not use the terms from the literature related to academic language proficiency (e.g. SLIC, CALP), but it was clear they understand the need for students to be able to understand the English used to teach math, science, social studies, and other subjects in addition to conversational English. While students and teachers sometimes used Spanish while working on projects and class activities, all projects, assignments, and tests were exclusively in English.

When asked specifically about the role of the iPod touch in English language acquisition, teachers mentioned a few specific examples. Both teachers pointed out that

all of the reading materials related to the class were in English. For example, Allison pointed out that the instructions for many iPod touch games that students enjoyed were in English and that this motivated the students to use English. Allison also said that the dictionary available on the iPod included the audio pronunciation and she felt that this was helpful in the students acquiring better language skills as well as learning the definitions of unfamiliar words.

Michelle mentioned that one of the teacher's aides showed fourth grade students how to switch the master language on their iPod and suggested that this might help them learn specific translations for the technical words displayed on the iPod touch interface. Michelle emphasized that students need to be able to read and decode in English as part of their academic success and clearly felt that helping her students attain this ability was a priority.

The first comment made identified by Juan when asked about the benefits of the iPod touch program was "it is technology that students find attractive, so the students are motivated and willing to use it." He continued by explaining how this is particularly helpful for ELLs:

> Using this technology [the iPod touch] lowers the students' affective filer so they are more comfortable using it; for example, they are more comfortable speaking to the device than speaking to the teacher or another person. So, they're developing language at their own comfort level and pace.

He pointed out that this was an especially useful benefit when trying to encourage students to practice speaking.

Constructivist Learning

Both teachers said that they use activity-based learning extensively and this was evident from classroom observations. From observations, the teachers used elements of the sociocultural constructivist approach to learning. However, based on the principles of constructivism (construction, authenticity, elaboration, social, and self-regulation) summarized by Sandberg et al. (2011), they fell short of implementing this approach fully.

The first principle of construction was met in some observed activities, specifically the research activities and videos related to the study of energy and the e-book stories about historical figures. In these activities, students did use the tools at their disposal (mostly the Internet accessed through the iPod touch) to acquire the information they needed. The principle of authenticity was occasionally met, with one example being the energy videos where students were instructed to describe the real-world uses of each type of energy. However, other activities seemed unconnected from real-world experiences. The constructivist principle of elaboration was also partially met. The classroom observations revealed that students used multiple web sites to find information about energy or about historical figures. Analysis of student *Keynote* presentations about rocks, the food chain, and energy seemed to include pictures and diagrams that were from multiple sources. Observations and teacher interview data showed that the social element of constructivism was frequently present. During observations, one particular area where students learned from each other was how to use the iPod touch to accomplish class assignments (rather than learning specific information about the subject of the class).

The final principle of self-regulation was not present. While teacher interviews and student interviews revealed that the students occasionally discovered different ways to use the iPod touch to learn both in class and outside of class, observations revealed that classroom instruction tended to be almost entirely directed by the teacher.

Based on artifact analysis, there is some evidence that class activities that were intended to be constructivist in nature may have fallen short of fully meeting this goal. The *Keynote* (Apple, 2012b) presentations included as part of the artifact analysis and described in Chapter Four demonstrated that mobile Internet technology allowed students to easily find information and transfer it without necessarily improving their understanding or constructing knowledge.

According to the teachers, *Keynote* (Apple, 2012b) presentations were a fairly common type of activity with the iPod touch in these ELL classrooms. One key constructivist-oriented attribute of a *Keynote* (Apple, 2012b) presentation is that it inherently forces students to find, organize, and summarize information. The *Keynote* (Apple, 2012b) app opens to what is essentially a blank slate. Though it offers some pre-defined options for style and format, the content must all come from the user. A mobile Internet device like the iPod touch allows easy access to information and audio-visual content to integrate into a *Keynote* (Apple, 2012b) presentation, but artifact analysis showed that this easy access may have emphasized organization and presentation of the information too much at the expense of actually understanding the information.

These artifacts showed examples where the focus on finding information and creating the presentation may have overshadowed the importance of constructing

understanding. While finding relevant information using the Internet is a useful skill in today's world and an important aspect of digital literacy (Bawden, 2008; Gilster, 1997), some slides created by the students seemed to show that their understanding of the material they found and edited was limited.

While each presentation included examples of images and/or words that seemed either irrelevant or beyond the understanding of fifth grade students, each presentation also included accurate information on slides with text written by the students themselves. For example, the nightingale presentation had a slide with the text: "They fly each year because they want to protect there selfs from the winter they often go to Africa." The grammatical and syntax errors indicate that this text was probably not copied verbatim from a web site or other Internet resource, suggesting that the students did find this information about the reason nightingales migrate and paraphrased it themselves. The results of this case study indicated that students were able to construct some knowledge from these types of assignments, but that they also found and used information and images that were not relevant or that they likely did not fully understand.

The results from student interviews presented in Chapter Four supported that iPod touch use was common and that students used the iPod touch both for practice and drill purposes and as a tool to facilitate project-based work. Students enjoyed using the iPod touch devices overall, but consistently mentioned the group projects as their favorite activities with the devices (as opposed to the games and other apps). This finding is in agreement with literature that advocates the effectiveness of sociocultural constructivist

learning (e.g. Roschelle, 2003; Werstch, 1991; Looi et al., 2010; Comas-Quinn et al., 2009; Mifsud and Morch, 2010).

While this case study had no direct comparison to an environment without the iPod touch devices, data indicate that the iPod touch devices contributed to some of the principles of constructivism observed and reported. Many of the knowledge construction activities relied on the content capture and media presentation capabilities of the iPod touch. While the actual academic content of the class activities was only marginally authentic, the process of aggregating and presenting information in electronic format is a skill students are likely to use in some real-world careers and situations, making the learning and practice of using the iPod touch's capabilities an authentic learning experience in this respect (Sandberg et al., 2011). The iPod touch enabled fast and easy elaboration through individual access to multiple Internet sources.

The iPod touch also facilitated the social principle through the content sharing via Apple TV, though most student communication and collaboration was done face-to-face and not though the iPod touch. Overall, the Internet resources accessible through the iPod touch and the students' ability to use the features of the iPod touch did seem to serve as a source of information that allowed students to move into their zone of proximal development (Vygotsky, 1978) in some instances. Rather than interacting with the teacher or their peers, students acquired knowledge they were seeking by using the mobile Internet devices.

The two teachers identified different primary benefits of the iPod touch, with one seeing it as a collaboration tool and a way to improve technology literacy and the other

seeing it as a resource and learning tool. Allison said her students learned "by doing" and working in groups while Michelle said her students learn best by trying to figure things out. However, both teachers described learning styles consistent with sociocultural constructivism.

While both teachers recognized the effectiveness of constructivist principles and made the effort to frequently include class projects using the iPod touch, the artifact analysis and classroom observations revealed that key principles of constructivist learning were absent or only marginally present. The teachers were trying to use a constructivist pedagogy they knew would be effective for their students but based on my research data, I feel that they did not fully understand constructivism. They never used the term specifically and they seemed unaware of the key principle of self-regulation. While the implementation of the iPod touch devices inspired more project-oriented learning with constructivist elements, it did not result in fully constructivist learning. The interview responses from teachers indicated that they felt teaching approaches consistent with constructivism were effective and they would likely be open to using a more fully constructivist approach with more guidance and training.

Implementation Affordances

Overall, the implementation of the iPod touch initiative at this district leveraged most of the affordances of the devices identified in the literature to some degree. In particular, teachers and students took advantage of: (1) access to media and Internet, (2) media capture and creation, and (3) engaging and desirable device and interface. Some

students took advantage of the mobility and informal/anywhere learning and the use of learning tools and instructional apps affordances by watching educational videos or using educational apps outside of the classroom. These affordances generally correspond to the findings from previous research about this initiative (Liu, Navarette, & Wivagg, 2013). Based on interview responses by the district bilingual coordinator and my own perspective as the district technology coordinator, the district took advantage of the cost-effective computing affordance of the devices.

Another affordance of mobile Internet devices from the literature is their ability to provide learning tools and instructional apps (e.g. Banister, 2010). General-purpose apps (like Internet browser, camera, media editing, etc.) were often used for class projects. Students also used a number of game apps related to spelling and math, both as part of classroom activities and on their own. While this initiative leveraged this affordance, one implementation practice neither mentioned nor observed was the use of apps designed to provide structured and engaging constructivist learning experiences. All of the specific education-related apps mentioned or observed were games designed to provide practice and drills. Software, websites, and apps that provide problem-based constructivist learning activities exist and would enhance learning if included as part of classroom activities or made available to students for informal learning.

One affordance that seemed absent from observations, interviews, and artifact analysis was situated learning and student-defined activities. This affordance is a key benefit of mobile Internet devices and one of the affordances most strongly connected

with constructivist learning (e.g. Jonassen and Land, 2000). The implications of this are discussed below in the context of Research Question 2.

Mandatory Implementation

The results of this research show that mandated mobile Internet technology implementation initiatives can lead to pervasive use even when teachers are initially hesitant. The teachers regularly used the iPod touch devices in classroom instructions and many students reported using the devices outside of school. This is significant because the mere presence of a technology does not ensure its frequent use, especially when the teachers are initially unfamiliar with the technology and apprehensive about using it. These teachers would not have requested or initiated this program.

Though mandatory implementation is probably becoming increasingly common in U.S. K-12 schools and research on these mandatory programs will likely increase, recent literature focuses almost exclusively on mobile Internet technology programs implemented by motivated teachers and researchers. Based on the bilingual coordinator and teacher interview data, teachers were admittedly apprehensive about the program initially but understood that it was a requirement. However, both teachers became enthusiastic about the initiative and about the potential of the iPod touch devices. One factor was realizing how much the students enjoyed using the devices. Student interview data supported that the students really like having the iPod touch. In interviews, all students reported that they like having the iPod touch for school. Six said they like it for

its non-educational entertainment content such as games, movies, and music, and six of the nine said that they like it because it helps them learn.

Another factor that increased teachers' enthusiasm was training and support that increased their knowledge level and made them comfortable using the devices. As mobile Internet technology continues to proliferate, bringing this technology into classrooms with apprehensive teachers may become more common (e.g. Norris et al., 2007; Tomasino et al., 2007). Data from this case study suggested that providing training and support and focusing on the benefits to students may help hesitant teachers more quickly and willingly implement mobile Internet technology initiatives.

Digital Literacy

All data sources supported that the implementation of the iPod touch initiative made classes media-intensive. Class projects used images to create presentations and electronic books, photograph flashcards, and informational videos. Teachers integrated the iPod touch devices even in relatively traditional math instruction by having students photograph, annotate, and share their work using the device. Students used multi-media games on the iPod touch to practice basic learning in spelling and math both in-class and at home. While the goal of all these activities was to learn subject matter in core content areas, the extensive use of media had the beneficial latent effect of improving students' digital literacy to help them master a key element of a cultural context in the school environment and among peers that involves technology (Gee, 1999). For teachers, improved digital literacy attained by learning how to use the features and apps of the

devices increased their confidence and reduced their apprehension about integrating the devices into their teaching.

STUDENT-DEFINED ACTIVITIES AND INFORMAL LEARNING

Literature (e.g. Sandberg et al., 2011; Lin, 2007; Caudill, 2007; Norris & Soloway, 2004; Clark et al., 2009) suggests that informal learning is effective and is one of the primary advantages of mobile Internet devices as a learning tool, especially when the devices are available outside of class and also suggests that initiatives to implement mobile Internet technology should specifically try to encourage informal learning. However, interviews with teachers and classroom observations did not mention or reveal any deliberate efforts by teachers to encourage informal learning with the iPod touch devices or any specific suggestions from teachers to students about how students might use the iPod touch outside of school. While the implementation of the iPod touch initiative leveraged many affordances, it largely neglected the affordance of informal learning – perhaps the most important affordance of mobile Internet devices. The nature of the teachers' interview responses suggested that the teachers would have supported more informal learning and it is likely that they just were not fully aware of this potential. In fact, one consequence of reported inappropriate use was prohibiting students from taking the devices home based on parental requests (which completely precludes this affordance).

Teachers used the iPod touch devices almost exclusively for in-class activities. Other than the one student who reported exploring the *Skyview* (Terminal Eleven LLC,

2012) app (that takes pictures of the night sky and then identifies the stars, constellations, and other visible objects), no other student reported using the iPod touch to initiate their own learning about a new situation outside of school. Teachers did not mention or demonstrate any specific instruction aimed at giving students the motivation or skills to do this. While other students reported that they discovered some of their own apps for spelling and math practice, use of the *Skyview* (Terminal Eleven LLC, 2012) app was the only example of learning not directly related to class activities that seemed to be purely initiated by a student outside of class.

Many apps and features of the iPod touch require Internet access and it is not possible to download new apps without an Internet connection. The fact that teachers believed at-home Internet access is relatively rare while the majority of interviewed students reported having access might mean that teachers underestimated the potential for student iPod touch use outside of class. When asked how many of their students had Internet access at home, both teachers felt the number was relatively small. Allison said "half at most" and Michelle described her estimate as "not very many - a handful." Allison believed that students who have Internet access at home tend to use their iPod more outside of class.

Of the nine students, one reported that his iPod touch from school was the only computer/gaming technology available in his home. Three students said they had other technology devices (generally game systems and parents' cell phones) at home, but no Internet access. One student even complained that the iPod touch needed a wireless network connection to access the Internet and that with no Internet at home, he could

only use Internet-based functions and apps at restaurants and other places with free wireless connections. The remaining five reported that they had Internet access and two of these students specifically mentioned Wi-Fi. Of those with Internet, all reported having a computer or laptop along with other devices such as smart phones or tablets. While the fact that five of the nine students who were interviewed reported having Internet access at home may indicate that more students have access than teachers realized, there were still a substantial number of students who did not have Internet access at home.

The lack of an Internet connection at home significantly limited some students' options for informal learning with the device beyond the "standard" apps installed by the teachers that did not require Internet access to function. Different K-12 populations may be more likely to have Internet access and home Internet access will likely grow over time, but offering Internet access outside of school might be a necessary step to fully realize the informal learning potential of mobile Internet devices.

Previous research about earlier years of this iPod touch initiative (Liu, Navarette, & Wivagg, 2013) found that the affordance of extended learning time was prominent among middle school students (grades 6-8) but not among elementary students (grades 4-5). Findings from this case study support that elementary students' educational use of the iPod touch outside of school was largely limited to occasional games to practice math and spelling. One possible explanation may be that the younger elementary school students were less inclined than older students to use their iPod touch devices to extend their

learning. Another possibility is that the elementary teachers, being newer to the initiative, may have provided fewer defined ways for students to extend their learning.

IMPLEMENTATION CHALLENGES

Challenges identified in this case study aligned with constraints identified in the literature (e.g. Caudill, 2007; e.g Keengwe et al., 2009; van 't Hooft and Vahey, 2007b; Sandberg et al., 2011; Tomasino et al., 2007; Roschelle, 2003; Looi et al., 2009) and with the constraints identified in previous research on this initiative (Liu, Navarette, Maradiegue, & Wivagg, in press; Liu, Navarette, & Wivagg, 2013). However, two commonly identified constraints – obsolescence and focus on technology over pedagogy – were not present.

Of the constraints identified in the literature, the most significant one from this case study was the need for support (e.g Keengwe et al., 2009; van 't Hooft and Vahey, 2007b). Infrastructure challenges were readily evident in several of the classroom observation sessions. Technical challenges observed and reported were related to configuration of devices and knowing how to use the device and its features. Implementation of the iPod touch required three types of support. First, the district needed a robust technology infrastructure along with technicians to maintain this infrastructure to provide sufficient and reliable Internet access. Second, the district needed support staff with a good understanding of how to use the devices and their apps to train and assist teachers. Third, these support staff also had to know how to apply the features and apps of the iPod touch in an educational setting. Teachers and the

administrator both emphasized the importance of training as a means of support and as a way of overcoming teacher hesitancy about implementing the technology.

As reported by teachers and the district coordinator, teachers' uncertainty about the program was an initial challenge. As discussed above, providing teachers with training and support and having them see how students benefitted from the technology overcame this challenge. Thus, the constraint of teacher resistance (e.g. Sandberg et al., 2011; Tomasino et al., 2007) was strongly related to the constraint of the need for support. Some of the teachers' initial apprehension was because of their own unfamiliarity with the iPod touch and its capabilities, but they said that they grew more comfortable as they learned more. Thus, providing the needed technical support and training is an important step in reducing teacher resistance.

The final constraint identified from the literature is access control and inappropriate use (e.g. Roschelle, 2003). This constraint was observed and reported in the data, though it was not a major or frequent concern. Teachers reported a few complaints from parents about students using their iPods to exchange inappropriate messages or access inappropriate content at home. They also reported that inappropriate use declined over time, suggesting that consistent supervision is effective in minimizing this constraint. Class observations revealed that the iPod touch devices offer distractions, but teachers dealt with this proactively by having students place their iPod touch devices face down during instructional time. During iPod touch activities, the teachers circulated through the class and re-directed the occasional student who was using the iPod touch for something other than the class assignment.

Though identified in the literature as a common constraint (Looi et al., 2009), obsolescence was not directly reported as a concern in this case study. This is likely because at the time of the data collection in the 2012-2013 school year, the iPod touch was still a current-generation device still being produced and sold. The model of the iPod touch used by students was not the very latest model available, but the newer model had only minor improvements (such as a slightly larger screen size and a higher resolution camera). Eventually, the iPod touch model used in this initiative will become obsolete and the district will face the constraint of obsolescence. One reason that obsolescence might become a concern is that it makes a big difference in the cost-effectiveness of the technology. The interview with the bilingual coordinator indicated that the iPod touch initiative is currently cost-effective for the two years the program has been in place. With plans to continue the program in the 2013-2014 school year (and possibly beyond), the devices have already outlived the two-year window for obsolescence estimated by Looi et al. (2009). So, the eventual obsolescence of the devices should not greatly impact the cost-effectiveness of the overall initiative. While obsolescence was not identified as a challenge, Juan pointed out that the budget was a concern. However, the fact that funding procurement was an administrative concern did not directly relate to whether pending obsolescence would make the devices less cost-effective. Juan's concern was focused on the challenges of prioritizing district funds rather than on justifying the value and cost-effectiveness of the iPod touch initiative.

One other constraint identified in the literature, a focus on technology over pedagogy (Caudill, 2007), was not largely evident in the data from this case study. The

fact that the teachers in this initiative were reactive to a mandate for the technology implementation may have counteracted the tendency of more eager teachers to focus on technology over pedagogy. However, the student artifacts provide evidence that the teachers may not have provided the pedagogical support behind the use of technology in some cases. Internet searches with the iPod touch make it easy to find text, images, and information about various topics (such as historical figures, nightingales, rocks, energy, and the food chain). However, much of the information available on the Internet is not presented in a way that fourth and fifth graders can understand. The student artifacts showed examples of *Keynote* (Apple, 2012b) slides where students copied information from the Internet that they probably did not fully understand. Pedagogy behind these types of assignments should include steps to ensure that students understand the information they put in their project slides.

IMPLICATIONS FOR PRACTICE

Despite the presence of sometimes significant challenges, the district was able to implement the iPod touch initiative. None of the challenges prevented the continuation of the program. While the implementation occurred and persisted, some aspects of the implementation did not realize the potential of mobile Internet technology (particularly for fully constructivist pedagogy and for informal learning). The results of this case study show that successful implementation requires proactive efforts to maximize potential as well as anticipating and overcoming challenges. Overcoming challenges is a necessary condition for successful implementation, but this is not sufficient without

leveraging affordances to maximize the potential. Based on the results of this cases study, there are several specific implications in each of these areas.

Overcoming Challenges

Creating an environment in which mobile Internet technology initiatives can flourish requires ongoing commitment from the district administration. In cases where the teachers who implement the technology initiatives are hesitant or reluctant or where implementation is mandatory rather than voluntary, success requires that the teachers have a willingness to teach using the technology. Results from this research show that good training to increase familiarity with the devices and an emphasis on the benefits to students can help apprehensive teachers support technology initiatives. The district prioritized training for the teachers and this was a successful part of the implementation. This training taught them how to use the devices and gave them ideas on how to integrate the technology into their teaching. This had the direct effect of giving teachers the ability to use the iPod touch effectively but also addressed the constraint of teacher resistance (e.g. Sandberg et al., 2011; Tomasino et al., 2007).

In addition to technical training for teachers, ongoing support at two other levels is important and necessary. First the district needs to provide adequate infrastructure. In this case study, network bandwidth availability was the main infrastructure challenge. While network bandwidth is an important consideration for other mobile Internet technology programs, other infrastructure issues such as facilities, hardware, and device maintenance may also be important. Part of the infrastructure includes the staff needed to

maintain it. Infrastructure problems can unexpectedly disrupt planned learning activities using mobile Internet devices and responsive and capable technical staff can minimize the severity and duration of these disruptions. In interviews, teachers did not mention giving up on planned iPod touch activities due to technical problems. During classroom observations, I witnessed crippling technical problems that disrupted a whole class lesson. However, teachers remained committed to using the technology because the responsive technical support emphasized the district's commitment to the technology program. This consistent message and accompanying support is crucial for any school that implements similar technology programs.

The other necessary level of support is staff who can help teachers use devices effectively. While infrastructure problems often affect all students and teachers, other technical issues such as device configuration and running apps correctly can also disrupt classroom learning even if only one person is affected. Classroom activities can halt when a teacher has to help students with technical issues related to their devices. Thus, support staff such as the Instructional Facilitators (IF's) observed in this case study are a valuable resource. They can address individual technical issues and keep the teacher available to continue the lesson. IF's can also show teachers and students how to handle common technical issues to minimize future problems.

Maximizing Potential

Maximizing the potential of mobile Internet devices in education requires effective teachers. Even in student-led constructivist learning or informal learning that

occurs outside the classroom, teachers provide an essential framework for learning. Results from this case study show that constructivist classroom learning experiences and informal learning among elementary students do not automatically occur at substantial levels just because mobile Internet devices are used extensively.

While training teachers in the basic use of the devices and apps is an essential precondition to basic implementation, further training and professional development can help teachers more fully exploit the affordances of mobile Internet technology. Findings from this research identified two areas where further professional development for teachers would have increased the effectiveness of the iPod touch initiative. First, teachers would have benefitted from in-depth training on constructivist learning principles. While they naturally recognized that students enjoyed working collaboratively on project-oriented assignments and often chose these types of assignments, these assignments sometimes lacked some elements of constructivism, especially self-regulation (Sandberg et al., 2011). Second, teachers would have benefitted from professional development that showed them the potential of the iPod touch for informal learning beyond using it to practice math and spelling. Professional development that showed teachers specific examples, web sites, and apps that facilitate constructivist informal learning would have been particularly helpful.

Finally, Internet connectivity is an important feature of mobile Internet technology. While all students were able to use the Internet at school, student interviews revealed that a substantial number of students did not have wireless Internet access at home. Future initiatives to deploy mobile Internet technology should consider providing

Internet access to students who need it so they can use the full capabilities of their devices.

CONTRIBUTIONS TO THE LITERATURE

This case study contributes to the literature by focusing on questions and issues related to mobile Internet technology that are absent or rare in other published research. As discussed previously, this study focuses on understanding implementation rather than measuring and evaluating outcomes. With innovative mobile Internet technology initiatives designed by experienced researchers and led by motivated teachers, the focus on outcomes used in much of the literature is appropriate. However, the proliferation of mobile Internet devices in education will mean that more initiatives will occur in situations like this case study where teachers who are initially resistant are mandated to use the technology, making implementation an important focus.

Importantly, this research has a practical focus that stems from my dual role as a researcher and as practitioner. Academically, this case study provides an understanding of a mobile Internet technology initiative in a unique context (iPod touch device, U.S. K-12 public education, ELL students, and mandatory implementation). It also supplements the existing but relatively sparse research about mobile Internet technology in elementary education in the U.S.

Practically, this case study provides specific information and recommendations for educators who are trying to start or expand mobile Internet technology programs. While this research focused on a single case study, it identifies challenges such as teacher

motivation and network infrastructure that are widely relevant in other school settings. This research also provides solutions and suggestions to meet challenges, based both on approaches that worked and on areas where potential was unfulfilled. A key contribution of this research that stems from its implementation focus is the identification of necessary preconditions and strategies to maximize potential discussed in the previous section.

LIMITATIONS OF THIS RESEARCH

As with all research, this study has limitations. While its focus on fourth and fifth grade ELL students (mostly native Spanish-speakers) in Texas public schools includes a combination of dimensions lacking in other research, this focus also means that generalizations to other broader populations and transferability to other specific contexts are somewhat tenuous. As presented in Chapter One, the elements of this combination are:

1. The iPod touch as a tool.
2. The U.S. as the geographic setting.
3. Public K-12 education (specifically elementary) as the academic setting.
4. Teaching English language and literacy to ELLs
5. A sociocultural approach as the primary theoretical perspective.
6. An educational setting where the use of mobile Internet technology is an administrative requirement.

Other situations that have some but not all of these elements may show different types of implementation, different levels and types of informal learning, and different implementation challenges.

As a case study, this research allowed the researcher to deeply and qualitatively explore the learning process among a population, but this in-depth understanding was in many ways specific to the context of this case (such as teacher characteristics, student characteristics, pedagogy, tools, administrative environment, budget,) and the findings of this research may have limited applicability to other contexts. Because these results come from a case study of a specific program in a single school district, many details and specifics of my findings may not be observed in other situations. For example, the processes and activities that elementary ELL students in Texas use to gain proficiency in English language and literacy may differ from the experience of ELL high school students in the U.S. or English-speaking elementary school students in Spain trying to learn Spanish. However, many aspects of this case study are likely present to some degree or in some form in other situations that share key similarities like grade level, teacher attitudes, and bilingual environment.

NEEDS FOR FUTURE RESEARCH

As mentioned, most available research about mobile Internet technology focuses on programs implemented by highly motivated teachers. More research needs to examine situations where technology implementation is an administrative requirement so that educators can understand successful ways to integrate technology in these

environments, which will likely becoming increasingly prevalent. As a qualitative case study, this research did not conduct a comparison with a control group or quasi-control group. While some teacher interview questions did ask how aspects of teaching changed with the implantation of the iPod initiative, future evaluation-oriented research would provide a better understanding of what aspects of teaching and learning (both positive and negative) are directly attributable to the integration of mobile Internet devices.

The goal of the iPod touch initiative in this case study expressed by the bilingual coordinator (who is responsible for its implementation and for obtaining the funding) is to accelerate English language proficiency. This case study explored ways that teachers used the iPod touch devices in a bilingual education context, but did not try to measure whether this goal was reached. Future research to investigate the link between the iPod touch initiative and improved English language proficiency would be a welcome addition to the literature. Particularly, longitudinal research to understand the eventual impact and outcomes of mobile Internet technology in K-12 education would also be interesting and valuable. However, this was unfortunately beyond the scope of this research. Though studying the processes of language learning using the iPod touch can identify immediate and short-term learning outcomes that may be indicative of long-term success, the ultimate goal of ELL education is academic success through students' educational tenure. Due to time and resource limitations, this study was not able to determine conclusively whether the use of the iPod touch has the intended eventual outcome.

There are several other avenues for further research to enhance the understanding of the use of mobile Internet technology. First, further research should explore other

technologies. The iPod touch initiative for ELLs that is the case for this study was implemented throughout the district because school administrators felt it offered significant benefits. However, research about other pedagogical and technological alternatives would help further an understanding of which practices and tools work best in which contexts.

A quantitative approach to collect data from a large and representative sample of school districts would provide an important understanding of how many schools use different types of mobile Internet devices for K-12 bilingual/ELL education. This type of research could also obtain or incorporate data on education outcomes, demographics, and other variables as possible correlates of the presence, extent, and/or strategy of mobile Internet technology implementation.

Finally, this case study is limited to a specific place and environment. Many of the processes and characteristics from this case study are likely common to other similar situations. However, more research exploring the implementation of mobile Internet technology in other settings would be valuable to validate (or challenge) my findings and to identify new issues related to this process.

CONCLUSION

Previous research has shown that mobile Internet devices, including the iPod touch, can have positive learning outcomes in a variety of learning contexts. These contexts include elementary public education in the U.S. (e.g. Kiger et al., 2012; Shin et al., 2012; Bannan et al., 2010), other K-12 levels in the U.S. (e.g. Brown, 2009; Franklin

& Peng, 2008), and English language learning (e.g. Lu, 2008; Liu, 2009; Hwang & Chen, 2013; Kim & Kim, 2012). This research has provided some evidence to support these findings in a unique combination of these contexts absent from the literature. However, it has also identified some ways that the use of mobile Internet devices did not achieve the potential suggested by other research, particularly in the realm of informal learning.

While some learning outcomes were observed, this research did not focus on measuring or evaluating these. Rather, it sought to understand the implementation process and how outcomes may be related to implementation issues. Based on analysis and interpretation of the data, this research came to the conclusion that aspects of implementation likely mediate learning outcomes. For example, the fact that teachers chose to use media creation and editing apps led to learning activities that involved collaboration and project-based learning. The inclusion of game apps for practicing math and spelling on students' iPod touch devices probably influenced how they used their iPod touch devices for continued learning outside of school. Configuring the devices with more apps like *Skyview* (Terminal Eleven LLC, 2012) or more sophisticated constructivist-based learning games or activities might have resulted in more informal learning.

Many examples of mobile Internet technology in education that have been the focus of academic research have involved motivated teachers and researchers using carefully designed and controlled pedagogy. In this case study, the teachers were moderately prepared and initially apprehensive about using the iPod touch devices. While this program began in less than ideal initial conditions, the stakeholders overcame

challenges to implement the program. Once implemented, teachers, students, and school administration felt the program had positive results.

From analysis of interview data, classroom observations, and artifact analysis, this research concluded that some effective use of the technology seemed to naturally emerge from the implementation. Teachers and students used the technology and used it in some collaborative and constructivist ways. However, the implementation mostly neglected one of the biggest advantages that mobile Internet technology can offer – informal learning. Based on these results, I conclude that some benefits can result from use of mobile Internet devices if educators plan for implementation challenges. However, maximizing benefits for elementary ELLs likely requires dedicated effort to inspire, encourage, and teach students to use the devices for informal learning

Appendix A – Teacher Interview Questions

1. When initially told about the iPod touch initiative, what was your reaction?
2. How have your feelings about the initiative changed?
3. Describe your familiarity and comfort level using technology.
4. What role does activity-based learning have in your teaching?
5. How do you think your students learn most successfully?
6. How have you used the iPod touch in classroom activities?
7. What apps have you used in classroom activities and how have you used these apps?
8. What apps have you seen students use on their own and how do they use these apps?
9. What uses of the iPod touch have come from student ideas and suggestions?
10. What have students told you about how they use their iPod touch outside of the classroom?
11. What are the benefits of using the iPod touch in your teaching?
12. What are the disadvantages or problems using the iPod touch?
13. Have the iPod touch devices helped students learn English? If so, how? If not, why not?
14. Do you know which students have Internet access at home? If so, does this affect their learning? How?

Appendix B - Student Interview Questions

1. Other than your iPod touch, what other technology devices do you use (computers, laptops, cell phones, video games)?
2. How do you feel about having the iPod touch? Why do you feel that way?
3. How do you use the iPod touch on your own during school? What apps do you use and how do you use them?
4. How often do you use the iPod touch outside of school? What apps do you use and how do you use them?
5. What apps and iPod touch activities have you discovered on your own? How do you use these?
6. What apps and iPod touch activities have you discovered from your friends or other kids in your class? How do you use these?
7. Who else in your family uses your iPod touch? What apps do they use?
8. What are your favorite class activities using the iPod touch?
9. What class activities with the iPod touch do you not like?

Appendix C - Administrator Interview Questions

1. What do see as the goals for this iPod initiative?
2. What would success of this program look like?
3. What level and types of support does the initiative require?
4. What are the problems with managing and maintaining the iPod touch devices?
5. How would you describe the teachers' attitudes towards the iPod touch program? Have they changed over time?
6. What are the problems or drawbacks associated with the iPod initiative?
7. What are the benefits?
8. How do the benefits of the iPod touch program compare with the costs? What other programs would be more cost-effective?

Appendix D - Classroom Observation Form

Time: ______ Observer: ______ Classroom Goals: ______

Teacher: ______ Grade level: ______

Class Arrangement: (Draw or take picture with camera) ❑ Rows with individual desks ❑ Pods of desks	**Teacher Behavior** ❑ Lecturing ❑ Modeling/Demonstrating ❑ Coaching/Scaffolding ❑ Leading Discussion ❑ Listening/Watching ❑ Talking to Individuals/Groups ❑ Answering questions/Addressing comments ❑ Other
Grouping Activities ❑ Whole Group ❑ Small Group ❑ Independent	**Student Behavior** ❑ Off Task ❑ Listening/Note taking ❑ Asking questions ❑ Discussing ❑ Working on computer/iPad/iPod to solve problems ❑ Helping each other
Technology Use	**Notes**

Appendix E – School-Installed-Apps on iPod touch Devices

DEFAULT APPS

- Calculator
- Calendar
- Camera
- Clock
- Contacts
- Game Center
- Mail
- Maps
- Messages
- Music
- Newstand
- Notes
- Photos
- Reminders
- Stocks
- Videos
- Voice Memos
- Weather

REFERENCE

- Dictionary Merriam Webster
- Dragon Dictation
- ESEN Spanish (Translator)
- iFood
- PIX-EN-ES

ENGLISH LANGUAGE ARTS

- TimeReading Lite

SPELLING

- Build Word World lite
- Phonic
- Simplex Spell
- SpellBoard
- Spelling City
- Word Warp

SCIENCE

- Moon
- NASA
- Science
- SCIENCE Science VL

MATH

- Estimate Fractions
- Estimate mm
- Fractions McGraw Hill
- Lobster Diver
- Math Showdown Multiplication
- Math Zombie
- McGraw Hill Multiplication Beat the Computer
- MGraw Hill Divisibility
- Multiply
- Pearl Diver
- Sparklefish
- Times Table Warp

PRESENTATION/MEDIA EDITING/STORYTELLING

- iMovie
- Keynote
- Skitch
- Storykit

GAMES/ENTERTAINMENT

- At Bat MLB.com
- Brain Trainer
- Uno
- Yahoo Sportsacular

CREATION/ARTISTIC

- Comic Touch
- DoodleBuddy
- SimpleDraw

FUNCTIONAL

- Dropbox
- eLocker2
- Flashcardlet

- Flashcards
- Remote
- Safe Browser
- vClicker

EDUCATIONAL VIDEOS

- Brain Pop
- Brainpop ES
- iTunes U
- Khan Mobile

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