Summer 2014

The Smartpen as a Mediational Tool for Learning Language and Content Areas: The Case of English Learners in Mainstream Classrooms

Rae Mancilla

THE SMARTPEN AS A MEDIATIONAL TOOL FOR LEARNING LANGUAGE AND CONTENT AREAS: THE CASE OF ENGLISH LEARNERS IN MAINSTREAM CLASSROOMS

A Dissertation

Submitted to Duquesne University

Duquesne University

In partial fulfillment of the requirements for

The degree of Doctor of Education

By

Rae L. Mancilla

August 2014

THE SMARTPEN AS A MEDIATIONAL TOOL FOR LEARNING LANGUAGE AND CONTENT AREAS: THE CASE OF ENGLISH LEARNERS IN MAINSTREAM CLASSROOMS

By

Rae L. Mancilla

Approved May 27, 2014

_____	_____
Dr. Nihat Polat Professor of Instruction and Leadership in Education (Committee Chair)	Dr. Laura Mahalingappa Professor of Instruction and Leadership in Education (Committee Member)
_____	_____
Dr. Jason Margolis Professor and Chair of Instruction and Leadership in Education (Committee Member)	Dr. Davi Reis Professor of Instruction and Leadership in Education (Committee Member)
_____	
Dr. Sandra Quiñones Professor of Instruction and Leadership in Education (Committee Member)	

ABSTRACT

THE SMARTPEN AS A MEDIATIONAL TOOL FOR LEARNING LANGUAGE AND CONTENT AREAS: THE CASE OF ENGLISH LEARNERS IN MAINSTREAM CLASSROOMS

By

Rae L. Mancilla

May 2014

Dissertation supervised by Dr. Nihat Polat

The use of mobile devices for supporting the instruction of second language (L2) learners is an emerging and rapidly growing area of inquiry. Previous research on mobile assisted language learning (MALL) has concentrated on the development of isolated linguistic skills through a common set of mobile technologies, such as PDAs and iPods, with limited attention given to alternative mobile devices or situations of L2 learning that require the simultaneous learning of language and academic content (Wu, Jim Wu, Chen, Kao, Lin, & Huang, 2012; Viberg & Grönlund, 2012; 2013). In particular, little is understood about how English Learners (ELs) educated within mainstream classrooms choose to appropriate mobile technologies to meet their learning needs, with respect to both their development linguistically and across academic course disciplines.

To inform this gap in research, this study used a quasi-ethnographic, instrumental case study design to explore how a group of middle school ELs used an understudied mobile device, the Echo Smartpen, to mediate their learning of language skills (e.g., speaking, reading, writing, listening, vocabulary) and of academic content areas (e.g., math, science, social studies). It also sought to examine how the Smartpen could assist ELs' learning processes with respect to individual learner characteristics (e.g., affective, cognitive, metacognitive). To accomplish this purpose, multiple sources of data were collected from seven student participants, their English as a Second Language (ESL) specialist, and primary mainstream teacher. These sources consisted of technologically-mediated digital data, such as the students' digitized notebooks, as well as traditional methods qualitative data collection, including individual and focus group interviews, and learning artifacts. The overall theoretical framework guiding the data analysis was Vygotskian sociocultural theory (SCT), complemented by grounded theory and the constant comparison coding method (Strauss & Corbin, 1990; 1998). Key principles for the analysis were the Vygotskian notions of mediated learning through physical and psychological tool use (Lantolf, 2000).

Findings from this study provide insights about the process of mediated language and content learning with the Smartpen for ELs clustered around three major themes: 1) extended opportunities for language learning through self-constructed artifacts; (2) extended opportunities for content learning through co-constructed artifacts; and (3) extended learning self with the Smartpen. In addition to the main emergent themes, research findings incorporate the participant-based metaphorical concept of time travel as an important sub-thematic element in tracing ELs' use of the Smartpen across temporal and educational contexts (e.g., school and home). Finally, this study concludes with a discussion of theoretical and pedagogical implications for the

integration of mobile devices for ELs in mainstream settings, as well as with recommendations for future research deriving from this research.

DEDICATION

This dissertation study is lovingly dedicated to my husband, Alejandro, and dearest daughters Gloria and Grace, whose unwavering inspiration has made this moment possible.

ACKNOWLEDGEMENT

This investigation could not have come to fruition without the indispensable help and support of countless individuals. First and foremost I must acknowledge the divine inspiration and strength that has flowed to me from the fountain of my Heavenly Father who has sustained me through this long journey and filled these pages with text. I would also like to express my extreme gratitude to the members of my household, especially Alejandro, Gloria, and Grace, who have financially, emotionally, and prayerfully supported me in the most gracious ways over the past three years. Without their sacrifice and patience this dream of mine to become "Dr." would have never been realized. To you girls, *thank you for having the eyes of children and always reminding me how far I had come instead of how much farther I had to go*.

I would also like to extend my sincere thanks to my longtime academic advisor, mentor, and dissertation chair, Dr. Nihat Polat who first sewed the seed of graduate work years ago when I was yet a master's student, and inspired me to embark upon this educational path of doctoral work. I also gratefully thank my dissertation committee members for "scaffolding" me in this dissertation process. Your vital contributions, time commitment, lending libraries, and flexibility with me have been much appreciated. I feel very blessed to have had the opportunity to work with such excellent minds as all of you Dr. Margolis, Dr. Mahalingappa, Dr. Polat, Dr. Reis, and Dr. Quiñones. I know I have emerged a more refined researcher because of your investment and belief in me and my potential as a scholar. Thank you for seeing what I could not!

Additionally, I would like to sincerely acknowledge the student and teacher participants in this research study, especially "Ms. Chua." Your cooperation, willingness, and dedication to this study have made it a reality. The greatest benefit of this work has been your influence on my

thinking about language learning and technology through the many lessons you've taught me throughout our year of working together.

To the members of Cohort 4, Anne, Theresa, Ashley, Ahmet, Ufuk, and Ramona, thank you for steadfast companionship in this academic marathon. Your friendship, email exchanges, phone calls, kind words, and brainstorming sessions have been instrumental for my growth as a researcher. I hope to be as supportive of you as you have been of me in this process.

I would be remiss to not acknowledge my family for their role in bolstering my development as an academic. I extend my appreciation to Carole, for the days and nights of childcare, and my sisters Renee and Rachel for their optimism.

Finally, I thank my parents Curtis and Roxanne for instilling in me a passion for learning and for working hard to lay the educational foundation for my career as an academic many decades ago. Yes, Dad, it's true, I've been in school my whole life!

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

Applications: Apps

English Learners: ELs

Echo Smartpen: Smartpen

First Language: L1

Second Language: L2

Second Language Learners: L2 learners

Sociocultural Theory: SCT

Self-Determination Theory: SDT

Chapter I

Introduction

1.1. Context of the Study

The linguistic and cultural landscape of the American classroom has drastically changed in the past decade and is now more diverse than ever before. English Learners (ELs) constitute the fastest growing student population in American public schools today, with figures projected to reach 10 million by 2015, or one of every four students in a classroom by the year 2025 (Van Roekel, 2010). These changing demographics have permeated virtually every state in the country, as the national average for the enrollment of ELs has reached over 10 percent (Batalova, & McHugh, 2010), underscoring the fact that many states previously unexposed to the presence of linguistically and culturally diverse learners are now confronted with ways to accommodate, and more importantly, serve their unique learning needs.

Different from their native English-speaking peers, ELs face a number of significant challenges regarding their ability to be academically successful in the American school system. Success for ELs is highly contingent upon their development of academic literacy (Ernst-Slavit, Moore, & Maloney, 2002; Slavit & Ernst-Slavit, 2007), which Warschauer, Grant, Del Real, and Rousseau (2004) define as "the reading, writing, speaking, listening, and thinking skills, dispositions, and habits of mind that students need for academic success." (p. 525). Cummins (1979; 2008) distinguishes between cognitive academic language proficiency skills (CALP) and basic interpersonal communication skills (BICS), noting that while BICS may develop within two to three years for language learners, CALP often requires five to seven years of intensive and

content-focused linguistic instruction. Thus, for ELs "learning" is a complicated process that first requires their ability to access the content of the curriculum through the gateway of English proficiency, which can be a prolonged developmental process.

In spite of the linguistic and cultural barriers involved in educating ELs, recent mandates have held them to the same benchmarks for demonstrating academic progress as their native English-speaking peers (NCLB, 2001). The persistent national achievement gap between ELs and their non-EL counterparts suffices as evidence to document their gross under service by the current educational system. Recent reading assessments by the National Association for Educational Progress (NAEP) indicate a difference of 36 points and 44 points at the 4^{th} and 8^{th} grade levels respectively between ELs and non-ELs (NCES, 2011). These numbers not only signal the comparative underachievement of ELs, but more importantly point to the failure of educational practices to support their reading development. Moreover, when compared to their native English-speaking peers, ELs are also 10% more likely to drop out of school and less likely to graduate from high school (Grant Makers for Education, 2013; Maxwell, 2013). In fact, the longer ELs take to become proficient in English, the greater likelihood that they will choose to drop out of school. Together, these numbers point to the need for effective and timely instructional intervention for ELs in schools.

A substantial contributing factor to ELs' difficulty in schools is the fact that their unprecedented growth has not been matched by a commensurate growth in professionals qualified to work with them. Teachers who are specifically trained as English as a Second Language (ESL) teachers, and who possess the knowledge, skills, resources, and strategies for working with and nurturing ELs, are at a minimum nationwide. Only one

percent of public school teachers fall into this category, translating into a student to teacher ratio of 150:1 (Face the Facts USA, 2012). Due to the combination of their growing numbers and the limited specialized staff trained to work with them in schools, ELs are increasingly placed in inclusive classrooms with mainstream teachers whose formal preparation is not in language, but rather in a traditional content area (e.g., mathematics, science, English, or social studies) (Pettit, 2011). In most cases, these teachers are unfamiliar with the pedagogical and content knowledge necessary for making modifications to lessons so that the content is comprehensible for second language (L2) learners, and appropriate for their developmental proficiency level in English.

In recognition of the key role that mainstream teachers have begun to play in the education of ELs, many states (e. g., Pennsylvania) have implemented reforms to their preservice teacher education programs in order to better equip them to provide the instructional and linguistic support that ELs need to meet the three ultimate goals: English proficiency, cultural proficiency, and academic achievement (Samson & Collins, 2012). Though well-intended, these teacher-focused initiatives are in their nascent phases and will require time before they fully disseminate to the classroom level. Additionally, a body of teacher education literature underscores the complex nature of preparing mainstream teachers to work with culturally and linguistically diverse learners, noting the reticence of self-efficacy beliefs and beliefs about their responsibility for educating ELs (Durgunoğlu & Hughes, 2010; Polat, 2010; Polat & Mahalingappa, 2013; Reis, 2013; Walker, Shafer, & Iiams, 2004), which may not be fully addressed through teacher preparation coursework. Although teacher education is a promising way to better the

educational prospects of ELs in the future, it is neither guaranteed nor immediate in producing results.

To date, most efforts to serve ELs in mainstream settings have been teacher-centric with heavy reliance on teachers to be the primary source of learning support through instructional modifications (Gibbons, 2003). Considering the many demands placed on mainstream teachers to adapt instruction for ELs, while simultaneously differentiating for their English-speaking peers, the time-intensive process of language learning for ELs, and their current academic distress, there is a pressing need to identify and implement new alternatives for supporting them that can supplement teacher intervention. In their report on effective instruction for ELs, Calderón, Slavin, and Sánchez (2011) suggest the use of technology as a progressive pathway for supporting instruction and learning across the content areas of math, science, and social studies, promoting an integrated curriculum of language, literacy, and content development. Thus, despite accessibility issues (discussed in Section 1.3), technology and mobile learning platforms may provide ELs with extended opportunities for the mastery of academic content and language in mainstream educational settings in self-directed and independent ways that complement existing teacher efforts.

1.2. Purpose Statement and Research Questions

In pursuit of new and additional avenues for assisting ELs in becoming academically successful, the purpose of this study is to explore and describe the potential of mobile technology to provide learner-driven academic and linguistic support for ELs in classrooms designed for the content-based learning of native English speakers. Broadly speaking, the core of the inquiry centers on the question of *how* a specific type of mobile

technology—the Echo Smartpen—(described in section 3.3) can help ELs in these mainstream settings where they have been "pushed-in" to become better-equipped learners of the English language and/or of lesson material within the system of one charter school.

To address this main research objective, the following subsidiary questions will guide the study:

RQ 1: How does the Echo Smartpen tool support the learning of middle school ELs in learning language skills, (e.g., reading, speaking, etc?)

RQ 2: How does the Echo Smartpen tool support the learning of middle school ELs in different content areas (e.g., math, science, etc.)?

RQ 3: Does the Echo Smartpen provide any affective, cognitive, and metacognitive benefits for ELs? If so, what are some of these benefits?

Considered together, these research questions aim to address the complex and multidimensional nature of learning for ELs in order to uncover the multiple ways that mobile technology may potentially impact their learning process. This work will describe the collective case of a group of middle school ELs and their experiences using the Smartpen tool in strategic and customizable ways for learning as interpreted through the lens of Vygotskian sociocultural theory (Vygotsky, 1978). Moreover, a secondary goal of the study is to illuminate any potential affective, cognitive, and metacognitive benefits made available to L2 learners through the Smartpen technology, placing at the forefront the interrelatedness of affect, cognition, and metacognition that plays a unique role in L2 learning (Anderson, 2002). Since mobile devices can provide learning opportunities beyond the physical boundaries of the school, ELs who struggle with mastering the

language or content within the formal classroom setting may benefit from the informal learning opportunities afforded through this mode of learning.

1.3. Significance of the Study

Research on mobile assisted language learning (MALL), the study of language learning with mobile devices, has concentrated on the foreign language (FL) classroom where the learner's motive is strictly L2 learning in the sense of individual language skill training (e.g., reading, writing, speaking, listening, etc.). Lan, Sung, and Chang (2007) highlight that MALL research has encompassed the delivery of isolated speaking, vocabulary, and grammar instruction through mobile devices with primarily college level FL learners. This language skill-centric perspective does not account for L2 learning scenarios where L2 learners are surrounded by the target language and culture and educated through the L2 in academic disciplines (i.e., K-12 ESL settings). The application of mobile technology in such situations where the L2 learner's goals are multifaceted, and involve the learning of speaking, reading, writing, and listening proficiencies in tandem with content learning objectives is very limited. To this end, the current work is poised to make a substantial contribution to MALL research through its focus on the K-12 school-aged population and its exploration of the integration of mobile technology in a content-based context for L2 learning.

Although a wide range of handheld mobile devices exist on the market, few of them have been explored for L2 learning. To date, most studies on the uses of mobile technology for L2 learners have focused on mobile phones and personal digital assistants (PDAs) (Wu, Jim Wu, Chen, Kao, Lin, & Huang, 2012), emphasizing the need to broaden research on educational technology to consider the role that other mobile

technologies may play in L2 education. In particular, the Smartpen device has been an under-researched piece of mobile technology and an untapped resource for L2 learning (Mancilla, 2013). Understanding the instructional affordances and impact on learning that individual mobile technologies may have is especially significant, as Kukulska-Hulme (2009) advises that in the current phase of mobile technology research the features and capabilities of individual mobile devices significantly impact learner choices and behavior. Considering that little is understood about the educational potential of the Smartpen and how it can be applied in contexts of L2 learning, this study is poised to make an interdisciplinary contribution to literature in the fields of mobile and educational technologies as well as to Second Language Acquisition (SLA).

Regarding pedagogical relevance, this work has prospective implications for both practitioners and school policy makers in terms of integrating the Smartpen technology into mainstream classrooms to support ELs. Since ELs typically attend economically disadvantaged schools where their access to technology within the classroom has been historically limited (Cattagni & Westat, 2001; Kleiman, 2004; Warschauer & Matuchniak, 2010), little is actually known about if and how they take advantage of mobile technology for learning when provided with developmentally appropriate access. Supplying them with the Smartpen device is a necessary first step in gaining insight into the potential benefits of mobile technology for a new generation of 21st century L2 learners whose perspective has been largely absent from the mainstream literature on mobile learning. Given the many responsibilities placed upon teachers of culturally and linguistically diverse learners, conclusions about the Smartpen from this study may provide them with a viable and immediate tool they can use to respond to the

instructional needs of ELs in content area classrooms in new and possibly transformative ways.

The increased recognition that mobile technology is fundamentally changing how people learn (Kukulska-Hulme, 2009) has resulted in a national impetus for the policy integration of mobile devices. New mandates from the U.S. Department of Education (2010) require states, districts, and schools to include mobile devices in their educational plans and to adopt technologies and develop policies that leverage access to mobile technologies for learning, particularly for marginalized populations. These efforts to foster digital literacy for 21st century learners through policy changes that prioritize technology integration have also been echoed by the National Common Core Standards for Education that stipulate the embedding of technology in instruction across content areas, specifically around language learning (Boling & Spiezo, 2012). As school districts revise their technology policies for alignment to the Common Core Standards and national mandates, their decision-making regarding mobile device integration will likely be influenced by existing scholarship such as the current study on how various types of mobile devices have been effectively incorporated into education for L2 learners. Provided that mobile devices themselves are often relatively cheaper and more portable than conventional computer technologies (Swan, van t Hooft, Kratcoski, & Unger, 2005), devices such as the Smartpen may be of special interest to school districts due to budgetary realities.

Finally, in the age of rapidly evolving mobile technologies, research on the educational applications of mobile devices must focus on understanding students' behavior or uses of the technology rather than the actual technology itself (Zhao, 2003).

As argued by Hockley (2013), "Interaction with mobile devices is only one part of the picture; of key importance in any discussion of mobile learning are the interactions that it supports and the ways in which these lead to learning" (p. 80). This study attempts to achieve this goal through a process-orientation that places understanding the mechanisms of learning with technology at the forefront, trying to uncover specific ways that students use the Smartpen for learning that may be generalizable to other mobile technologies utilized by other L2 learners.

1.4. Overview of the Dissertation

In this section I provide a brief overview of the structure and content of this dissertation. Chapter Two reviews the research literature on the use of mobile learning technology with second language learners, particularly ELs, and outlines previous research on the Smartpen device used in this study. It also details the theoretical framework of Vygotskian sociocultural theory and its relevant tenets applicable to mediated learning which comprise the theoretical lens for the data used in this study. In this chapter operational definitions of all germane terminology are provided. Chapter Three concerns the research methodology, specifically the research framework, questions, participants, and setting. It later describes the procedures associated with the qualitative data collection and methods for analysis. Chapter Four presents the results of the previously outlined research questions generated by the data analysis. Chapter Five later expounds upon and situates the research findings within the context of the previous literature. Finally, it discusses broader practical implications drawn from this work as well as limitations, and concludes by mapping out potential research directions for future work as indicated by the research findings.

Chapter II

Literature Review

2.1. Overview of Mobile Technology for Learning

In this review of literature I first provide background information on the field of mobile learning and current models of mobile technology integration in the classroom. This information helps to contextualize the current study and set forth the operational conceptualizations that are used throughout this dissertation.

2.2. Introduction to Mobile Learning

Mobile learning is now a burgeoning movement in education as mobile devices have become more accessible, convenient, and affordable for learners in the U.S. (Martin, Diaz, Sancristobal, Gil, Castro, & Peire, 2011). Recent survey data reveals that the percentage of American youth between the ages of 12-17 who own their own mobile devices (i.e., cellular phone and tablet PC) continues to rise, and that young people are spearheading mobile connectivity across the country (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013). The growing number of students who have become routine users and owners of mobile devices has fueled educational initiatives to learn how to best incorporate these devices into classrooms for learning purposes. Investigations into the advantages of using mobile technologies for learning activities have spanned various academic disciplines, including science, social sciences, library sciences, math, and language courses (Franklin & Peng, 2008; Hwang & Chang, 2011). Language education has been seen as a genre especially well-adapted to mobile-assisted language learning (MALL) and a significant body of literature has been dedicated to the use of mobile technology for enhancing learners' second language acquisition, although it has been

largely exploratory in nature and produced inconclusive findings (Viberg & Grönlund, 2012; 2013).

As a field, mobile learning is still relatively new and its rapid evolution has contributed to the lack of clarity in its theoretical underpinnings and operational terminology (Peng, Sua, Chou, & Tsai, 2009). Thus, what is meant by the term mobile learning is still the subject of considerable debate; however, many scholars do agree that "mobile" is a more global term than previously conceptualized as, referring not only to the mobility of the technology itself, but also to that of the learner, and more importantly to the learning experience and its ability to transcend spatial, temporal, and/or conceptual boundaries (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sanchez, & Vavoula, 2009; Traxler, 2007). Mobile devices are also another topic of discussion, as there is some confusion regarding what qualifies as a mobile device in terms of size and portability (e.g., whether tablet PCs and laptops are mobile devices); however, considering the spontaneous nature that mobile learning evokes, devices that are not handheld or carried "habitually or unthinkingly," meaning without a premeditated purpose (e.g., laptops, iPads, and tablet PCs) should not be considered mobile devices (Traxler, 2009). Similarly, networking considerations also draw a fine line between mobile learning (m-learning) and ubiquitous learning (u-learning), as some mobile devices have wireless networking capabilities and/or sensors (e.g., Smartphones), while others do not (e.g., standard PDAs) permitting ubiquitous access to learning materials and/or learner collaboration via wireless communication with mobile devices (Cheung & Hew, 2009). Thus, some instances of networked mobile devices may straddle the camps of m-learning

and u-learning. However, for the purpose of the current study, *m-learning* was the primary focus, since the Echo Smartpen did not support wireless access.

The way in which mobile learning has been enacted in education has taken various forms over the years. Yu (2007) delineates three generations of mobile learning, the first which focuses on information transfer via mobile devices, the second on pedagogical design, and the third on the use of context-aware technology (as cited in Wong & Looi, 2011). Questions about the role that mobile technology should play in the learning process have been addressed by Puentedura's (2010) SAMR model, which describes four possible "postitionings" of mobile devices for education: *substitution* (technology substitutes a traditional learning tool with no functional difference); *augmentation* (technology substitutes a traditional tool with functional improvement); *modifications* (technology allows for the learning task to be redesigned); and *redefinition* (technology permits the creation of new learning tasks). The redefinition category encompasses learning activities that could not conceivably occur without mobile devices and coincides with the discussion of mobile learning as either safe or disruptive (Stead, 2006). Safe mobile learning is explicit learning with mobile devices used as the medium to transport otherwise inaccessible resources into the traditional learning environments (i.e., the classroom); in other words, the learner never leaves the confines of the classroom to learn with mobile technology. In contrast, disruptive mobile learning implies that the learner is self-directed and can engage in informal or implicit learning opportunities beyond the traditional classroom space, using mobile devices to construct knowledge in everyday settings, which in turn disrupts the transmission or banking model of education (Freire, 1970).

The issue of how much control and responsibility should be allocated to the learner for effective mobile learning is controversial and still poorly understood. Part of what complicates developing a clear understanding of how to best implement mobile technology in classrooms stems from the fact that learners, when given control over mobile devices, may choose to appropriate them in ways unanticipated (Kukulska-Hulme, Traxler, & Pettit, 2007) or even unauthorized by teachers. Despite the unpredictability associated with mobile technology, some pedagogical models have emerged to describe a continuum from more teacher-driven to student-driven possibilities. McFarlane, Roche, and Triggs (2007) outlined three distinct mobile design activities: teacher-directed, teacher-set, and autonomous learning to refer to the amount of freedom or independence given to students to govern the use of their mobile device. While the first two models underscore the role of the teacher in determining the applications and outcomes of learning through mobile technology, the latter is concerned with the role of the learner in creating opportunities for themselves using mobile technology according to their curiosity, needs, and personal interests. Kukulska-Hulme (2010) echoed this teacher-learner dichotomy, stating that:

> On one end the emphasis is on making content and activities available on mobile devices, with the expectation that learners will engage with the language learning and complete it, [a]t the other end of the continuum, learners are entirely self-propelled and undertake activities such as finding and downloading language learning resources or even creating some for others. (p. 121)

To date, most of the research on mobile learning has tipped toward the teacher-led end of this spectrum, focusing on teacher-specified activities delivered through the technology or on issues of content delivery or design (Kukulska-Hulme & Shield, 2008; Kukulska-Hulme et al., 2007).

2.3. Mobile Assisted Language Learning (MALL)

The term MALL was first coined by Chinnery (2006) to describe a domain of mobile learning that pertains exclusively to second and foreign language study. Since so few MALL studies have specifically focused on the use of the Smartpen tool for language learning, I begin by reviewing the modest literature base in the first part of this section. Then, I proceed to highlight studies utilizing mobile devices that possess similar functionality and/or related instructional goals to demonstrate their connection to the current work. This section is organized according to the application of mobile technology for enhancing language competencies in the order of vocabulary, reading, grammar, writing, listening, and speaking domains.

2.3.1. Language learning and the Smartpen. Documentation of the use of the Smartpen digital pen for L2 learners is virtually non-existent despite the fact that it was created in 2008 (Schreiner, 2008). There has been considerable speculation among researchers in terms of the potential benefits of digital pen technology. Carlson (2012) proposes a number of potential educational applications of the Smartpen, many of which are applicable to language learners and their teachers. Possible teacher uses include recording personalized audio-visual lessons for students as *pencasts* (digitalized interactive broadcasts of textual and audio notes), creating augmented communication materials (Piper, Weibel, & Hollan, 2011), and gathering data about students' self-talk

and metacognitive problem-solving processes for designing interventions (e.g., mathematics, Johnson & Naresh, 2011). Students could also use the device to create personalized audio study materials, rehearse for oral presentations, and replay lecture materials for improved note-taking. Despite the wide range of possibilities, studies that investigate these benefits are at a minimum.

Respective to language study, there have been a couple of preliminary attempts to examine students' self-reported perceptions of the Smartpen among older L2 learner profiles. Shea (2011) created tutorial pencasts with the Smartpen in which she modeled for university L2 learners how to write Japanese characters that were later posted on the class website and on YouTube for optional student viewing. The small-scale survey responses indicated that students strongly agreed that the pencasts helped them to improve their character writing; however there was no formal means of assessing the relationship between viewing the tutorials and actual learning. While site analytics suggested repeated student viewing of the pencasts as a potential learning benefit, the use of the Smartpen in this study was essentially teacher-directed and inconclusive regarding actual student learning activities associated with the device.

In a different study, Knox, Herrington, and Quin (2011) collected interview data on 22 adult English learners during a six-week workshop series to evaluate their perceptions about the general affordances of using the Smartpen for note-taking. They concluded that "the Smartpen appears to offer a number of affordances for learning English in the areas of comprehension, pronunciation, intonation, and retention of learning" (p. 2741). Participants reported to believe that the Smartpen functioned as a tool for extending their opportunities to practice and perfect their own pronunciation and

intonation through the in situ models of native English speech that they were able to capture with their devices. Others reported that the recording and playback features of the device enabled them to record their own voices and hear themselves in new ways when rehearsing for the delivery of oral presentations. They believed that listening to themselves allowed them to reflect on their speech and make modifications to their pacing, ultimately helping them to become more comprehensible speakers of English. Finally, some participants found the Smartpen helpful for their note-taking skills by reducing the amount of information they needed to capture in real time instructional settings. They marked their notes with keywords that allowed them to bookmark important moments during classroom instruction and return at a later point in time. Together, this exploratory study demonstrates that for adult L2 learners, the Smartpen may mediate learning in several ways, especially through this notion of "classroom time-travel" that is unique to the Smartpen due to its ability to synchronize recordings of visual and audio notes. Since this work was conducted as a short-term project, and focused only on adult learners, the learning benefits of the Smartpen may or may not apply to younger L2 populations.

2.3.2. Mobile-assisted vocabulary learning. The use of mobile technology for vocabulary learning is the most commonly researched aspect of MALL across the language competencies. Most of the studies on using mobile devices for vocabulary instruction have taken an information transfer, or "push" approach (Mellow, 2005), where unsolicited SMS or mobile email messages containing vocabulary lessons have been delivered to students from their language instructors. The goal of the push method has been to maximize learners' repeated exposure to target vocabulary words through

explicit instruction that occurs via the mobile device outside of the classroom environment. In these instances the mobile device has served as a physical tool or delivery mechanism for extending the learning space for students by increasing their instructional time in a way that would not be otherwise possible without the use of the device.

Several studies have demonstrated positive vocabulary learning gains on recall and recognition tests, and in delayed post-test vocabulary retention for L2 learners through the use of SMS messaging (Alemi, Sarab, & Lari, 2012; Cavus & Ibrahaim, 2009; Thorton & Houser, 2005). While these studies have demonstrated that vocabulary gains are possible through SMS or mobile email instruction, it is less clear exactly how these gains are produced. Through exploratory measures, Thorton and Houser (2005) concluded that frequent messaging reminds student to study vocabulary, while Cavus and Ibrahiam (2009) suggested that students choose to study their vocabulary more frequently because they enjoy the flexibility associated with mobile learning. In their work specifically with 5th grade ESL students, Sandberg, Maris, and de Geus (2011) found that the educational value of a vocabulary application for mobile phones was strictly a function of students' extended practice time rather than the content provided by the application.

More importantly, Lu (2008) noted that vocabulary gains are mediated by the frequency with which learners retrieve, read, and review the content of the SMS messages, highlighting the importance of understanding learners' choices and behavior associated with learning language with mobile devices. This concern is further underscored by Kennedy and Levy's (2008) work with SMS messaging for Italian

learning, in which they discovered considerable variation in what learners did with the messages once delivered to their devices, suggesting that the provision of vocabulary content does not guarantee learners' uptake of the instruction or its effective use. Although studies on SMS tutoring are useful in establishing the value of vocabulary learning through mobile devices, their major shortcoming is that they are artificial in relying on "mobile technologies for prescribed vocabulary learning tasks, or tested designed personalized learning systems to enhance students' vocabulary learning in the short term in language related courses" (Song & Fox, 2008, p. 239). They also represent a teacher-driven approach to vocabulary learning via mobile devices, in which the teachers select and deliver at their own pacing what they consider to be meaningful vocabulary to the learners, essentially controlling the learning from a distance.

Turning from the teacher as the designer of content, a second strand of L2 vocabulary research has explored the benefits of allowing students to design their own learning experience through mobile artifact creation. In these studies, the mobile device not only mediates learning as a tool that transforms the interaction between the learner and his/her environment, but also as a means of creating additional mediational tools in the form of digital artifacts. Particularly, a subset of studies on mobile vocabulary learning illustrates the way in which mobile technology may serve the purpose of capturing a meaningful representation of learning for later group reflection and personal meaning-making of content.

In an exploratory case study, Wong and Looi (2010) used wireless handheld devices containing cameras with groups of elementary aged Chinese English learners for learning the meaning of new prepositions and idioms. Students carried their mobile

devices beyond the classroom onto the school's campus to create visual photo-based artifacts that illustrated authentic uses of the target vocabulary. Students were also permitted to take their devices home for idiom learning and were instructed to post their artifacts on a class wiki for collaborative feedback and discussion. Their findings demonstrated that students engaged in three different types of personal meaning-making and reflection about the focal words brought on by the creation of the visual representations and accompanying sentences: literal, extended, and creative.

In a re-articulation of this idiom activity, Wong, Song, Chai, and Zhan (2011) explored the process by which digital artifacts can become cognitive tools for L2 learners. They discovered the importance of the camera's playback feature that enabled students to monitor their artifacts in real time and evaluate their congruency with the meaning of assigned idiom. Through the photo playback, students engaged in artifact mixing in which they construed new idiom representations from photos previously taken, demonstrating the transformative power associated with mobile devices that allows learners to return to previous moments in time and personalize their learning experience. Although limited to vocabulary learning, this study has important implications in terms of extending the benefits of artifact creation, playback functionality, and cognitive mediation to other areas of language study.

Another key study on student-centered L2 vocabulary learning via artifact creation is Song and Fox's (2008) work on incidental vocabulary learning with PDAs. This case study conducted with university-level ELs is especially pertinent to the current work because of its similar research design in allowing students to use their devices longitudinally and in unmitigated and undirected ways by the teacher. Such a

methodological approach allows insight into how students' instructional needs can be met by mobile devices from a bottom-up paradigm of independent use. Students in the study specifically used the camera and note-taking functions of the device to help them learn vocabulary by creating digital screenshots as records of unfamiliar vocabulary used within the classroom for later review. This marks an important distinction between this work and previous artifact studies in re-defining the meaning of seamless learning as capturing information from the traditional classroom and transporting it into the home environment for later reflection and learning.

Findings from this study indicated that several students found the note-taking function of the PDA particularly useful for vocabulary learning. They created written artifacts of unknown language/idiomatic expressions from class lectures, talks, and reading materials that they could refer to and define at a later moment of time. In one instance the camera feature was used to capture images from textbooks, and multimedia classroom presentations to aid in memorization of academic terminology, an application of mobile technology also noted in Anzai's (2013) photo note-taking study. Song and Fox's (2008) research also supported the pronunciation benefits associated with learning vocabulary with mobile devices, as the sound function of a downloaded dictionary allowed learners to hear and associate the audio pronunciation of unfamiliar words with their written forms. In sum, the authors concluded that "the mobile device functioned as an intellectual partner with the student to engage and facilitate deep learning" (p. 308). Thus, mobile devices with similar features may mediate vocabulary learning in similar ways, as a tool, through artifact creation, and as a "technological" peer.

2.3.3. Mobile-assisted reading development. Unlike vocabulary learning, the use of mobile technology for mediating the reading abilities of L2 learners is markedly limited (Lan, Sung, & Chang, 2007). Since many types of portable devices have small screen sizes, L2 learners have typically preferred reading on paper-based or other traditional formats (Huang & Lin, 2011), which may be why reading has not been a focus for mobile language learning. Research topics on L2 reading with mobile devices have included adaptive formats for vocabulary learning (Fisher et al, 2012; Hsu, Hwang, & Chang, 2012), collaborative reading (Lan, Sung, & Chang, 2007; Murphy, Bollen, & Langdon, 2012) and peer scaffolding (Chang, Lan, Chang, & Sung, 2012). Although most of these studies have made use of the mobile display of reading materials and other networked or customized mobile reading applications that have little in common with the capabilities of the Smartpen, mobile reading has been the only facet of language learning where digital pen technology has in fact been tested. One focal study with relevance to the current work is discussed in detail below.

Dissimilar to previous research on L2 reading with mobile devices, the focus of Chen, Tan, and Lo's (2013) work was not on reading strategy instruction or reading comprehension but rather on oral reading fluency, which qualifies more as a speaking than reading skill. They explored the ability of Qu-voice digital pens to facilitate oral reading fluency for young Taiwanese English learners through the recording feature of the pen which enabled pronunciation practices and pronunciation review. Learners used their digital pens to listen to oral reading demonstrations of textbook excerpts, and then imitated the sample pronunciations multiple times before attempting their own recording of the reading passage with their pens. Students replayed their oral recordings and

corrected their errors before sharing them with peers on an online course management system. Results from this study indicated that students who participated in the repeated reading strategy with the digital pen achieved greater oral fluency of the reading texts than those who did not. In essence, students benefited from the scaffolding of listening to and imitating an expert reader enabled through the mobile device.

Like other artifact-based vocabulary studies, the recording and replay features of the digital pen allowed for the creation of audio artifacts that could be used for self-regulated learning. Learners in the study self-monitored their audio recordings for accuracy and exercised agency over their progress in oral fluency by controlling the number of times that they reviewed and rehearsed the reading text before creating their own recording. Moreover, once created, the recording functioned as an artifact not only for their personal reflection and improvement, but also for the cooperative generation of knowledge. An important drawback of this study is its focus on mobile technology strictly within the bounds of the classroom, which to some extent undermines the entire premise of mobility and the mobile learning experience associated with mobile devices. Additionally, this use of digital pens can be seen as somewhat artificial in that the reading materials were entirely prescribed and teacher-selected, which raises questions about how digital pens may be more authentically employed for reading instruction when learners themselves create or select the reading content.

2.3.4. Mobile-assisted writing and grammar instruction. Studies focusing on the development of grammar and writing skills for L2 learners have been equally underrepresented areas of MALL research (Viberg & Grönlund, 2012). To date, no MALL study has exclusively examined writing development for L2 learners through

mobile devices, which is somewhat unsurprising given the predominance of mobile phone research and its usefulness as and oral/aural communicative device.

In a stand-alone investigation of mobile technology for grammar learning, Baleghizadeh and Oladrostam (2010) explored the potential of mobile phone recordings to mediate EFL students' oral grammatical fluency and knowledge about three primary grammatical categories through self-recording, self-monitoring, and self-correction of grammatical errors. In a process similar to Chen, Tan, and Lo's (2013) reading fluency study, students used the recording feature of mobile phones to create speech recordings of prescribed grammatical exercises which they later used to analyze and reflect upon their own errors. They also shared their recordings with others in the classroom where classmates helped to detect their errors and make corrections. Though the authors concluded that the students who completed mobile speech recordings produced higher grammatical accuracy post-test results than the control group, the defining source of the mediation is unclear. Namely, the gains in grammatical accuracy are non-specific and could be attributed to the act of creating audio artifacts, the metacognitive act of noticing, or the peer scaffolding activity, (i.e., mediational space) that was facilitated by the mobile tool. Like other studies on mobile devices for L2 learning, this study also limited the application of the mobile technology to the classroom setting in an experimental task, which does not inform issues of how mobile devices may enhance grammar learning in natural contexts for learning.

2.3.5. Mobile-assisted listening and speaking development. There is a growing interest in the integration of mobile devices for cultivating listening and speaking skills among ELs. Most of these efforts have focused on maximizing language learners'

exposure to listening input through audio resources that are either downloadable to or accessible through mobile devices. These include extended practice opportunities via audio books (Choi & Chen, 2008; Reinders & Cho, 2010), commercial textbook audio resources (Demouy & Kukulska-Hulme, 2010; Nah, White, & Sussex, 2008), podcasts (Abdous, Camarena, & Facer, 2009), and interactive mobile software systems with virtual or peer agents (Hwang, Wu, & Su, 2008; Hwang & Chen, 2013; Liu, 2009). The use of digital pen technology for promoting the speaking and listening development of L2 learners is markedly absent from the literature.

Studies on L2 learners' perceptions of engaging in supplemental practice with mobile devices show that students are generally positive about mobile listening and report that it helps them improve their language skills, particularly oral and aural skills, as well as vocabulary building (Abdous, Camarena, & Facer, 2009; Belanger, 2005; Facer, Abdous & Camarena, 2009). Other benefits associated with mobile listening is the elimination of spatial or temporal boundaries (i.e., being able to listen outside of class, time-shifting), the ability to access texts on demand in personalized ways, the student-centeredness of mobile platforms, and the potential for self-pacing (Demouy & Kukulska-Hulme, 2010; Nah, 2008; Oberg & Daniels, 2013).

Notably, Demouy and Kukulska-Hulme's (2010) documentation of students' experiences using iPods and mp3 players for additional listening and speaking practice demonstrated that while learners agreed that it was useful to practice listening skills with technology, they felt that these specific types of mobile devices did not support the level of listener control that they desired. Some students felt that traditional forms of computer-assisted listening (e.g., DVD-ROMS) were more sophisticated in allowing them to:

> Play snippets or longer extracts, pause, go back to a specific point in a recording, reveal the transcription, play a clip any number of times with or without the transcription, record themselves, re-record immediately, play back their recording, jump from one question to another easily. (p.10)

These same concerns were raised by participants in Thorton & Houser's (2005) work who found mobile phones inadequate for carefully listening to sounds and limited in their control functions. Thus, the precision and learner benefits afforded by highly-developed playback features and user-controls cannot be underestimated in listening and speaking training, and reflect the need for researching listening development through other forms of mobile technology that are not as limited in functionality as the mobile phone.

A body of empirical studies has provided some evidence on the outcomes of using mobile devices for improving learners' listening and speaking skills. Al-Jarf (2012) compared the aural and oral skill acquisition of EFL students who participated in a self-paced listening and speaking program accessible by mobile devices outside of class with students who did not have access to the self-study materials. She found post-test gains in student achievement across several measures: auditory discrimination, listening comprehension, oral expression, oral fluency and pronunciation for listeners who engaged in mobile listening. Moreover, these gains were related to the amount of time spent practicing with the mobile system, a result which is also supported by Hwang, Wu, and Su (2008) who found that learning achievement was a function of the frequency and duration of completing listening exercises with a PDA. These findings highlight the role of listener involvement in the success of mobile listening, as well as the benefits that

repetition, multiple exposures to listening input, and self-paced instruction can have for language learners.

Other studies have addressed the unique ability of mobile devices to provide collaborative and contextualized listening and speaking opportunities for L2 listeners (Hwang & Chen, 2013; Hwang, Wu, & Su, 2008). Unlike previous work on extending listening and speaking practice through commercial materials (Al-Jarf, 2012; Demouy & Kukulska-Hulme, 2010; Nah, 2008), Hwang and Chen (2013) explored the effects of culturally situated learning with an interactive mobile listening system comprised of self-generated and peer-based recordings. When comparing high school EFL learners who used the mobile system for learning vocabulary with those who did not, the authors found a significant relationship between the time spent listening to sample peer recordings and students' post-test scores on vocabulary and conversational activities, affirming the value of listening to peer models in a virtual mediational space. Additionally, the more students engaged in speaking activity, the greater their achievement whether or not they reviewed these recordings. This underscores the important role that speech plays in mediating L2 acquisition and the ability of mobile technology to foster both productive and receptive language use.

A separate line of research on L2 aural and oral development has shifted from listener training with prescribed linguistic content to classroom-based content captured in the form of audio podcasts broadcasted through mobile devices (e.g., mp3 players, iPod, and mobile phones). Podcasts have applications for all educational levels (Facer, Abdous, & Camarena; Hew, 2009) as a substitute or supplement for classroom instruction as well as for creative uses (McGarr, 2009). Insofar as L2 learning, podcasting has been heralded

for its ability to make course content accessible to students beyond the time and space of the classroom (Meng, 2005), enhance students' study skills in preparing for exams and clarifying classroom concepts (Evans, 2008; Facer, Abdous, Camarena, 2009), and extend opportunities for skill development through listening, speaking, and pronunciation practice via diverse and intercultural listening texts (Lee, 2009; Lomicka & Lord, 2011). Podcasts possess some distinguishing characteristics that make them especially suitable for L2 listening, namely the ability for learners to control the speed of audio playback, to listen repeatedly, to listen anytime and anywhere, and to choose the content they want to review (Heilesen, 2010; Rahimi & Katal, 2010). Recent work by Facer and Yen (2012) provides empirical support for the case of supplemental podcasting in language courses, noting that students' final course grades were positively related to their revision of podcasted course lectures. Thus, the ability of podcasts to transfer control to the learner and to transport classroom content beyond the physical classroom space is key to L2 receptive language development, yet these learning benefits have been solely associated with teacher-created podcasts of classroom instruction (Hew, 2009).

The application of student-created podcasts has been most frequently applied to L2 oral pronunciation research. Studies on the effects of students recording their own audio podcasts for improving pronunciation abilities have been limited to foreign language contexts (Ducate & Lomicka, 2009; Lord, 2008) and have yielded somewhat mixed results as per their effectiveness in improving scores on comprehensibility and pronunciation Student-reported benefits from using podcasting as a technique for pronunciation training include the ability to listen and imitate model speakers and to hear other models of speech before recording their own (Ducate & Lomicka, 2009). The

advantages of using mobile devices for performing audio exercises has also been demonstrated by Gromik's (2012) case study on EFL students' weekly creation of video monologues, in which learners' word count per monologue was increased through regular speaking practice. In this work, mobile phone recording allowed learners to become both producers and evaluators of their own speech, enjoy extended preparation time for audio practice, solicit peer feedback on their recordings, and engage in multiple attempts and revision of their speech recordings. Despite the inconclusive evidence on the tangible linguistic outcomes of using mobile devices for enhancing oral performance, these studies indicate that the process of recording, reviewing, and improving speech afforded by mobile technology is in itself helpful for L2 learners.

2.4. Mobile Assisted Content Learning for ELs

The majority of research on MALL has concentrated on the assistive power of mobile devices for the single purpose of language learning in terms of the development of isolated language skills. The studies reviewed in the above sections illustrate the range of ways that mobile devices have been utilized to facilitate language instruction and learning for vocabulary, reading, speaking, listening, and grammar. Currently, the use of mobile technology to help L2 learners learn both language skills and the content of academic subject areas has been marginal at best. In this section I provide an account of the literature on the topic of mobile technology use for acquiring content from subject area courses, specifically science instruction. By doing so, the current gap in knowledge surrounding the use of mobile devices for content-area instruction is made apparent.

2.4.1. Science instruction. Mobile device use for enriching the learning experience of L2 learners within different academic disciplines common to schools is a

new line of inquiry and has been limited to science instruction. A few studies have taken into consideration the dual positioning of ELs as both learners of language and of academic content and explored ways that mobile devices may provide supplemental, content-specific linguistic support for science courses. A recent investigation by Cruz (2012) examined high school teacher and ELs' perceptions of learning biology vocabulary with an extracurricular iPod application designed to extend practice opportunities with key terminology. Her findings presented overall mixed impressions about the usefulness of the mobile game for enhancing out of school vocabulary study habits from both student and teacher vantages. Many ELs felt that using the application made learning the academic content vocabulary easier and enjoyable, helped them review for tests, and provided repetition that assisted them in memorizing key terms. More negative feedback included boredom and time constraints imposed by the game. In short, both students and teachers expressed difficulty adapting to the use of iPods for educational purposes, which has been a concern raised in several mobile learning studies (Stockwell, 2007; 2010) where the mobile device also serves personal purposes.

A second group of studies piloted the use of mobile devices for building conceptual background knowledge and academic vocabulary for elementary ELs in science classes (Billings & Mathison, 2012; Levitan, Mathison & Billings, 2010). These studies aimed to broaden learners' exposure to key vocabulary terms and schemata prior to formal instruction through audio podcasts in both English and the students' native language Spanish. In the latter work, Billings and Mathison (2012) noted improvement in the academic performance of ELs who learned with the podcasts, underscoring the benefits that mobile devices may offer in providing first language support for L2 learners

in academic settings. In their earlier study, although it did not produce statistically significant results, students reported feeling more prepared for daily instruction and better able to anticipate the lesson content as a result of listening to the advanced organizer podcasts.

Together these investigations constitute an important first step in generating understandings about how mobile devices may support ELs in learning subject area content, but much terrain remains to be explored. A limitation of the abovementioned works on science learning is their focus on the learner as the receiver rather than the architect of learning, meaning that the learners in these studies were powerless to create new learning opportunities with their mobile devices; they could only interact with or review the materials already provided. Noteworthy as well is the fact that the content of these vocabulary-building exercises was entirely determined by the instructors and researchers, which does not inform the question of how mobile devices may impact language and subject area learning when learners themselves take control of the content they can access with the technology. Finally, since learners in these studies could only use their mobile devices for studying science, questions remain as per how mobile devices may permit seamless learning across other subject areas common in mainstream educational settings.

2.5. MALL and Individual Learner Characteristics

The intersection of how individual learner characteristics relate to the use of mobile devices for L2 learning has been identified as an area that requires more research in MALL (Viberg & Grönlund, 2012). Learner characteristics are classified here as affective, cognitive, and metacognitive (Horwitz, 2008). *Affective factors* involve

learners' emotions and motivations toward L2 learning. They encompass perceptions about their ability to perform in a given learning situation (Bandura, 1994), as well as anxiety and motivation. In L2 learning, anxiety can be associated with a specific anxiety-provoking stimulus or state, such as tests (e.g., *test anxiety*), or with the exercise of a particular language skill (e.g., *speaking anxiety*, *listening anxiety)* (Horwitz, 2001). Both anxiety and motivation have been extensively studied in the field of SLA. In particular, motivation for L2 learning has been described using the framework of Self-Determination Theory (SDT) that defines a continuum of intrinsic and extrinsic motivators of behavior to explain how volition is affected by various social and cultural factors (Deci & Ryan, 2010). Next, *cognitive factors* relate to different ways L2 learners process information (e.g., aptitude, learning styles), while *metacognitive factors*(e.g., beliefs, strategies) consider the ways L2 learners think about and regulate their own learning (Horwitz, 2008). For L2 learners, these individual factors are known contributors to the successful mastery of L2 (Dörnyei, 2005) and may influence their behavioral patterns in terms of how they choose to utilize mobile devices to support their L2 learning, what they find useful about mobile devices, and specifically how they capitalize on the unique affordances for L2 learning that mobile devices make available for them (Ducate & Lomicka, 2013).

2.5.1. Affective benefits of MALL. Mobile technology presents several affective advantages for L2 learners relating to motivation. Some scholars propose that the high affective value of mobile learning can be attributed to "factors such as control over goals, ownership, fun, communication, learning-in-context, and continuity between contexts" (Jones, Isroff, & Scanlon, 2007, as cited in Sharples et al., 2009, p. 9). Many studies on

the use of mobile technologies for L2 learning provide evidence that learning with mobile devices is interesting, enjoyable, satisfying, and motivating for learners (Chen et al., 2013; Gromik, 2012; Lan, Sung, & Chang, 2007; Lui & Chui, 2010; Norbrook & Scott, 2003; Sandberg et al., 2011; Tan & Liu, 2004) and benefits them in many ways, by increasing the amount of time spent on learning tasks (Hwang & Chen, 2013), fostering self-regulated learning (Kondo, Ishikawa, Smith, Sakamoto, Shimomura, & Wada, 2012), and promoting high quality classwork (Swan, et al., 2005). In particular mobile gaming formats have been associated with increases in L2 learner motivation as compared to traditional teaching methods (Kondo et al. 2012; Lui & Chui, 2010; Sandberg et al., 2011). However, precisely what makes mobile learning motivating for L2 learners is uncertain. Some scholars believe that it may be a function of the novelty associated with technology (i.e., "the wow effect," Sharples et al., 2009). Ushioda (2013) cautions that motivational research has yet to demonstrate the capacity of mobile devices to produce sustained engagement in L2 learning, a concern substantiated by Kondo et al.'s (2012) work where ELs had a significant drop-off in their participation in use of a mobile game for L2 learning across academic semesters. Hence, while it is clear that mobile devices can help motivate L2 learners to learn a language initially, it is uncertain whether they provide any long-term motivational benefits.

Moreover, mobile devices offer several freedoms to L2 learners that lower the affective filter (Krashen, 1982) and make L2 learning a more comfortable and less stressful process. For example, mobile technology provides L2 learners' a sense of physical privacy in practicing their language skills in self-determined locations away from peers, which is shown to build their confidence especially in listening and speaking

skills (Gromik, 2012; Lan et al., 2007; MALL Research Report, 2009). Learning with mobile devices also helps L2 learners feel less nervous about using their L2 with live interlocutors because they can safely rehearse interactions at their own pace, thereby preparing themselves for authentic contexts of language use (Chen et al., 2012; Lui & Chui, 2010). The comfort and distance afforded by mobile learning environments also helps reticent and less proficient L2 learners feel more at ease in collaborating with peers and asking for instructor assistance when needed without fear of peer scrutiny (Lan et al., 2007). Finally, the flexibility of mobile devices allows L2 learners to author their own ideal learning environments, configuring the time and place of learning most conducive for them. This feature of mobile technology is known to reduce L2 learners' anxiety and improve their performance in the target language (Kessler, 2010) which is consistent with other literature supporting the ability of technology to lower the affective filter for L2 learners (Beauvois, 1997; Bradley & Lomicka, 2000; Poza, 2005; Zhao, 2005).

2.5.2. Cognitive and metacognitive benefits of MALL. MALL studies on the cognitive benefits of mobile technology for L2 learning are scarce, which reflects the general understanding that cognitive variables are fixed aspects of a learner that are difficult to modify (Riding, Glass, & Douglas, 1993). In contrast, mobile devices are considered flexible tools for learning that *can* be adapted to accommodate the needs of individual L2 learners (Chen & Chung, 2008) and personalized to suit their cognitive learning styles. Research gauging the learning benefits of digital pen technology (Chen et al., 2012) for field-dependent (perceiving the whole in relation to parts) and field-independent (perceiving parts in relation to whole) ELs noted no difference between the two experimental groups in terms of their learning gains in oral reading fluency

regardless of their cognitive orientations. This finding underscores the distinct quality of mobile devices to individualize instruction when learners can independently control their use. Another line of research on cognitive learning styles (i.e., verbal, visual) and mobile vocabulary instruction for ELs supports the notion that the presentational mode of content (i.e., textual, pictorial) must be differentiated according to the L2 learners' proficiency level and learning style for the most effective learning outcomes (Chen, Chang, & Yen, 2012; Chen, Hsieh, and Kinshuk, 2008). Together these studies underscore the potential of mobile technology to transcend the boundaries of cognitive differences by providing a customizable L2 learning experience.

Mobile devices also help L2 learners become active participants in their language learning process by presenting them with opportunities to deepen their knowledge of metacognitive strategies and monitor their personal language use. One line of inquiry has examined mobile podcasting as a tool for increasing L2 listeners' awareness of metacognitive strategies to organize and evaluate own academic listening skills (Rahimi & Katal, 2012; Weinberg, Knoerr, Vandergrift, 2011). However, as Rahimi and Katal (2012) found, this use of podcasting for L2 learning may be contingent upon a threshold level of initial metacognitive strategy use on behalf of the learner, and thus most effective for L2 learners of higher language proficiency (Oxford, 2002). Other studies have highlighted the ability of podcasts to enhance L2 learners' consciousness of their pronunciation skills and phonological abilities by allowing them to hear themselves (Ducate & Lomicka, 2009; Lord, 2008), or what is known in SLA as noticing (Schmidt & Frota, 1986).

Kukulska-Hulme (2009) further emphasizes the unique ability of mobile devices to promote L2 learners' noticing of linguistic input across a variety of settings through their mobility and recording functionality. She proposes the use of language learning diaries as a type of digital artifact where L2 learners can reflect on authentic features and uses of the language that they have observed as well as record any thoughts, feelings, attitudes, and knowledge relating to their individual learning processes. This use of digital diaries is consistent with Oxford and Chamot's (1990) social and affective strategies for L2 learning. The reflective value for L2 learners of documenting and archiving their learning experiences through mobile devices has been further explored in relation to blogging about cultural encounters (Comas-Quinn et al., 2009), situated vocabulary use (Wong & Looi, 2010), and individualized feedback on speaking and listening development (Hsu, Wang, & Comac, 2008). In sum, mobile devices are potential avenues for the metacognitive growth of L2 learners as mechanisms of strategy instruction and creators of reflective spaces.

2.6. Summary

Although mobile technology has been applied to various academic disciplines, its relationship to language learning (MALL) is particularly well-documented in the literature as it relates to the acquisition of isolated language skills (e.g., vocabulary, grammar, etc.). While language acquisition and use cannot necessarily be simplified into the development of these individual skills, this distinction is helpful in understanding the specific benefits of language learning with technology that mobile devices may embark. The use of mobile devices such as iPods and Mp3 players for improving L2 learners' listening skills through self-paced listening training and supplemental podcasts is widely

recognized; however the usefulness of mobile devices for speaker training remains inconclusive. Together these studies offer rich descriptions of the many applications of mobile technology for L2 learning, but are limited in their scope of mobile technology as applied only to the formal classroom learning experience, teacher-directed activities, and results based on primarily experimental designs. More research with a process versus product orientation is needed in this area to expand the literature on how students volitionally use and appropriate mobile devices for their L2 learning needs across educational contexts (formal and informal).

Recently, a new line of inquiry examining how L2 learners can learn the content of academic courses through the use of mobile devices has surfaced in consideration of ELs who learn *through* a language in addition to learning *about* a language. Focusing on science instruction, a few studies have used iPods as a delivery device for supplemental vocabulary content with limited success and some resistance from students and teachers. Among lessons from this research is the potential of mobile devices to support L2 learners through access to materials in their L1. As an emergent facet of mobile technology research, more studies are needed that address other content area disciplines represented in schools.

As evident from the MALL literature cited above, most research on mobile devices for learning has made use of mobile phones and PDAs, with a more recent shift to multimedia players such as IPods and Mp3 players. Few studies have addressed the possibility of the Smartpen device as a tool for supporting L2 learners. While some preliminary research suggests that the Smartpen may facilitate comprehension, pronunciation, and writing skills for L2 learners, and potentially assist in their retention

of learning, these results pertain to adult learners who used the technology for short periods of time. Thus, there is a need to extend the research on the Smartpen to younger L2 populations and examine the effectiveness of this specific device over time for L2 learning.

Finally, understanding the relationship between individual learner characteristics and learning with mobile devices is a dimension requiring more attention in MALL research. The literature on the affective, cognitive, and metacognitive benefits of L2 learning with mobile technology suggests that mobile devices positively impact the learning experience; however none of this research involves the focal device in this study. Therefore more research is necessary to explore if and how the Smartpen provides similar benefits for L2 learners in terms of motivation, enjoyment, reflective learning, customization, and a reduced affective filter.

In summary, to collectively address these shortcomings in the interdisciplinary research of MALL I proposed a qualitative research study seeking to better understand how a group of young ELs use the Smartpen tool for learning both language skills and course content within and across school and home settings. A secondary goal of the study is to gain an understanding of the benefits associated with using the device for learning purposes from the student perspective as they relate to individual learner characteristics. The following chapter will include a description of the research design used to study this line of inquiry.

2.7. Theoretical Framework: Vygotskian Sociocultural Theory

Sociocultural theory constitutes the theoretical foundation of this study. This section provides an overview of the theoretical framework of Vygotskian sociocultural

theory (SCT) and describes its usefulness for the current project. I begin by providing a general description of SCT which includes a discussion of Vygotsky's views on learning and the mediated mind and continues on to detail the central threads of SCT: internalization, regulation, and the zone of proximal development (ZPD). Afterward, I discuss some special considerations regarding how SCT relates to L2 learning and then offer a rationale as to why SCT is applicable to research on mobile learning. I conclude by explaining how I will draw from its concepts and apply them as the theoretical lens for interpreting L2 learners' use of the Smartpen device.

2.7.1. Overview of SCT.

Mediation. The cornerstone of Vygotskian SCT is the notion of the mediated mind, or the belief that all higher mental capacities (e.g., attention, memory, logical thought, planning, problem-solving), foremost learning, are mediated by culturally constructed physical and psychological tools (Lantolf, 2000). According to this view, humans learn through the use of various material and symbolic tools that they use to interact with their world and which harbor the potential to profoundly change the nature of these interactions, or transform their learning experience in new and previously impossible ways.

In his original writings, Vygotsky (1978) specified two primary forms of mediation: physical and psychological tools. Physical tools are essentially concrete tools that "allow us to change the world in ways that the simple use of our bodies does not" (Lantolf & Thorne, 2006, p. 199), while psychological tools are signs that are symbolic or semiotic in nature and include language and other cultural artifacts. Hence, the orientation of physical *tools* is external, while that of psychological tools (*signs*) is

internal whereby the learner attempts to master his/her environment and oneself respectively. In this sense all learning is an inherently social phenomenon, occurring first on the external social plane (intermental) and then on the inner psychological plane (intramental) (Cole & Wertsch, 1996), always mediated by speech either social or private (Polat & Schallert, 2013).

Importantly, by virtue of their existence tools do not have the power to shape or mediate learning experiences, but instead depend on the learner to act upon them (Swain, Kinnear, Steinman, 2010) in meaningful ways. Therefore, mediated learning is an active process of knowledge-construction and personal meaning-making by which learners organize cognition through "the mastery of symbolic mediators, their appropriation and internalization in the form of inner psychological tools" (Kozulin, 2003, p.24).

Internalization, regulation, and ZPD. Studying learning in SCT means understanding internalization, or "the process through which cultural artifacts, such as language, take on a psychological function" for learners over time (Lantolf & Thorne, 2006, p. 203). For Vygotsky (1987) this process of internalization is required for all content learning and specifically the development of what he termed scientific concepts, or the concepts formally introduced by teachers in school through explicit instruction (Daniels, 2008). Scientific concepts are those that require higher-order thinking, unlike spontaneous or everyday concepts that can be acquired through learners' personal experiences without much cognitive skill. Although spontaneous concepts constitute the building blocks for the development of higher-order scientific concepts (Wells, 1994) and thus play a formational role in learners' ability to internalize knowledge, mediated learning is most often at work in formal educational settings like schools.

An important goal for all learners by Vygotskian standards is self-regulation or "the ability to accomplish activities with minimal or no external support" (Lantolf & Thorne, 2006, p.200). The idea of using concrete and symbolic tools for learning is for learners to mature to the point where outward mediators are no longer necessary and cognition can be inwardly regulated. Mediation is divided into three stages characterized by the learner's level of dependence on the mediator—object, other, and self—with the extremes being a learner's thinking subordinated to the use of an object or entirely self-controlled. The intermediary state of other regulation is well known in SCT as the zone of proximal development (ZPD), and explains a mediational space or activity in which an "other" with more experience (expert or peer) bridges the gap between a learner's actual and potential developmental level through scaffolding, guidance, and collaboration (Vygotsky, 1978). The learning or meaning-making that occurs through social interaction with others within the ZPD reflects the *co-construction of knowledge* that occurs through collaborative discourse and activities (Hull & Saxon, 2009).Co-constructed knowledge differs from self-constructed knowledge in that it is socially-mediated by "others" rather than just the "self." As knowledge and meanings are shared within the ZPD, understanding is negotiated between the actors through speech, which is often referred to as *negotiated interaction*, or *negotiated meaning-making* (Vygotsky, 1986). Provided that language is used to initiate questioning, clarification, disagreement, confirmation, and comprehension checks, negotiated interactions have been seen as an important pathway for L2 learning (i.e., the Interaction Hypothesis, see Pica, 1994).

SCT and L2 learning. Studying mediated learning for L2 learners is an additionally complex and multi-layered process due to the concurrent positioning of

language as both a scientific concept and mediational tool. For L2 learners in English-dominant contexts, language is a scientific concept that they must learn and internalize (e.g., syntax of language, lexicon, etc.), while it is also the medium through which they learn other scientific concepts presented in their academic courses (e.g., math, science, etc.). Thus, language functions as a key tool for L2 learners to gain access to the content of the curriculum and to members of the target culture through social interaction.

L2 learning is an innately mediated process that involves many mediational mechanisms, the most important of which is the L1 (Lantolf, 2000). Language is the most powerful and pervasive semiotic tool for L2 learners that enables them to engage in self-mediation through the use of the L1 in the form of self-directed or private speech (Daniels, 2005). This power to self-mediate allows L2 learners access to necessary cognitive tools that have been developed in the L1, despite not having fully mastered the L2 or in the absence of other mediators. It affords them a level of agency that contributes to their classroom-based learning of both language and academic content, adding to the richness of studying mediational tool use when language is included in the repertoire of tools.

SCT is also a robust framework for addressing issues of educational practice for linguistic and cultural minorities (Moll, 1992), recognizing that L2 learning is a matter of developing competence in its mechanics as well as its culturally-based uses. Since L2 learners straddle L1 and L2 environments between their home and school communities, they have access to a wide range of mediational tools for learning that are not available to all learners. However, these tools and artifacts are not neutral, but rather retain meanings that are culturally-constructed (Cole, 1995) and that reflect the values and ways of

knowing of the culture to which they belong. Thus, L2 learners' use of mediational tools can be restricted by standards of cultural appropriateness and beliefs about what constitutes valuable "funds of knowledge" (González, Andrade, Civil, & Moll, 2001) drawn from their native or target cultures.

Operating on the Vygotskian assumption that affect and cognition are inseparable components of consciousness (Mahn & John-Steiner, 2002; Swain, 2011), learners' ability to construct knowledge is mediated by their emotional states (Imai, 2010). This is especially true for L2 learners, who can experience an array of emotions associated with learning and operating in a language and cultural milieu not their own (e.g., anxiety, fear; see MacIntyre & Gregerson, 2012). Providing tools for them to work out their emotions and regulate their affective states in reflective ways is prerequisite for establishing the conditions for their cognitive learning. Mahn & John-Steiner (2002) discuss some types of tools that may be helpful as mediational spaces in which L2 learners can negotiate their emotions (e.g., dialogue journals) in ways that allow them to be more cognitively receptive or classroom-ready. Therefore, affect is an important consideration for understanding the cognitive development and a mediating factor in concept formation for ELs.

2.7.2. Applications of SCT.

To mobile learning. Mobile devices are one of many ways that learning can be mediated through the unique affordances and sociocultural opportunities that they provide for learners (Comas-Quinn, 2009; Pachler, Cook, & Bradley, 2009). However, the rapid evolution and changing nature of mobile devices foregrounds the need for studying their educational applications from a process-versus product-based perspective,

maintaining on the forefront the question of *how* they support learning rather than *what* products of learning result from their use. Knowing that the devices in current use will soon be replaced by others calls for a focus not on the features of the device per say, but rather on understanding the latent mechanisms of learning with and through those features that may have some bearing on the educational use of future mobile devices.

This is where I believe that Vygotskian SCT and the method of genetic analysis can make an invaluable contribution to understanding the dialectical interplay between the development of students' higher-order thinking (i.e., learning) and mobile device use as it is historically situated along a continuum with development. Using the genetic method means studying learning as a glimpse of cognitive change or transformation in progress, rather than as a static end product (John-Steiner & Mahn, 1996). This method is especially relevant for studies that involve children, such as the one proposed, since Vygotsky himself believed them to be the ideal group for examining the dynamic formation of the mind as they grappled to gain control over the mediational means of their communities (Lantolf, 2006). In particular, focusing on the microgenesis of learning, or taking a short-term longitudinal approach to studying mobile technology integration for young L2 learners is necessary, as Pachler (2009) noted the complexity of conducting long-term longitudinal studies of mobile technology for ELs.

Further, the hallmark ability of mobile devices to be transported between formal and informal learning contexts (Looi et.al, 2009; Sharples, Taylor, & Vavoula, 2005) requires a theoretical framework that can account for their educational uses across multiple environs (e.g., home, school, etc.). In SCT, the formation of spontaneous and scientific concepts is interconnected and interdependent, with the former associated with

informal and the latter with formal contexts of learning. Therefore, SCT as an interpretive lens can illuminate how L2 learners use mobile technology to bridge their L1 and L2 learning environments by using mobile devices to capture and transport useful cultural and linguistic resources among home and school settings.

To the current study. Adopting a Vygotskian theoretical perspective allows me as the researcher to trace the socioculturally-situated processes associated with mobile tool mediation to reveal the myriad of ways that learners individually and collectively act upon their Smartpen tool and appropriate it for their cognitive needs.

In the present study, the Smartpen is considered a physical tool for the ELs that can potentially mediate their interactions within their multiple learning environments (i.e., formal and informal; school, home, etc.). This means exploring ways in which the ELs use the Smartpen to extend their own natural endowments within classrooms and take control of their learning to accomplish tasks they could not accomplish without the assistance of the device. Beyond its function as a physical tool, the Smartpen device can also be used to create symbolic artifacts or signs that may have a special significance for the learner and help them gain control over their psychological processes (e.g., planning, memory). This entails understanding the types of artifacts they create and what they use them to do or accomplish with respect to both L2 learning and acquiring the content of academic courses (i.e., scientific concepts: math, science, social studies).

Given the dual purpose of language for ELs, understanding Smartpen mediation will further require exploring ways in which learners make use of their Smartpen to facilitate the use of private and social speech both as a cognitive tool for acquiring scientific concepts and as a means of rehearsing, imitating, appropriating, and mastering

different aspects of English (Lantolf & Pavlenko, 1995). Similarly, it will involve examining how the Smartpen can enhance learners' awareness of their personal language use (L1 or L2) as a tool for learning the scientific concepts represented in their academic classes. In other words, the Smartpen may extend ELs' consciousness of their use of private speech by allowing it to surface from the psychological to the social plane. It may also allow them to capture others' language use and appropriate it for their own learning purposes through the device's recording and playback features.

As with all physical and psychological tools, the end goal of tool mediation is for learners to progressively become more self-regulated and less object-regulated in their thinking. In the context of this study, regulation as a concept will be helpful in observing any dynamics in ELs' behavior or dependence on the Smartpen as a physical tool or its products as psychological tools throughout the course of the study. For example, ELs may initially require the Smartpen to accomplish certain learning tasks or to create artifacts for their learning in the beginning of the study that they are later able to execute without the use of the Smartpen, indicating their cognitive growth in becoming less tool-regulated. Patterns of students' use of the Smartpen may also reflect changes in their reliance on the Smartpen for their learning, which will be reflected in both their user logs and through classroom observations. Finally, understanding how ELs' exercise agency in their decision-making and planning about using the Smartpen to reach their learning goals will provide additional insight into how they conceive of the device as integral or accessory to their learning experience.

Given the continuum of regulation proposed by Vygotsky, it is necessary not only to explore the extremes of object and self-regulation, but also to consider the

intermediary state of other regulation which occurs in the form of the ZPD. As applied to the present study, this implies unraveling the ways in which the Smartpen device facilitates the creation of new mediational zones for ELs with expert adults as well as peers, and how these mobile-mediated zones may differ from traditional ZPDs. Moreover, recently expanded notions of the ZPD have broadened what can be considered "expert" from animate to inanimate mediators (Swain, Kinnear, & Steinman, 2009) presenting the possibility of investigating the Smartpen not only as a mediator in the sense of a physical tool, but also as a learning partner in the ZPD.

The final strand of SCT that I draw from in this work relates to conceptualizing the Smartpen as a tool for affective mediation. From a Vygostkian standpoint, this entails exposing ways that the ELs use the device to engage in "emotional learning," or the process of learning how to regulate their emotions. Affective mediation can occur through their creation of new mediational spaces that host their emotional "work," or other artifacts that are used to shape their experience as learners with emotional needs. In this case the Smartpen may take the form of a diary or dialogue journal where ELs express emotional states or attempt to process or manage personal or social situations. Similarly, ELs may recount enhanced emotional states (i.e., at ease, more confident, etc.) or feelings of classroom-readiness that are tied to the use of the device for this purpose.

Chapter III

Research Methods

3.1. Overview of Research Framework

In this chapter, I first provide a description of the Echo Smartpen tool focused on in this study, and then detail the research methodology that aided me in addressing the global issue of how mobile learning devices can be used by second language learners in their quest to learn language and content within mainstream US classrooms. This section includes specifics on the participants, setting, data collection procedures and instruments, and data analysis techniques.

In particular, I discuss how a qualitative case study design with the application of methods from the tradition of ethnography assisted me in better understanding and interpreting the students' use of the Smartpen over eight months.

3.2. Case Study Design

Using an ethnographic case study design within an interpretivist framework afforded several research benefits for which it was selected for this investigation, namely the close collaboration that it permits between the researcher and the participants. Taking an emic perspective also allowed the participants' views of reality and stories to act as a window for the researcher to assist in making sense of their actions (Crabtree & Miller, 1999; Robottom & Hart, 1993, Willis, 2007). Although there are many genres of case studies, I specifically approached this group of 5th grade middle school English learners (ELs) as an instrumental case study (Stake, 1995). Such studies are recognized for facilitating an understanding of, and providing insight into, larger issues as supported by the cases analyzed. This was appropriate for this research endeavor, as I sought to both

understand the "bounded system" of this specific classroom of 5th grade ELs, as well as how they could be more globally representative of other middle school ELs across the country, focusing on the issue of their Smartpen technology use for learning language and instructional content.

For the purpose of this research, the case was bound by time and place, including only those 5th grade ELs located within this particular charter school setting for a period of eight months (Creswell, 2003). Having the study "bounded" in duration allowed me to account for any novelty the device may have for the learners at the beginning of the study as well as any initial learning curve for operating the technology itself. Likewise, this length of time allowed me to observe the students' Smartpen use in a variety of classroom types throughout a significant portion of the school year, including their Smartpen use over school holidays.

Employing a case study methodology was also relevant because of its robustness in using multiple data sources, which served several functions, including enhancing data creditability (Yin, 2003), by allowing for data triangulation between participants and across the data sources themselves. Taking each source as a piece of the puzzle, a more complete understanding of the whole phenomenon of mobile technology use in ELs could be achieved (Baxter & Jack, 2006). Indeed, case studies are also known for potentially allowing the researcher to become a participant observer, which facilitated my access to a more in-depth exploration of richer data (Meyer, 2001).

3.2.1. Classroom ethnography. In studying this case of Smartpen use for middle school ELs, I employed methods from classroom ethnography (Hammersley, 1990; Watson-Gegeo, 1997). While ethnography has been traditionally used in second language

research with ELs as a holistic way of gaining perspective about sociocultural processes in language learning, and the impact of institutional and societal pressures on the language classroom or on L2 learners (Duff, 2008; Watson-Gegeo, 1988), it is especially suited for studies pertaining to the mobile technology use of L2 learners for the reasons discussed below.

Studying the use of mobile technology presents several methodological challenges related to blurring the distinction between formal and informal learning environments, with its very mobility complicating researchers' ability to directly observe the device's use beyond the formal classroom space. In their piece on leveraging a research methodology for mobile technology, Looi et. al (2009) propose ethnographic methods as the recommended approach for studying seamless learning experiences offered through mobile technology such as the Smartpen.

Thus, although this study did not explicitly focus on the classroom "culture," in the sense of conventional ethnography, it attempted to describe the students' Smartpen use as situated within the larger classroom culture, exploring it as a possible underlying factor in shaping the ELs' use of the device. As the vast majority of my naturalistic observation occurred within the confines of the content area classrooms, I positioned the classroom as the primary site of field work. Among the ethnographic methods that I used to develop this study was my extensive contact with the mainstream classroom, direct classroom observation and field note documentation, participant-observation, artifact collection, and a focus on language use.

3.2.2. An ethnographic approach. An important distinction in ethnographic research is between ethnographic and quasi-ethnographic studies, which is essentially a

matter of time spent in the field. In this study, I utilized a quasi-ethnographic design (Murtagh, 2007), referring to the frequency of fieldwork site visits and overall length of the study. Specifically, the course of this study occurred over an 8 month period with intermittent on-site visits as permitted by the school's, teachers', and researcher's schedules.

3.3. The Smartpen Tool

The Echo Smartpen is a digitalized pen that has a built in microphone and a speaker that allows note-takers to record audio content while taking handwritten notes on special electronic dot paper (Livescribe, 2009). It synchronizes the audio content recorded with the pen with any handwritten notes on the digital paper, and then stores this data for later review. The playback buttons available at the bottom of each digital notebook page allow the student to tap on any written word, phrase, or image and return to the exact moment of instruction that was occurring when the note was made. Students can control the playback speed of their recordings and have pause, rewind, and fast-forward tools on the notebook's toolbar (Figure 1). The recording and note-taking features of the pen can also be used independently so that the pen may function as an audio recorder or traditional writing instrument.

For this study all participants were provided with a Smartpen tool and digital notebook. None of them owned their own Smartpen, so to be consistent with Naismith and Corlett's (2006) criteria of ownership for successful mobile learning projects, students were given a Smartpen to use for eight months so that they could treat it as if it were their own.

Figure 1. The Echo Smartpen Device

3.3.1. Smartpen training. To address any issue of unfamiliarity with the mobile device, all students were initially trained for one hour regarding the basic functions of the Smartpen and how to take notes with the pen and digital paper, using the sample training materials provided by Livescribe®. This training was facilitated by me as the researcher in the company of the ESL specialist to ensure that all learners understood the instructions and could ask any clarifying questions relating to how they should operate the device.

All parents were also trained by the ESL specialist in a brief half-hour afterschool session on how to support their students' use of the Smartpen using video tutorials accessible on the Internet. The parents were further informed about potential benefits of the pen as a tool for independent learning.

As the researcher I was also available throughout observations, particularly during the first weeks of the use of the tool, to assist students with any technical aspects of the

Smartpen as needed and to ensure that trouble-shooting does not interfere with their ability to use the device.

3.4. Participants

The main participants in this study were 5th grade ELs educated in a mainstream classroom in a public charter school located in the North East United States. Students' ages ranged from 11-12 years. The total number of participants was 7, and all were female, due to restrictions on the quantity of technological devices available to the researcher and the constraints of the school's ESL program which could provide only 7 eligible ELs of middle school age (all others previously exited from ESL program based on proficiency scores). Since the participants varied in their level of English proficiency, a brief demographic sketch of each according to pseudonym has been provided in Table 1. A more in-depth discussion of their first language background, level of English proficiency, and socioeconomic factors also follows to help facilitate the later discussion of research findings.

Table 1

Student Demographic Information

Name	Age	Age of Arrival	First language	English Proficiency
Berna	11 years	N/A	Turkish	Level 5, Bridging
Dilara	11 years	4 years	Turkish	Level 4, Expanding
Bikem	11 years	5 years	Meskhetian Turkish	Level 3, Developing
Sabiha	12 years	3 years	Russian, Meskhetian Turkish	Level 4, Expanding
Sonay	12 years	4 years	Russian, Meskhetian Turkish	Level 3, Developing
Lalehan	11 years	4 years	Meskhetian Turkish	Level 3, Developing
Tanyeli	11 years	5 years	Meskhetian Turkish	Level 3, Developing

All participants, with the exception of Berna, were born abroad and immigrated to the United States in early childhood. Berna and Dilara were born to Turkish-speaking families and shared standard Turkish as their first language background. While both spoke only Turkish within the home, Dilara's family regularly traveled back to Turkey, whereas Berna had never been to Turkey before. Both girls' fathers were the owners of successful local and national businesses respectively and can be considered of upper-middle class status.

Like Dilara and Berna, some of the other participants shared some commonalities. For instance, Bikem and Tanyeli were cousins, as were Sabiha and Sonay. Lalehan was not related to any of the other participants. These girls differed from Dilara and Berna in their cultural origins and first language backgrounds. Bikem, Tanyeli, and Lalehan were all born in Uzbekistan, while Sabiha and Sonay were born in Russia. The families of Bikem, Tanyeli, Lalehan, Sabiha, and Sonay were all politically exiled to the United States from their home countries and spoke a variety of Turkish in the home recognized as Meskhetian Turkish. This form of Turkish differs from standard Turkish in several ways; one of the most obvious is that it has borrowed words from other languages such as Georgian, Kazakh, Kyrgyz, Russian, and Uzbek. "Many speakers of Meskhetian Turkish in the United States are multilingual, speaking their dialect of Turkish, Russian, and the language of the country in which they lived before moving" (Aydıngün, Harding, Hoover, Kuznetsov, & Swerdlow, 2006, p.24). This was true in the cases of Sabiha and Sonay who received some formal schooling in Russia prior to their relocation, making Russian their official first language, although they reported not remembering it and using only Meskhetian Turkish regularly within the home.

Unlike the speakers of standard Turkish, the speakers of Meskhetian Turkish were of more modest economic means. Most of these students' parents were employed in working class professions such as delivery personnel or workers in the food industry (e.g.; pizza shop). Their families were typically much larger in size, often including grandparents and extended family members, who did not have formal educational training as did the parents of Berna and Dilara who had been previously educated at the university level in Turkey. In all cases, the students' mothers did not work outside of the home and for the most part had very limited English proficiency.

Regarding the students' English language proficiency, all participants were tested following the state- mandated protocol. The World-Class Instructional Design and Assessment (WIDA) composite scores for each student were used to determine their instructional level of English. The six-point scale and corresponding performance descriptors extracted from the WIDA Consortium (2007) have been outlined in Table 3 below to illustrate the language that students at each level of proficiency should be able to process, understand, use, or produce.

Table 2

WIDA Proficiency Descriptors

6: Reaching	• specialized or technical language reflective of the content areas at grade level • a variety of sentence lengths of varying linguistic complexity in extended oral or written discourse as required by the specified grade level • oral or written communication in English comparable to proficient English peers
5: Bridging	• specialized or technical language of the content areas • a variety of sentence lengths of varying linguistic complexity in extended oral or written discourse, including stories, essays or reports • oral or written language approaching comparability to that of

	proficient English peers when presented with grade level material
4: Expanding	• specific and some technical language of the content areas • a variety of sentence lengths of varying linguistic complexity in oral discourse or multiple, related sentences or paragraphs • oral or written language with minimal phonological, syntactic or semantic errors that do not impede the overall meaning of the communication when presented with oral or written connected discourse with sensory, graphic or interactive support
3: Developing	• general and some specific language of the content areas • expanded sentences in oral interaction or written paragraphs • oral or written language with phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written, narrative or expository descriptions with sensory, graphic or interactive support
2: Beginning	• general language related to the content areas • phrases or short sentences • oral or written language with phonological, syntactic, or semantic errors that often impede the meaning of the communication when presented with one to multiple-step commands, directions, questions, or a series of statements with sensory, graphic or interactive support
1: Entering	• pictorial or graphic representation of the language of the content areas • words, phrases or chunks of language when presented with one-step • commands, directions, WH-, choice or yes/no questions, or statements with sensory, graphic or interactive support

It is important to note that although some students fell into the same WIDA category, there was often considerable variation in their exact scores, making some students who were classified as "developing," more or less advanced than others because their score bordered the former proficiency level. These nuances are indicated as necessary in the research findings section using the preceding terms "early" and "late" to further distinguish between participants' abilities.

In addition to the student participants, their 5th grade mainstream teacher and ESL program specialist were also invited to participate in the study as two important informants, being the individuals most closely associated with their education within the school setting. All other content-area teachers (e.g., foreign language teachers) were also asked to contribute their observations; however all declined the invitation. Finally, assuming the role of participant-observer (Glesne, 2006) throughout the study, the researcher was also considered a participant.

Due to the limited number of ELs in the region designated for this study, coupled with the need to examine their interaction with the mobile learning device within the context of an inclusive and content-based classroom, purposeful sampling (Patton, 1990) was employed.

3.5. Setting

The setting for this research was a small, public charter school located in North East US. The school educated approximately 200 students, 20% of whom are non-native speakers of English and actively enrolled in the ESL instructional support program. As charter schools are increasingly attracting enrollments from among ELs and minority groups (Lazarín & Ortiz-Licon, 2010), they have become important sites for investigating learning and instructional support for language learners.

A distinguishing feature of this particular charter school was its focus on providing language immersion for students in English, as well as two additional world languages. This detail is significant on two accounts. First, it reflects a certain school wide commitment to serving the needs of language learners, or an intrinsic value for language-learning. Next, it also implies that the ELs simultaneously receive language

instruction in English, as well as one, and even two second languages depending on the students' native language background.

Another recognizable quality of this school site, and one which highly contributed to its selection for this study, is its format for ESL instruction. This school implemented a push-in program model, referring to a type of ESL instruction where the ELs remain in the mainstream classroom along with their American peers and receive content instruction through English (e.g., learning Math concepts through English). The role of the ESL teacher or specialist in such programs is to work alongside the grade-level teacher within the mainstream setting to provide language learning support for the ELs on demand. Though push-in program models are gaining momentum in the U.S., as efforts to integrate L2 learners into mainstream education more quickly and fully have increased (Platt, Harper, & Mendoza, 2003), they are still somewhat rare in areas with few or newly emerging populations of ELs.

Hence, in light of the objectives of this study, to explore potential technological support for language learners placed in mainstream classes alongside native English-speakers, it was necessary to conduct the research within a school that embraced the notion of including ELs in the mainstream learning environment. This study would not otherwise have been possible in a school with an ESL pull-out program, which continues to be the most prevalent ESL program type across the nation (Honigsfeld, 2009).

3.6. Data Collection

In my inquiry into exploring the multiple and varied ways that the Smartpen supported ELs in the mediated learning of language and instructional content within schools, as well as any affective, cognitive, and metacognitive benefits the Smartpen

afforded for ELs in mainstream classrooms, I used multiple strategies and sources for data collection, compatible with the case study and ethnographic designs for qualitative research.

The data that was collected and analyzed has been grouped into three broad categories set forth by Hagen, Robertson, Kan, and Sadler (2005) in their taxonomy of data sources related to the study of mobile learning devices. These sources include participant and technologically mediated data, simulation and enactment data, and data generated by a combination of new and established methods such as interviews and focus groups. The data that formed the basis of this study has been classified accordingly into the aforementioned authors' taxonomy as depicted in Table 3. During the analysis phase of this study these sources were further divided into primary and secondary data sources.

Table 3

Classification of Data Sources

Category	Data Source
Mediated Data: Access to data about the actual use is mediated by both participant and technology.	
1. Digital notebook archives	ELs; 5th grade mainstream teacher; ESL specialist
2. Digital observation field notes	Researcher (Appendix B)
3. Emails	ESL specialist
4. Record sheet of Smartpen use	ELs (Appendix C)
Enactment Data: Data about existing or potential use is achieved through some form of pretending.	
1. Concurrent verbal report	ELs (Appendix D)
Combination Data: Complementary data is accessed through new or existing methodologies.	
1. Individual	5th grade mainstream teacher; ESL specialist; ELs

Interviews	(Appendices E & F)
2. Mini-Focus Group Interviews	ELs (Appendix G)
3. Learning artifacts	ELs

3.6.1. Student-based data sources. The 7 middle school ELs were positioned at the core of the study, thus the data collected from them constituted the majority of the data used for this project. This was in a direct effort to place the students' perspectives at the forefront of the investigation as the primary users and informants about the usefulness of the Smartpen in language learning and content areas, and as the most significant window for examining any learner-based benefits the Smartpen can offer for ELs in the mainstream instructional setting.

The most abundant source of data was a student-generated multimedia artifact in the form of digital notebook archives available for each participant. These archives were collected from each student indirectly through a transfer from their Smartpen devices, and contained a visual and audio recording of the notes taken with the Smartpen device as well as a log of their Smartpen use. Individual recordings of note-taking sessions were viewed by the researcher through the Livescribe Desktop application to obtain a better understanding of how the Smartpen was used by the students and for what purposes. A sample of a digital notebook page viewed with the Desktop software is presented in Figure 2.

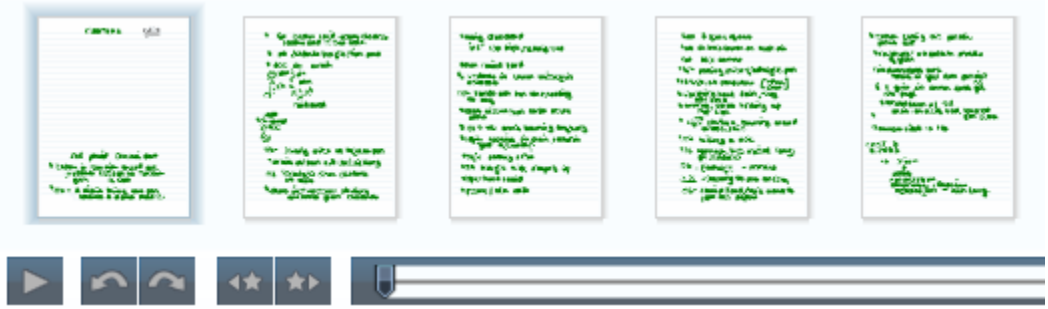


Figure 2. A Sample Smartpen Digital Notebook Archive

These digital artifacts were distinguished from the additional handwritten artifacts that were collected from the students in the form of drawings and small journal entries produced by the students that described and visually displayed the ways in which they used the Smartpen within and beyond the classroom space.

Students were also asked to describe their Smartpen use across various contexts for learning and any perceived affordances in at least three mini-focus group interviews (Casey & Krueger, 1994) of 3 to 4 students per session that were audio-recorded and later transcribed. Although one large focus group would have been preferable, the use of smaller focus groups was deemed necessary by the ESL specialist who later determined the composition of the focus groups based on peer group dynamics. The ESL specialist was present for the student focus group interviews as a resource for clarifying any misunderstandings the students could experience with the interview questions, but was not included as a participant in the interview.

As their academic schedules permitted, students were also invited to engage in individual interviews in the ESL specialist's office relating to their Smartpen use. Due to the variance in scheduling, some participants, such as Berna, Dilara, and Bikem were more frequently available to participant in individual interactions with the researcher than others like Sonay, Sabiha, Lalehan, and Tanyeli. All interviews adhered to a semi-

structured protocol in order to allow for the flexibility of follow-up questioning and to give room for a student-directed discussion (Drever, 1995). Descriptive field notes capturing the information from these interview sessions were taken by the researcher.

A concurrent verbal reporting task (Bowles, 2010) was conducted within the mainstream classroom in which the researcher as a participant-observer watched as an individual student took notes with the Smartpen during instruction and asked the student questions relating to why he/she made notations in the Smartpen notebook, the purpose of the notes themselves, as well as how he/she intended to use the notes in the future. These instances allowed the researcher to draw connections between classroom use of the Smartpen and students' learning objectives.

Finally, students were asked to keep a record sheet of their weekly use of the Smartpen, including the location in which they were using their pen and a brief description of the activity they were engaging in with the pen. This descriptive account assisted in understanding the contexts in which the Smartpen was most useful for students in terms of formal and informal learning opportunities.

3.6.2. Teacher-based data sources. Teacher-based data consisted of data collected from the ESL specialist as well as the 5th grade mainstream teacher who sustained prolonged contact with the 7 ELs throughout the school day. The teachers were asked to participate in formal and informal individual interviews in which they recounted their personal observations relating to how, and for what purposes students chose to use the Smartpen in the classroom. They were also asked to share examples of instances in which they found the Smartpen useful for the students' learning as well as details regarding the academic and linguistic development of the students. This type of

information was helpful in crystallizing the students' uses of the Smartpen as well as for providing insight into how learner-based factors came to bear on students' use of the Smartpen for learning.

Another source of teacher-based data was captured in the digital notebook archives collected from the Smartpen devices. Instances of when the teacher directly interacted with the student in the classroom, as well as particular moments of learning, were represented by the notebook pages.

3.6.3. Researcher-based data sources. Researcher-based data was comprised of naturalistic observations of the mainstream classroom and accompanying descriptive field notes of students' learning-related behavior with the Smartpen. Descriptive field notes from the researcher's vantage were also taken during all formal and informal interview sessions with the student and teacher participants.

3.7. Data Analysis

Data analysis was conducted in two phases; a preliminary analysis followed by a main analysis.

3.7.1. Preliminary data analysis. First, an *a priori* analysis technique was utilized for all interview-based data to determine the sections of potential relevance to the guiding research questions, that is, those in which the participants discuss issues relating to (a) formal and informal language learning opportunities with the Smartpen; (b) academic courses representing areas of linguistic or content struggle; (c) affective responses to the Smartpen or using it; (d) accounts about common uses of the Smartpen; (e) attitudes or motivations related to Smartpen use; (f) subject areas where Smartpen was utilized. Digital artifacts, such as the digitalized notebook pages and accompanying

audio-visual pencasts, were also examined for their relevance in providing insight into the research questions prior to transcription and further analysis.

All forms of audio data were transcribed using Express Scribe Pro Software. Transcription conventions followed a denaturalized approach that is common in ethnographic research (Agar, 1996; Cameron, 1996). This captured the substance of the interview verbatim, while avoiding attention to accents and involuntary vocalizations. Moreover, transcriptions of interactional communication and paralinguistic features were represented using the guidelines for conversation analysis outlined by Jenks (2011). Areas that required attention to nonverbal conduct, such as action (e.g., students' notebook activity) were also illustrated using the conventions for text and sequencing (Jenks, 2011).

As is the case in most small scale research projects, transcription was handled by the researcher using a continuous process of transcription and data interpretation (Maxwell, 1992; Miles and Huberman, 1994). Easton, McComish, and Greenberg (2000) recommend that ideally the researcher should be the interviewer and transcriber to avoid errors in accuracy when transcribing. The audio transcriptions were reviewed multiple times for accuracy and compared with several versions of the recording to ensure completeness. In some instances where the audio recordings occurred in the students' L1 (Meskhetian or standard Turkish), a native speaker of standard Turkish transcribed the recordings from Turkish into English. These transcriptions were carried out using a forward translation method that was then reviewed using a back translation method (Maneesriwongul & Dixon, 2004) by a second standard Turkish speaker with regular interaction and familiarity with the Meskhetian community to verify the content. Once

ready, all data files were directly uploaded into the Atlas.ti software platform for further exploration (version 7.0; Muhr, 1991; Friese, 2013).

3.7.2 Main analysis. The analysis and interpretation for this study was guided by Stake's (2010) definition of analysis as "taking things apart and synthesis as "putting things together" (p. 133), specifically by studying various episodes of learning experienced by the participants and their "activities, sequence, place, people, and context" (p. 133) . This model of analysis entailed multiple levels of researcher interaction with the data, namely coding, categorizing, network mapping, and theme generation as a means of producing findings and refining a global understanding of the various sources of data collected.

As a heuristic for remaining organized and procedural in my data analysis I followed Creswell's (2012) guidelines for qualitative case study data analysis and representation (p. 156-157). The chart below details the sequence of these overarching procedures.

Table 4.

Creswell's Protocol for Case Study Data Management and Analysis

Data Managing:	Create and organize files for data analysis using computer software
Reading & Memoing:	Read through text, note reflections in the margins, form initial codes using coding and memoing functions of Atlas.ti
Describing:	Describe the case and its context using conceptual mapping techniques
Classifying:	Use categorical aggregation to establish themes or patterns
Interpreting:	Use direct interpretation
Representing & Visualizing:	Present in-depth picture of the case (or cases) using narrative, tables, and figures

Using the constant comparison method for analysis (Strauss & Corbin, 1998), I examined the data through a cyclical and iterative process of coding that involved the repeated reading and reviewing of the data using a combination of structured and emergent coding techniques (Saldaña, 2009). Data was coded in three phases--initial coding, focused coding, and axial coding--using the qualitative data analysis software platform Atlas.ti as a tool for exploring the data (version 7.0; Muhr, 1991; Friese, 2013). Atlas.ti was specifically selected for use in this research because of its ability to support the coding of the rich multimedia data sources (textual, audio, image, video files) collected in this study. What follows are the details of each level of the coding process.

Level 1: In the primary analysis, I carefully scrutinized the data through a microanalysis of the data corpus in which I "split" the data into discrete and identified segments in order to meticulously examine and compare them for similarities and differences (Strauss & Corbin, 1998). I achieved this through a systematic, line-by-line coding technique in which I applied code names to individual sentences or phrases as the unit for analysis. Some of these code names and the development of the codebook was informed by my theoretical framework of Vygotskian sociocultural theory (SCT), specifically the constructs related to mediated learning, such as artifact and tool mediation, zone of proximal development, internalization, and self-talk, as well as Horwitz's (2008) taxonomy of cognitive, affective, and metacognitive factors. Other codes were allowed to emerge according to the dynamics of the data through a combination of attribute, descriptive, magnitude (for emotions), and *in-vivo* coding techniques.

Level 2: In the secondary level of analysis, I transitioned from initial coding to focus coding in which special attention was paid to the application and refinement of process codes (gerund-based). Saldaña (2009) recommends process coding "for virtually all qualitative studies, but particularly those that search for ongoing action/interaction/emotion taking response to situations, or problems, often with the purpose of reaching a goal or handling a problem" (p. 77). It was my intention at this point in the coding process to remain rooted in the process-based nature of the inquiry to discover *how* this device could mediate learning, and as it became apparent that the participants' use of the Smartpen was related to specific precursors and seemed to have some sequential qualities, this coding technique was well-adapted.

At this stage in the analysis I also began to conceptually explore code-to-code relationships to collapse codes into larger categories through a variety of manual and computer-based tools available in Atlas.ti. Specifically I made use of the code co-occurrence table, code co-occurrence explorer, and network view functions to both textually and visually examine code-to-code relationships and dig deeper into the underlying processes and sub processes of Smartpen use within and across participant cases. I also manually collapsed individual codes into broader categories by adapting Charmaz's (2006) recommendations for category development, which involved using the most frequent or significant codes to develop "the most salient categories" in the data corpus (p.46). Decisions about the saliency and thematic importance were guided by not only the absolute number of times a theme occurred in the data, but also by the number of individual participants who independently expressed the same idea, lending to its overarching relevancy (Namey, Guest, Thairu, & Johnson, 2007). Since this decision-

making required careful analytic thinking about the data, I completed several schematic tasks to assist me in determining which codes were most salient, the conditional relationship guide (Scott, 2004), and routine analytic memo writing within Atlast.ti. This process of conceptual mapping and analytic writing allowed me identity patterns and thematic connections in the data.

Level 3: In this final level of analysis I moved from codes and categories to broader themes grounded in the data and participants' experiences. Using techniques for axial coding, three primary themes emerged relating to participants' extension of learning opportunity as self and co-constructed, as well as the extension of the learning "self" through the use of Smartpen technology. Within each of these themes several related dimensions were also refined using methods borrowed from the tradition of discourse analysis. For example, at the discourse level, I explored participants' language choices in constructing and reflecting their realities of learning with mobile technology (Gee, 2013). These micro-level dimensions will be discussed in the following chapter as they relate to each theme.

While these main themes defined the central phenomena at work within the study, they did not account for the underlying temporal processes that recurred in the data and that suggested a specific sequential order for using the Smartpen as a learning tool. In an attempt to reassemble and reconfigure the fractured data in a meaningful way that foregrounded the participant voices', I chose to use the metaphor of a time machine (i.e., time travel) provided by Sonay, one of the participants in her interview (Focus group interview, 12/12) to re-interpret and re-organize the data around the subtheme of time as it related to each main theme. Although this metaphor was not initially apparent in the

early phases of coding, its centrality became increasingly evident to me as I immersed myself in the data through the iterative process of coding. To assist me in better understanding the pattern of temporal progression across participants and coding categories, I used several tools to map the continuum of time-shifting, specifically Spradley's (1979) taxonomy of universal semantic relationships and Strauss's diagramming exercises for axial coding.

In the following chapter I will present the data supporting each of the themes that evolved from the analysis described above through thematic narratives organized by research question. The temporal dimension or time flow of participants' learning activities with the Smartpen will be concurrently addressed throughout by the use of illustrations that accompany the main analysis. In order to "theorize across a number of cases by identifying common thematic elements across research participants, the events they report, and the actions they take" (Reismann, 2008, p. 74), in a way that is consistent with instrumental case study design and my overarching goal to illuminate macro level issues of mobile technology use for L2 learners, I have taken a thematic approach to representing the data.

To conclude this section, it is important to note that this multi-layered process of data analysis and interpretation was very much recursive, as I cycled through codes, collapsed them into categories and later related categories to themes that emerged from participant metaphors encountered in the preliminary phases of analysis. Amidst these iterations in levels 1-3, the researcher's reflective journal was an essential tool for streamlining my thinking about the data and was housed within Atlas.ti in the form of memos. These reflections were a site for engaging in my own questioning about the data,

to document emergent understandings, and to record of the constant dialogue I participated in when confronting contrasts and tensions within the data.

3.8. Researcher Perspective

In ethnographic forms of qualitative inquiry the researcher is embedded in the process of research design, data collection, and interpretation (Anderson, 2008). This reality, while creating the possibility of researcher bias and reactivity (Maxwell, 2012), also contributes to the richness of this type of methodology, in which "a major goal of the research process is self-reflexivity-what we learn about the self as a result of the study of the 'other'" (Chiseri-Strater, 1996, p. 115). Thus, rather than removing myself from the research process, I chose to take a reflexive stance, turning in upon myself as the researcher to look at how I was positioned in the study in terms of my own personal interests, biases, prior experiences, and subjectivities. By this I hope to be transparent about potential areas of bias or tension about the topics of language learning and technology that would allow the reader to make a balanced judgment of the information presented within the study (Creswell, 2003). Below, I disclose some key aspects of my researcher identity as a language learner and educator that have contributed to my stance in the current work and shaped the project origins. In addition, I discuss my perspectives on technology and the implications of my role as the broker of the mobile technology implemented in this work.

The endeavor to explore how technology may be effectively implemented in classrooms to facilitate learning for ELs, particularly in ways that can bridge home and school educational contexts, represents the culmination of decades of personal experience and observation as a second language learner and teacher. As a lifelong learner of

Spanish and proficient bilingual individual, I am intimately acquainted with the process of L2 learning in both formal (e.g., classroom) and informal (e.g., community) environments. My own student experience in content-based courses conducted entirely in an L2 has indelibly sensitized me to the struggles, challenges, and frustrations that ELs may endure in educational environments where they must learn *through* a language rather than *about* a language. This awareness of the unique instructional needs of ELs was cultivated throughout my career as an ESL teacher in which I witnessed the limited linguistic and academic support for culturally diverse learners beyond the classroom space (e.g., home) despite their persistent underachievement. It was, and continues to be, my conviction that ELs need more opportunities for extended instructional support to develop the knowledge and skills necessary for academic success across subject areas. The notion that technology might serve as a possible bridge between school and home learning contexts for ELs, as a vehicle for enabling additional support and furthering learning opportunities, grew from my years of work as an online language instructor where I saw the many educational benefits of L2 learning with multimedia materials.

In conceptualizing the current study on exploring the impact of learning with technology across educational contexts for ELs, mobile devices were selected due to their physical ability to transcend multiple learning environs. I approach this work with a special commitment not to the technology itself, but to understanding how students uptake technology for their personal learning needs, while acknowledging that technology alone can neither replace the classroom teacher nor guarantee learning as a panacea. Rather, the successful integration of mobile technology is contingent upon *how* it is used, and *if* it is adequately matched to the learners' needs. Thus, mobile devices

from my vantage can ideally be one of many tools that teachers can use to help support the academic development and linguistic growth of ELs.

Regarding the focal technology used in this study, I will clarify that I had no vested interest or prior affiliation with the Livescribe® Company or Smartpen device. It was selected simply for reasons of cost-effectiveness, lack of previous research history, and other purely academic purposes. Nevertheless, my role as the "supplier" of technology for this study or the technology broker cannot be ignored, as it is an important aspect of my positionality as it relates to the student participants in this study, their perceptions of me, and consequently the data collection process.

Indeed, being the bearer of a new technological device free of cost to students who would otherwise have limited outside access to technology potentially introduces the risk of their overly favorable responses to me, so as to secure their continued participation in the study and prolonged use of the Smartpen. It could also introduce the possibility for researcher bias in terms of looking for advantageous effects of the pen, since the goal of an intervention is to help learners. Another important consideration, as this work involves children, is the inherent power differential associated with work between adults and children (Christensen, 2004), which could also come to bear upon the participant responses if I am not careful to mitigate my presence as an "unofficial authority" to the minor participants. Accordingly, to preserve the integrity of the study and minimize any issues that could compromise its trustworthiness, I will methodologically address these possible areas of concern in the next section of this dissertation.

Finally, the last area of prospective partiality relates to my role as the architect of this project and the proclivity toward verification bias, or the inclination to select cases that confirm rather than disconfirm preconceptions, which commonly exists as a criticism of case study research (Flyvbjerg, 2006). Therefore, I systematically safeguarded against the possibility of any underlying bias of wanting the Smartpen to prove an effective instructional tool for ELs through a series of measures designed to protect the confirmability of the study. These steps will be outlined in the next section of the dissertation.

3.9. Issues of Trustworthiness, Confirmability, and Transferability

In qualitative inquiry, truth value is considered the most important criterion for evaluation (Krefting, 1991) and therefore is essential to protect. As stated earlier, my multiple roles in this study as the researcher observer, technology broker, and participant made it important for me to remain reflexive throughout the process of data collection and analysis. To enhance the trustworthiness of this work and to add to the validity of my interpretations of the data, I used several procedures. Congruent with the longitudinal nature of this study, I engaged in prolonged participant observation in the field (Maxwell, 2012) and kept a researcher's journal for the self-reflexive practice of interrogating my own predilections and opinions and to facilitate sense-making as I interacted with the data (Etherington, 2004). I also collected data through multiple sources and multiple viewpoints, which is a practice that allows "different facets of problems to be explored, increases scope, deepens understanding, and encourages consistent (re) interpretation" (Tracy, 2010, p. 843). Finally, I utilized member reflections with the teacher participants

as a collaborative opportunity for illuminating new aspects of the data and deepening the analysis through their review and feedback of my written report.

Some special considerations relating to the children participants in this study were also addressed in order to enrich the validity of the findings. Given that the students were ELs, and of varying levels of English proficiency, I had to be conscious that their language proficiency could interfere with their ability to articulate their true feelings, or act as a hindrance to their understanding of the interview questions. As a strategy, I was careful to use iterative questioning techniques (Shenton, 2004) and to adjust the language of the questions to accommodate for various levels of English comprehension. My professional experience as an ESL specialist assisted me in my knowledge of appropriate vocabulary selections for ELs. During all of the individual and focus group interviews, the students' ESL specialist was present to clarify any potential misunderstandings, to rephrase unclear questions, and to facilitate the interview process. Additionally, students were asked to create visual representations of their experience using the Smartpen as an alternative means of expression.

Regarding their status as minor children, I attempted to be mindful of the power differential that accompanies adults by conducting all interviews in a seated round table format to reduce any imposition associated with physical stature. Moreover, all interviews occurred in a location that the students were both comfortable and familiar with, the ESL specialist's office, in order to put them most as ease. It is my belief that my long-term engagement with the students and my integration into their classroom environment as a participant-observer helped me to develop a positive relationship with them that moderated the effect of my adult position.

The interpretivist frame applied to this study further required me to counteract any personal biases from being transposed onto the data during analysis. Hence, in addition to maintaining a reflexive stance to document my own subjectivity, I had also procedures in place to account for the issue of confirmability. This entailed the triangulation across data methods and sources, which facilitates cross-checking for multiple instances and examples of data to support a single inference. I also used the memo function within Atlas.ti to produce analytic memos that documented any discrepant or disconfirming evidence or cases (Miles & Huberman, 1994) that I searched for during my analysis and that would counter my own predilections or desire for the Smartpen to have a favorable impact on learning. Finally, in instances where I needed clarification of my own assertions and interpretations I sought peer debriefing with my research advisor to help determine if my assumptions were evident from the data or emergent from my own preconceptions. This practice of investigator triangulation for confirming and disconfirming the researcher's interpretation is recommended for case study research (Stake, 1995).

The final guideline of the transferability of research findings can be challenging to address due to the historically and culturally situated nature of qualitative inquiry. However, recognizing that the results of this study will not be entirely generalizable to all educational contexts, I attempt to provide rich descriptions of the setting, participants, and developing themes to allow the readers to locate possible areas of overlap between this work and their own situations. Using thick description to help readers align their own experiences with those related in research is a celebrated method of attending to concerns of transferability (Creswell & Miller, 2000).

3.10. Summary

To summarize, this chapter provided a detailed description of this study's research framework, blended data collection methods, data analysis procedures, and methods for addressing the criterion of credibility, transferability, and confirmability. This design was crafted to explore how middle school ELs could use mobile technology to mediate their learning of language skills and classroom content, as well as any affective, cognitive, or metacognitive advantages they experienced while using the Smartpen tool. Multiple data sources were employed in both traditional and technology-mediated formats, including digital notebook archives, individual and focus group interviews, learning artifacts, and observations, gathered from both student and teacher participants. The data analysis process was cyclical and consisted of open, axial, and selective coding, categorization of codes, and later thematic and conceptual development informed by multiple layers of analysis and the Vygotskian sociocultural theoretical lens. Data analysis and interpretative procedures required building associations between the emergent themes and the relevant interdisciplinary literature in second language acquisition and mobile learning to consider how these findings coalesced with pre-existing theory and possible theoretical extensions.

Chapter IV

Results

4.1. Overview

This chapter presents the findings for each research question using a series of emergent themes and thematic narratives deduced from the analysis of the data (Wolcott, 2008). Ultimately the data are represented using a combination of exemplars, text samples, artifacts, and graphical figures that have been chosen to represent patterns apparent in the larger data set (Mishler, 1990). Due to the voluminous data produced in case study research, the examples that have been selected for data visualization and presentation are only those that provide the richest and most informative window into understanding the participants' experiences.

Specifically, each thematic thread is described as it corresponds to one of the main research questions. It is also accompanied by the sub-thematic thread of time as an organizational metaphor that is initially explained below, preceding the findings for the first research question. The narrative structure for reporting research findings will include orientation information relevant to the emergent theme, supporting quotations or graphical displays, and a minimal commentary to frame how the theme connects to the research questions (Burnard, 2004; Creswell, 2007). A more in-depth discussion and interpretation of these findings will be presented later in Chapter V, using the Vygotskian Sociocultural theoretical lens to explore implications for mobile technology and L2 learning.

4.2. The Sub-thematic Thread of Time

*Figure 3.*The Smartpen as a Time Machine

> See, every time I forget something really important like, oh wait I forgot my spelling test and stuff, I can record it on my pen and then I can touch on it and then I can remember what I was saying. It's like a time machine that that takes me back in space and I can hear what I said! It's like a time machine so I can go back in time and remember what I said.
>
> (Sonay, Focus group interview, 12/12)

This powerful metaphorical portrayal of the Smartpen as a time machine is central to understanding its mediational function for L2 learners. As a time machine, the Smartpen was able to alter the way the ELs experienced time. It allowed them to move through time in new and unfound ways and, to some degree, exercise control over it. Sonay specifically discussed the freedom to re-experience time in relation to traveling back in time and space to previous moments of learning with the touch of a button. She underscored two precursors necessary for time-traveling with the Smartpen: the initial creation of an artifact through recording and the subsequent use of the same artifact through the pen's playback features. The temporal flow of this cycle of creation and revision formed the organizational undercurrent for all the participants' learning experiences with the Smartpen and is carried throughout the findings for all the guiding research questions.

4.3. Thematic Thread One

Extending Opportunities for Learning Language: Self-Constructed Artifacts

4.3.1. Overview of Findings for Research Question One

How does the Echo Smartpen tool support the mediated learning of middle school ELs in learning language skills, (e.g., reading, speaking, etc.)?

"I use it [the Smartpen] for my languaging." (Lalehan, Interview, 6/13).

Like Lalehan, for all of the participants in the study, the Smartpen became a tool used for "languaging," a term often used in SCT-oriented SLA perspectives (Swain, 2005), and one which she used to encompass her use of the pen for developing the various skills associated with L2 learning (e.g., reading, writing, speaking, listening, and vocabulary). For L2 learning, results revealed that students worked largely individually to generate self-constructed artifacts of their learning experiences through the recording and note-taking features of the pen. These artifacts served one of two primary purposes: (1) to extend their access to instructional uses of the target language (English) that occurred within the classroom environment, or (2) to extend their productive uses of the language within the classroom and home settings. Although the creation of the artifacts benefited the learning of all the language skills, the later re-visiting of them corresponded mostly to the development of listening comprehension and vocabulary skills. Since the creation of these self-authored artifacts facilitated the learners' access to models and use of English in audiovisual, oral, and written modalities that would not have been possible without the use of the Smartpen, I have operationalized them as extended language learning opportunities.

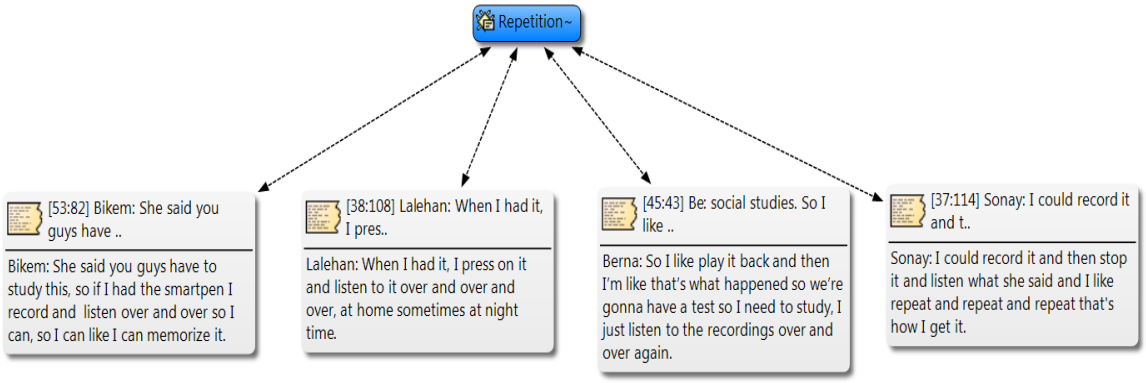
Results suggested that the way in which the Smartpen supported the development of each language skill differently involved a series of modifications to the learning experience. For listening comprehension and vocabulary building, the Smartpen enabled augmented access to the target language through: (a) extended input, (b) extended control over input, and (c) extended vocabulary support. For speaking, reading (fluency), and writing skills, it entailed the increased use of the target language prompted by: (a) an extended audience, (b) extended models, and (c) extended practice respectively. Notably, no evidence of the Smartpen's ability to support the learning of grammar was identified. In what follows, I will present findings that support each of these dimensions of L2 learning with the Smartpen as they related to the learning of certain language skills.

4.3.2 Support for Listening Comprehension

Extended Input: "I listened over and over so I can understand it." (Bikem)

Listening comprehension is an interactive, interpretive process where listeners match what they hear with what they already know (Vandergrift, 2002). Findings indicated that for all of the participants, the Smartpen provided access to what has been widely recognized in L2 research as one of the most effective forms of listening comprehension support: the repetition of input (Chang & Read, 2006). By creating a recording of the classroom instruction, participants were able to extend their access to the material in order to repeatedly revisit and make sense of it beyond the classroom space. Notions of listening *anytime and anywhere*, a highly desirable and useful experience in terms of maximizing opportunities of exposure to comprehensible input (Krashen, 1982), were prevalent in the data. Several participants expressed their repeated revision of

listening texts as a method for improving listening comprehension. These perspectives are presented in a network view in Figure 4.



(Observation, 1/13) (Focus group interview, 6/13) (Observation, 2/13) (Focus group interview, 12/12)

Figure 4. Network Diagram of the Use of Repeated Input

As Bikem noted, the repetitious listening to previous recordings was intended as a strategy for memorization, or to improve her memory of classroom instruction. Berna also spoke to the ability of the Smartpen to help her remember the details of lessons through this process of recording and review in a learning artifact. She said, "If I don't have the Smartpen I can't remember every detail. I still remember some things, but with the Smartpen I can remember "EVERYTHING! (Emphatic)." Her stress on the word "everything" emphasized the important role the Smartpen played in aiding listening comprehension, allowing learners to remember details that they would otherwise miss. Such a benefit of this tool was also supported by students' classroom teachers. For example, Ms. Chua described the usefulness of the extended input for the learners in terms of replicated lesson content when she said:

> The pen, it enhanced their study skills in a way they don't have to depend on their notes, but they have the recording that has the word for word how the lesson was conducted.
>
> (Interview, 2/13)

The ability for learners to travel back in time to the exact lesson or segment of a lesson that they recorded without restrictions on the number of times they could re-live it was central to the mediational function of the Smartpen. The diagram of this process is depicted in Figure 5. Time travel was unrestricted to the current physical location or temporal state of the participants, as common settings for "listening back" to recordings were "home, recess, and during free time." However, since the act of re-listening occurred outside of the classroom, it must be noted that the pen did not seem to enhance learners' real-time listening skills within the classroom. In fact, to some extent it promoted their dependence on the recorded version of classroom activity by allowing them to engage in later review. Thus, given the importance of real-time listening comprehension, the ability of the pen to provide access to extended input could also be interpreted as somewhat disadvantageous or counter-productive to listening development.

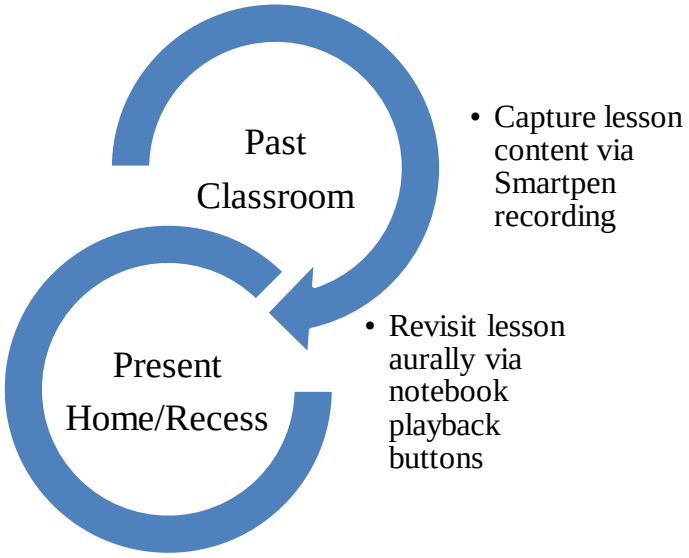


*Figure 5.*Temporal Shifting for Listeners Engaged in Recording and Review

Extended Control: "When I record my voices I use them and use a skipper and skip."(Sonay)

Results suggested that an important aspect of re-experiencing listening texts for some participants with the Smartpen was the enhanced capability they had to control the listening input using the playback buttons of the device. In the above quotation, Sonay referenced using the buttons on the notebook to skip over parts of the recording, which gave her the ability to engage in narrow listening (Krashen, 2004), or the repeated listening and self-selection of listening texts about familiar topics. Given that the learners were initially present in the class sessions they recorded, the need for them to review the entire lesson was often unnecessary. However, upon reviewing the listening text, it is assumed that they already possessed a certain degree of familiarity with the content as a result of previous exposure, making the recordings ideal for narrow listening and increased listening comprehension. Berna, like Sonay, Dilara, Lalehan, and Tanyeli, mentioned using the pen's playback features when listening to customize their listening experience.

> I just listen to the parts that are like most important. When I go to the story, I just go right here. And if it didn't start the story yet, you know that bar [the jump bar], if it didn't start the story then I go to the middle line. Then, if it already started then I go in between.
>
> (Interview, 1/13)

Indeed, it is important to note that the utility of the playback toolbar to be useful for learners relies on a certain level of initial comprehension in order for them to identify the most important parts to review. In the case of Berna, a more advanced EL than the others, this seemed easy to do; however, developing ELs may possibly skip over important

information in a recording due to underdeveloped listening comprehension skills. Therefore, the use of recording playback is accompanied by this caveat.

Moreover, the playback function also seemed to allow learners to specifically select how they reviewed the content. For example, Dilara in particular discussed adjusting the speed of the audio recordings to a more comprehensible level for her needs. She said, "I make it [the recording] go slow cause she was speaking fast cause we had little time" (Interview 1/13). Therefore, while the Smartpen offered listeners extended access to identical instructional content, it enriched the possibility that they would comprehend it by giving them control over its delivery. While this form of listening aid can certainly contribute to comprehension as a scaffold post-instructional delivery, it does not necessarily support the ability of learners to process the speed of real-time classroom instruction.

4.3.3. Support for Vocabulary Learning

Extended Vocabulary Support: "In case somebody tells me a word that I don't even know I just type it [playback button], so then I know the meaning and the word, what the meaning is. (Lalehan)

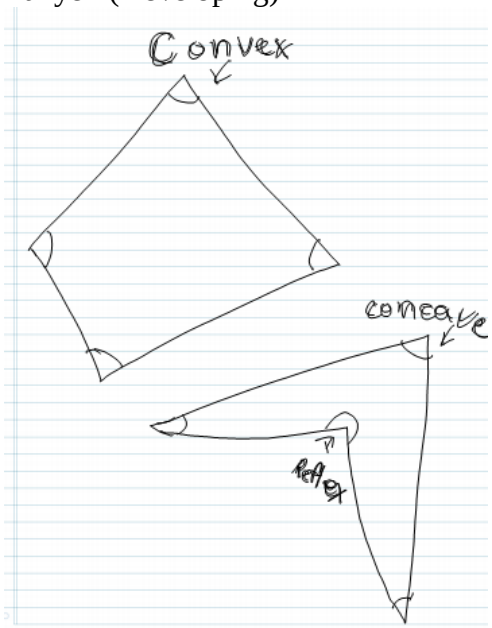
Findings suggested that across all of the participants a major use of the Smartpen was for the creation of self-authored multimedia glosses that extended their access to vocabulary support. By definition, multimedia glosses are short definitions, notes, or annotations that facilitate the comprehension processes for L2 learners in different modalities--textual, visual, and auditory (Lomicka, 1998; Mohsen & Balakumar, 2011). Indeed, research on L2 vocabulary learning emphasizes the positive effect on vocabulary retention that occurs when "words or phrases are presented with different types of media

(Chun & Plass, 1996, p. 183) as well as "the beneficial effect of student participation in authoring on the usage students make of the context while acquiring L2 vocabulary (Nikolova, 2002, p. 113).

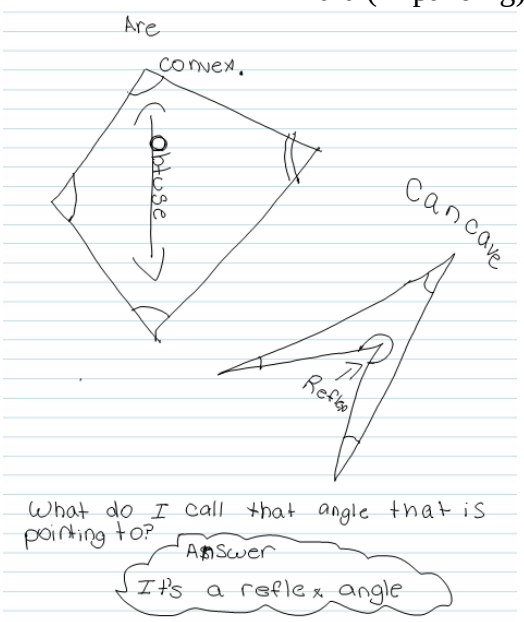
With the Smartpen, students were actively engaged in the creation of their own multimedia glosses that represented word-meaning associations in multiple ways through the use of the pen's recording and note-taking features. The creation of glosses to capture key classroom language in modalities that would not be possible without the tool was especially noticeable in the acquisition of math register. Results revealed that students of all language levels used their pens to create visualizations of specialized math vocabulary (visual mode) that they annotated with the name of the target terminology (text mode) and captured the audio definitions or teacher's explanations of with the recording feature (audio mode). An example of the vocabulary glosses generated during a lesson involving the specialized vocabulary of math angles is presented below. Three illustrative cases encompassing three different levels of English proficiency are displayed with the accompanying teacher narration to evidence the contextualized nature of the vocabulary learning enabled through recording.

> Now this is important because when you have a reflex angle, when your shape looks like this, and there's a reflex angle this is called concave. An easy way to think about this is what's a cave? Tell me what a cave is. It's like a hole in a wall, you can go inside. Well look at this, doesn't this look like a cave? Like you could go inside this shape almost? This is an easy way to remember that this is concave. Now the other type of polygons we're going to be talking about today are convex, convex. This means none of these angles are pointing out. None are coming into the shape.
>
> (Mrs. Mitchell, Math Class, 11/12)

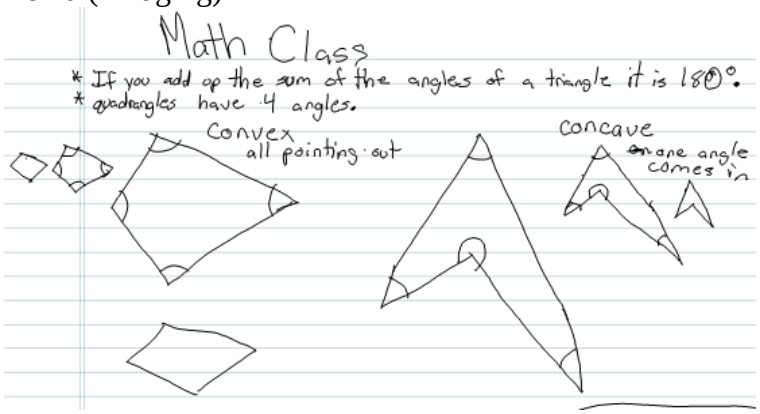
Tanyeli (Developing)



Dilara (Expanding)



Berna (Bridging)



Although the students' notes display varying degrees of sophistication, all learners were able to capture authentic and contextualized uses of the target terminology for convex, concave, and reflex angles by crafting these vocabulary artifacts during real-time math instruction. Importantly, the representation of these terms was multi-modal as they accounted for visual and textual representation, as well as Mrs. Mitchell's audio mnemonic devices for establishing word-meaning associations, a desirable outcome in

SLA. For some participants like Sonay, the visualization of these new terms was the most facilitative for learning. She stated, “I draw pictures to understand what I'm talking about” (Focus group interview, 12/12). For others like Berna, there was more value in the embedded audio component of the vocabulary glosses. She said, “I hear the word in a sentence so I can like figure out what it means” (Interview, 1/13). Bikem also referenced the importance of audio in connecting words and their meanings (Interview, 6/13). Her words described the process of learning vocabulary with the Smartpen as a series of sequenced events centered on the written and audio learning modes. These events are depicted in Figure 6 below as they bridge the process of the creation and use of the multimedia vocabulary gloss.

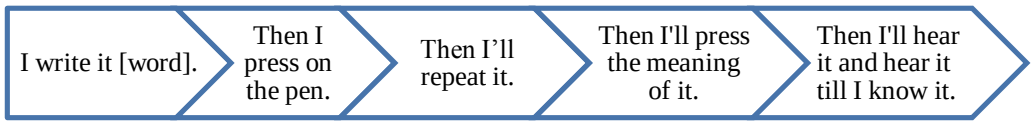


*Figure 6.*Temporal Sequence of Multimedia Glosses: Creation and Use

Here, Bikem marked the act of notating the word as the beginning of the vocabulary learning process with the Smartpen that terminated with internalization of the word after continued audio review. The idea that learning was initialized through the act of writing the vocabulary word was supported by the cases of Tanyeli, Sonay, and Sabiha, who used private speech (i.e., inner speech, self-talk) to pronounce vocabulary words aloud while writing them. For instance, as Tanyeli drew and labeled the visual representation of the target words, she rehearsed to herself, “convex, concave, and reflex,” which is consistent with a sociocultural theoretical perspective that emphasizes

the use of self-talk as a tool for gaining control over the lexical association of the word and its meaning (McCafferty, 1994).

In addition to the linguistic benefits associated with the act of creating the vocabulary artifacts, the review of them seemed to facilitate the meaning recall of the target terms (van Zeeland & Schmitt, 2013) for some learners. As mentioned in the introductory excerpt by Lalehan, participants used the playback button on the Smartpen notebook to obtain access to the audio gloss of a vocabulary word at a later moment in time. In fact, this behavior was directly observed during a math class in which Berna reviewed a vocabulary artifact she created at an earlier date and time in order to answer a question posed by Mrs. Mitchell that required the production of the target term "reflex". This exchange from November is noted below, with double parentheses signaling the return to an earlier vocabulary artifact.

3:08
Mrs. Mitchell: If you can remember when we were talking about angles at the beginning of this unit, one of these shapes has a special angle. What is that special angle? I drew an arrow to the angle I am talking about.
((Berna returns to notes taken in math class 10/12))
(.16)
Mrs. M: What do I call that type of angle? Berna?
Berna: A reflex angle?
Mrs. M: A reflex angle, which means that if I were to measure this, it would be greater than 180 degrees.
(8.25)
((Later within the same classroom period Berna approached Mrs. Mitchell))
Be: Ms. Mitchell, you know how I knew the answer to this?
Mrs. M: You looked back, I saw.
Be: I have <u>all</u> the answers.
13:05

In this example, the vocabulary gloss about reflex angles that Berna created in October served to trigger her recall of the term in November when asked to produce it in

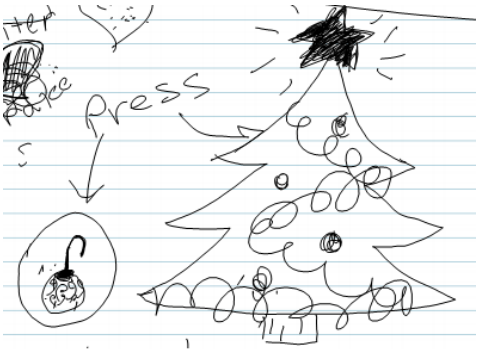
another context. Her access to the gloss was an extended vocabulary support that not only enabled her active class participation in this instance, but also reinforced the link between the word and its meaning through repeated exposure and reinforcement. Notably, Berna was the only student for which the review of a vocabulary gloss was directly observed.

4.3.4. Support for Speaking

Extended Audience: "It's my microphone!" (Sonay)

Results showed that participants commonly used the Smartpen to communicate oral messages through the device to an extended audience not present during the actual recording. Many of them referred to the Smartpen as their "microphone" and their audience typically consisted of friends, teachers, and even a future self. Lalehan explained that recordings were "for me, my future, my teachers, and my family" (Focus group interview, 6/13). By creating audio recorded artifacts, the participants extended their use of oral language in several ways. First, they authored scenarios of authentic communication with their Smartpens by using basic interpersonal communication skills (BICS) to communicate with peers, teachers, and themselves about important happenings or observations in their immediate surroundings. Sabiha represents the most illustrative example of this type of *interactional* speech act, or speech intended to maintain a social relationship (Brown & Yule, 1983), although Sonay, Tanyeli, Lalehan, Bikem, and Berna also created similar audio artifacts. The use of the Smartpen as a messaging tool can be seen in a narrated illustration that Sabiha created for her school friends while at home over winter break.

Hi everybody, I had the best winter break! I decorated my tree, like a long time ago it was fun, but I also got my Christmas presents and guess what I got? I got a friendship bracelet maker. It's really cool, it's like knitting but it's really different and my sister got a ribbon head-maker, like if you don't have anything for your head, it teaches her how you decorate it with beads. It's really cool too. And I'm saying this so you guys could, so I could show you guys after winter break and right now I'm showing you. So, I'm Sabiha. I really missed you guys over the break. Really, I was having fun too, and I went snowboarding, I went to lots of store with my uncles, I went to lots of my families' houses...I really missed everybody. I missed all my teachers too. That's all I have to say right now, bye!



(Notebook, 12/12)

Here, Sabiha engaged in a virtual conversation or simulated social interaction with her friends through the pen's ability to record. She basically used the Smartpen to compensate for their physical absence and later planned to share this recording with them in person as evidenced by the bookmark labeled with the word "press." Creating this recording not only accomplished a communicative goal, but also challenged Sabiha to expand the limits of her communication through the use of circumlocution techniques to express the meaning of unfamiliar vocabulary such as "head-band maker," which she referred to as "head-maker."

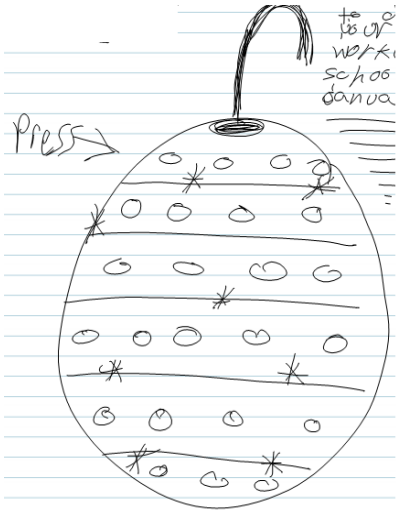
Her conception of this recording as an actual dialogue or speech act is evidenced by several discursive features. First, she opened the dialogue with a reference to the absent interlocutors in the words "Hi everybody," and later made several references to "you" and "you guys," as though directly communicating with them in real-time. She also asked questions to her friends within the recording, despite the fact that they were

not physically present to respond. In some sense, this same absence of actual interlocutors that provided greater opportunities for using oral language skills could also be seen as potentially problematic in terms of participants not receiving corrective feedback for errors in speech through response. In cases where participants committed errors in their use of oral language, these errors could become fossilized over time without identification and correction by another speaker. However, given most participants' limited access to English-speakers within their home environments, their actual use of the target language through the creation of these digital stories can be considered a first step toward fostering their oral language development.

Similarly, several participants used the Smartpen to create audiovisual artifacts that were not intended for an external audience, but rather for themselves. These recordings typically shared a similar motivation, to act as a future reminder or as a tool for mediating memory. The goal of this speech act was inherently *transactional* in nature, referring to the information-transferring function of speech (Brown & Yule, 1983). Again, Sabiha's case provides the richest example of this type of recording, although Dilara, Berna, and Sonay also produced various kinds of audio reminders for the audience of self. An example of this type of self-directed communication is presented below.

This is a decoration and it's one of the decorations on my tree. I wanted to draw it so I can never forget it's my favorite one, and it really sparkles when you see if for real life, and it's really pretty. I never want to forget about it so that's why I wrote this decoration and bye!

(Notebook, 12/12)



This activity exemplifies Sabiha's self-motivated use of oral language spurred by the personal meaning she attached to the ornament. She essentially attempted to use speech to eternalize the experience of this ornament through the creation of an artifact, which she clearly stated in the words, "I never want to forget about it." Like in her previous recording, Sabiha closed the communication to herself by saying goodbye, although this self-directed recording did not share the same discursive characteristics of the interactional recording directed toward her peers (e.g., interrogatives).

For Sabiha, using the Smartpen to record information for herself was a way of projecting her own voice into the future in which she would assume the role of consumer rather than producer of the artifact. In short, Sabiha's use of oral language was facilitated by the concept of an extended audience that included herself as a listener made possible through mobile technology. The way in which the Smartpen allowed Sabiha and the other participants to re-experience or re-organize time through these recorded narrations is depicted in Figure 7.

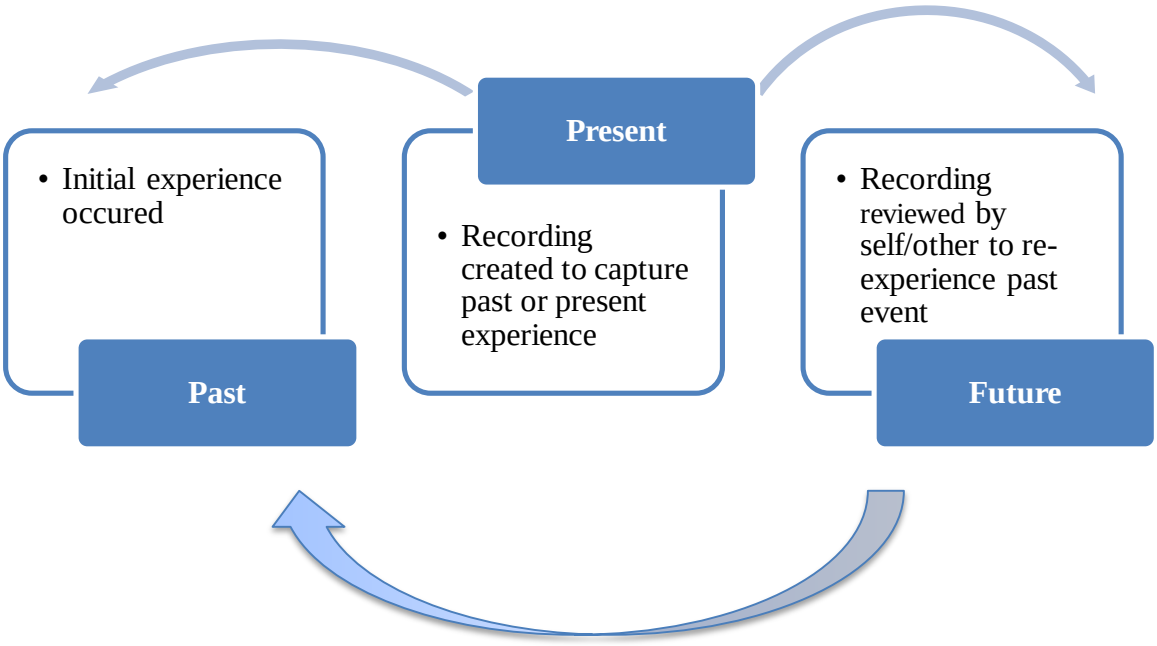


Figure 7. Temporal Flow of Oral Language Activities Enabled by Artifact Creation

In addition to creating these interactional and transactional recordings that enhanced their oral language use outside of the classroom, findings show that participants commonly used the Smartpen to create audio artifacts of playful uses of language both within and outside of the school setting. The term language *play* is adopted from Cook's (1997) definition of ludic or fun language that involves playing with language forms (e.g., sounds, rhyme, song, grammatical parallelism) or with semantic units to create fictional worlds. According to Broner and Tarone (2001), language play can be distinguished from other forms of languaging (e.g., rehearsal) because "It is accompanied by smiles or laughter, by marked shifts in pitch or voice quality or both, uses language forms known to be mastered by the speaker, creates a fictional world of reference, and appears to be addressed to an audience" (p.367).

Based on data from the participants' recordings, examples of language play with language form and with semantic units have been identified. For Bikem, Lalehan, Tanyali, and Sabiha the creation of songs was a major facet of their language play with form. In two cases, for Berna and Sabiha, their songs involved rhyming words, which is another level of language play. Results suggested that for all of the learners, regardless of their level of English proficiency, language play was an important facet of their extended oral language use. Examples of two songs vocalized and recorded by Sabiha and Berna have been included below.

Sabiha	Berna
I'm just dancing to my beat, just doing what I see oh oh oh :::Just dancing to my beat just doing what's neat oh oh oh:::Just sing how you sing. I'm doing what's neat, just talking to my beat oh oh oh:::Just saying, just dancing to my beat just doing what's neat oh oh oh:::	F is friends who do stuff together. U is for you and me. N is for anything anytime at all, here in the deep blue sea.
(Recording, 11/12)	(Recording, 10/12)

While Sabiha's example was a completely self-authored set of lyrics, Berna's was a musical rendition of a rhyming acrostic poem from a popular American cartoon series. From participant interviews, the students were aware of some of the learning benefits associated with songs (Abbott, 2002). They seemed to view them as a learning tool as indicated by Bikem who said, "I still don't know what they are some words but like in a song, I hear it, hear it, and like when I wake up the song's stuck on my head" (Focus group interview, 6/13). This suggests that the use of language play was intentional or strategic for the learning of specific language forms.

Respective to language play with semantic units, several participants utilized language to create fictitious worlds through role-play. Within these role-play scenarios, Sabiha, Sonay, Berna, Lalehan, and Tanyeli often assumed alternative identities which permitted them to experiment with language forms and semantic units that they would otherwise not utilize in everyday speech. Some of the phrases they emulated can be considered examples of formulaic language, or prefabricated, fixed patterns of words (Wray, 2005). The most common pseudo personalities apparent in the data were that of news reporter, weather reporter, or actor/actress. An example reported from Sabiha's case, in which she performed the role of weather reporter, is included below.

> Hello, this is the weather, it's been a really long thunderstorm today it's been raining and daining [draining] and it's been really bad, just so bad that there's a hurricane. ((*Blowing wind*))
>
> The weather today will be quite sunny but quite cool.
>
> (Notebook, 11/12)

In this example Sabiha appears to attempt to enact a context for using weather vocabulary. It is clear that some of these expressions consisted of formulaic semantic units, like quite sunny, or raining and draining, some which she had already mastered and some she was working to master (e.g., daining). Her addition of sound effects also denotes the playfulness of this recording, as well as the definite change in the tone of her voice, which was common amongst all of the participants. Often this change in pitch or voice quality involved a concerted effort to annunciate words or articulate more clearly in ways that would not be found in their natural speech. An important mediational quality of the Smartpen was its provision of a safe virtual space for hosting these performative speech acts.

4.3.5. Support for Oral Reading Fluency

Extended Models: "Just read into it. It's recording." (Berna)

Similar to many other studies on the use of mobile devices for reading, the Smartpen was not especially useful in fostering reading development across readings sub-skills (e.g., accuracy, comprehension, strategies) because it was not necessarily designed as a reading device in terms of having a screen (Huang & Lin, 2011). The way in which it most readily seemed to support L2 reading relates to oral reading fluency. For ELs, acquiring reading fluency can be a difficult task due to the role word identification plays in developing fluency and the high percentage of unknown words and language forms they encounter when reading (Horwitz, 2013). Bikem's words reflect a very common usage of the Smartpen amongst participants as a device for capturing models of fluent readers. Oral reading fluency is defined as the ability to read a text aloud accurately and quickly with the appropriate pacing and intonation (Report of the National Reading Panel, 2000). One of the major strategies used for improving oral reading fluency amongst struggling readers is the use of repeated reading (Samuels, 1979), or the repeated exposure to a reading passage through reading and re-reading silently or orally (Farstrup & Samuels, 2008).

Results suggested that learners using the Smartpen were able to increase their exposure to reading texts through the recording feature which they used to record their teacher reading aloud to the entire class or their classmates reading aloud in popcorn reading circles. Berna's statement above was a directive to another peer in a small group reading session where she required the students of her group to read into her Smartpen. Given that most of the students in the group were non-ELs, their oral reading skills were

presumably more advanced than her own. This behavior of recording others' voices reading aloud was especially prevalent within the reading-intensive classes of reading and social studies where the textbook was a primary instructional tool and commonly read aloud to the class. Similar patterns of recording were also observed in the data from Lalehan, Dilara, and Bikem.

Regarding the value of recording others' models of fluent reading, the participants shared a common belief that their teachers' voice was a "better" model of reading than their own. In general, this belief seemed to be grounded in the teacher's ability to modify her voice to reflect various characters in the reading. In contrasting the teacher's reading with her own, Berna said:

> It's just more motivating and then when the teacher reads it. She puts like more, she puts feelings into it. Like if somebody's talking and they're sad she like says it like they're sad. When she's doing a story she actually does the different character sounds. When I read it just feels like I'm just reading normal.
>
> (Interview, 11/12)

Dilara also supported the motivational value of being able to record her teacher as a model of reading. "It makes it so cool, like one person doing a whole play" (Interview, 11/12).

As referenced by the participants, teacher guidance forms the basis of the repeated reading strategy, because the teacher represents a model of reading that they cannot yet produce on their own and do not have access to within their home environments. Ms. Chua confirmed the barrier of limited literacy in both L1 and L2 for the participants and their families based on school-home visits, making the access to fluent models of reading even more pressing. She stated:

> They [the parents] didn't learn how to read and write English. Even if they know how to speak Turkish they don't know how to read or write it.
>
> (Interview, 11/12)

Findings indicated that with the Smartpen, the students' access to their teacher as a guide was extended beyond the classroom space into the home setting since participants could transport the models of reading they recorded across educational contexts. This technologically-enhanced version of the repeated reading strategy can be described in three tiers, the first of which entailed the capturing of reading models within the classroom. The second tier was the repeated exposure exercised in the review of the reading models, and the third in the repeated reading, or independent rehearsal of the reading passages that were originally introduced in the classroom. For Lantolf (1997), self-rehearsal is a form of languaging necessary for the mastery of new forms in L2, which is consistent with the participants' use of rehearsal for developing their oral reading fluency skills. The repeated reading process can be represented sequentially as it corresponds to time and as it depicts the shift in regulated learning from other to self. This stepwise sequence is represented in Figure

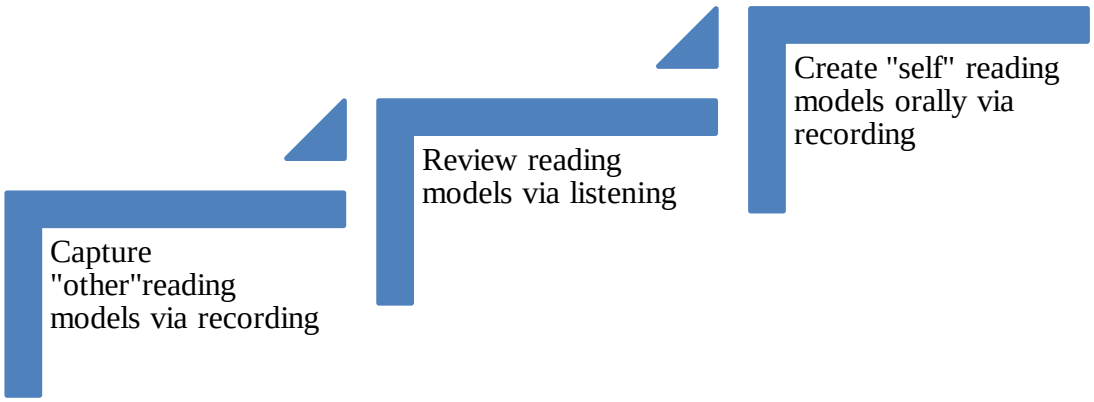
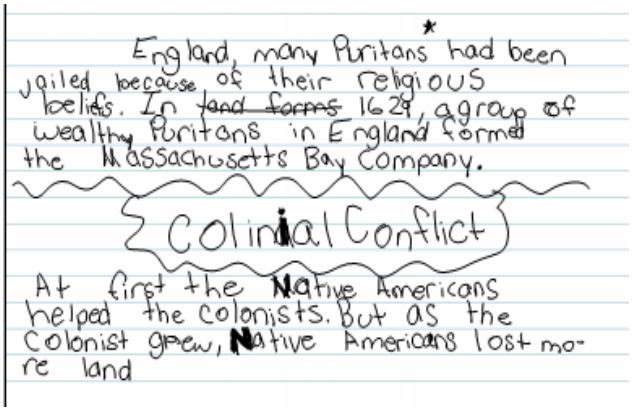


*Figure 8.*Temporal Flow of Repeated Reading Strategy with the Smartpen

Bikem presents a good example of the way in which participants utilized the models of reading that they recorded within the classroom to generate their own models of reading through rehearsal. While Bikem, Dilara, and Berna all created the same recording of their teacher Mrs. Mitchell reading aloud to the class from the social studies textbook, Bikem took a step beyond the other participants to create a separate recording of her own voice reading the same passage aloud within her home environment. The comparison between Bikem's recording and Dilara's notes about the same classroom topic (colonial North America) is illustrated below.

To live in North America:

King Charles gave the Massachusetts Bay a charter to live in North America. Puritans came to North America for religious freedom. First statesman was named Boston, now Rhode Island. Roger Williams was a discoverer and leader from Massachusetts. Williams paid a native American for some land which became Rhode Island. Thomas Hooker founded Connecticut; he


England, many Puritans had been jailed because of their religious beliefs. In ~~land forms~~ 1629, a group of wealthy Puritans in England formed the Massachusetts Bay Company.

Colonial Conflict

At first the Native Americans helped the colonists. But as the colonist grew, Native Americans lost more land

believed that each clan should be independent. (Bikem, Recording, 1/13)	(Dilara, Notebook, 1/13)

It is important to note from this excerpt that Bikem grappled throughout her recording with issues of pronunciation, especially with the formal nouns related to colonization. However, her attempt to read to herself demonstrates a level of self-mediation associated with approximating the teachers' model of the reading text with respect to intonation and stress through repetition. It is somewhat unsurprising that Dilara and Berna did not create recordings of themselves reading this particular passage aloud because their level of language proficiency was higher than Bikem's. As such, the ability of the Smartpen to promote the development of oral reading skills through exposure to reading models and rehearsal may be especially helpful for developing ELs.

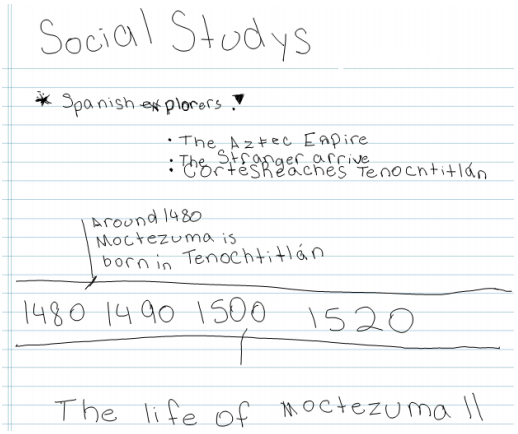
4.3.6. Support for Writing

Extended Practice: "The more pages you use the better writer you are." (Ms. Chua)

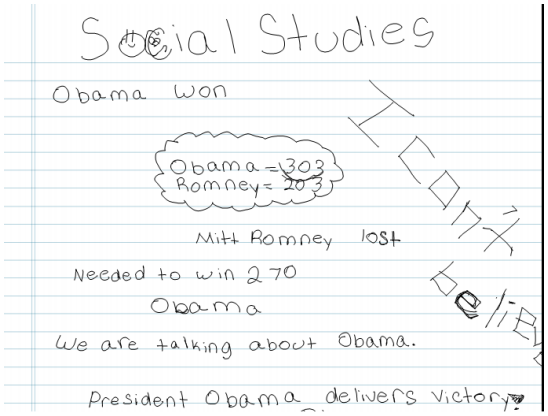
In the words above Ms. Chua referenced the extensive writing that the participants engaged in on account of using their Smartpens. It was common for the students to keep track of the number of pages that they used in their notebooks as a means of gauging the amount of writing that they were doing. The idea that writing more or more frequently could help them to become better writers was apparent in their persistent reporting of these page numbers during researcher observations. These included comments such as "I wrote up to page 18" (Bikem) and "I did it up to page 29" (Dilara).

In general, the extended practice of writing that occurred with the Smartpen was mostly a function of taking notes during classroom instruction, which was a new learning behavior for the participants (to be discussed in research question three). The type or genre of writing represented in their notebooks is most closely aligned to structured versus expressive forms of writing, which typically consist of copying dialogues, completing worksheets, and keeping a vocabulary notebook (Horwitz, 2013). SLA research also supports structured writing as the most beneficial form of writing practice for ELs (Gómez, Parker, & Lara-Alecio, 1996). The types of structured writing found within the students' notebooks included vocabulary lists, graphic organizers, and main idea and supporting detail notes, many of which were modeled on the chalkboard by Mrs. Mitchell, their mainstream teacher. For Berna and Dilara, the two students who took the most classroom notes, improvement was demonstrated over time in their writing ability at the word level, as was evident in their notebooks. Included in Figure 9 below are two examples of self-corrected spelling that occurred at the micro-level of writing development.

Dilara10/12

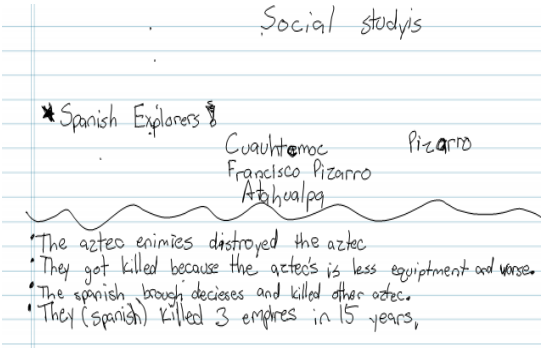


11/12



Berna

10/12



11/12

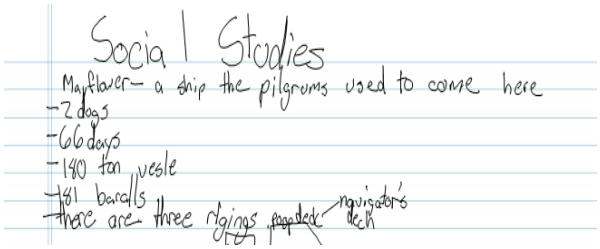


Figure 9. Temporal Development of Writing Skills

In both of these examples the participants improved their spelling of the word "Social studies" in a month's time after using it regularly as a header to identify their notes. This small indicator of writing development attributed to extended practice underscores the ability of the Smartpen to mediate writing skills for ELs through structured writing opportunities.

4.3.7. Summary of Thematic Thread One

This first thematic thread highlighted some ways that the Smartpen mediated the learning of various language skills. Collectively the participants in this study pointed to

the potential of the Smartpen to extend their physical access to language-based materials as well as their productive uses of English in oral and written forms across educational settings. Some dimensions of this theme involved the notions of learner control over listening input, multimedia vocabulary support, languaging in interactional, transaction, and playful ways, and extended practice of reading and writing through the use of this mobile device.

From the data, the Smartpen's contribution to the development of certain language skills was more apparent than others. For example, in fostering speaking skills, the pen's use was multi-faceted through extended audiences of both self and other, while in writing it was more uni-dimensional as limited to the genre of structured writing. However, at both micro and macro levels, instances of growth were evidenced for participants individually and collectively as it related to their experiences of using the Smartpen for creating self-authored artifacts.

Finally, this thematic thread of the creation and use of self-authored artifacts for language learning speaks to the issue of how student-driven uses of mobile technology can facilitate L2 learning through formal (e.g., repeated reading) and informal (e.g., self-talk) opportunities, while also extending the scope of L2 leaning beyond the classroom space.

4.4. Thematic Thread Two

Extending Opportunities for Learning Math: Co-Constructed Artifacts

4.4.1. Overview of Findings for Research Question Two

How does the Echo Smartpen tool support the mediated learning of middle school ELs in different content areas (e.g., math, science, etc.)?

To address this research question regarding the potential of the Smartpen as a mediational tool for learning across content area disciplines, the participants' use of the device in their primary academic courses was considered. However, the data overwhelmingly revealed math as the most saturated content area for which the Smartpen was used, and thus has been selected as the focus for this section. The actual reasons for which participants used the pen for math learning more than for other content areas were somewhat unclear. The lack of pen use (note-taking or recording) for other disciplines could indicate that it is not a useful tool for learning science, social studies, or foreign languages. In fact, many teachers did not allow the pen to be used for foreign language study, which may reflect its lack of congruence with learning these subjects. Alternatively, it could suggest that in English reading and writing classes, the language skills were already integrated into the content area courses, making the pen irrelevant for these specific subjects. In any case, to summarize the patterns of use across various subject area disciplines according to the number of class periods recorded, a frequency graph is presented in Figure 10, below. The purpose of this display is to provide a portrait of when the Smartpen was used by the participants and to highlight the disproportionate use of the device for learning math. What follows is the presentation of the second

thematic thread as it relates to the extension of learning through co-constructed learning opportunities exclusively in math.

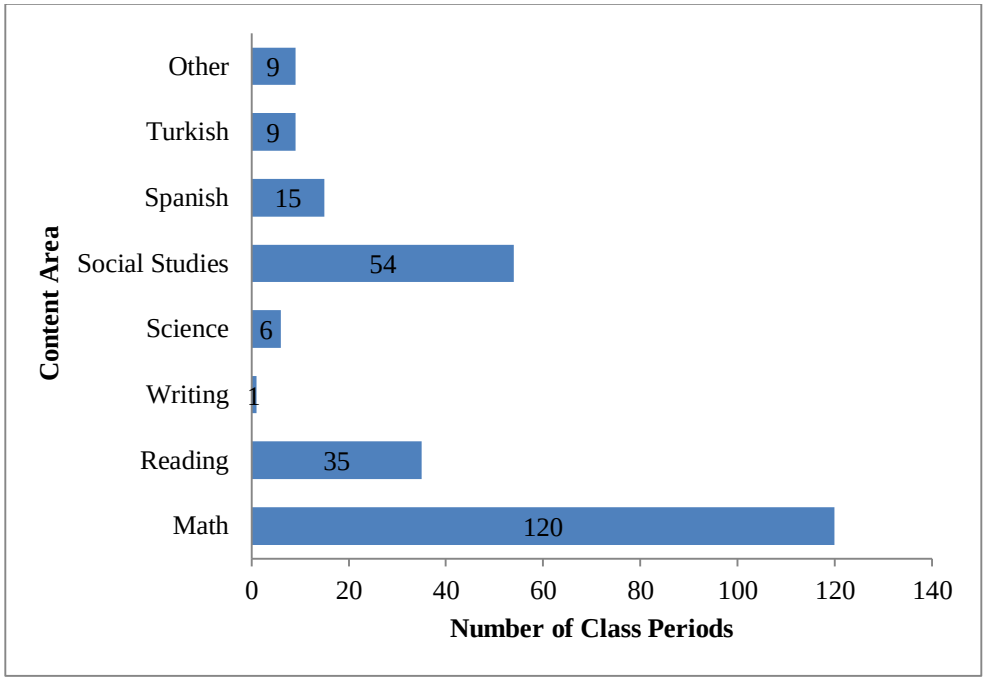


Figure 10. Summary of Smartpen Use by Content Area

> "My ESL students don't have the basic computational skills the other students have. Like addition and subtraction, even multiplication."
>
> (Mrs. Mitchell, Interview, 2/13)

Mrs. Mitchell's words above illuminated a common thematic undercurrent for all of the participants that emerged from their notebooks, recordings, and interview data, essentially their struggle in learning math concepts rooted in a lack of foundational skills. When looking across participants, all of the learners expressed math as their most challenging subject in school, some with more extreme difficulty than others, like Dilara who said, "Math is hardest class, my top hate list is for math (Interview, 2/13). From frequency tabulations it was apparent that the participants made the most use of their

Smartpens during math class and for learning math concepts, with a rationale explained best by Berna who stated "I like using it at math because we do a lot of complicated stuff in math" (Interview, 11/12).

In exploring how the Smartpen specifically contributed to the participants' ability to learn the complicated stuff of math, it became clear that unlike in their learning of language skills, the use of the Smartpen for recording and note-taking was not solely an individual endeavor, but instead a collaborative one. A common pattern observed for six of the seven participants was the use of the Smartpen in cooperation with a more expert other (e.g., teacher or family member) for scaffolded problem-solving sessions that were co-authored and captured as artifacts for later review through the recording and note-taking features of the device. Because these personalized learning moments occurred beyond the bounds of the mainstream lesson delivery, they are considered as an extension of learning opportunity for the participants, as they represented an alternative space for learning interactions. In delving deeper into the descriptive dimensions of these co-created learning experiences, specifically if, when, how, and why they occur (Saldaña, 2009), they fell along a continuum based on the (a) co-author, (b) setting, (c) math content, (d) balance of participant interaction and (e) use. In what follows, findings about the characteristics of the co-development of math skills with the Smartpen will be discussed.

4.4.2. A Co-Authored Artifact: "I take my pen and I let her talk in it." (Dilara)

As described by Dilara, the Smartpen commonly accompanied individual student-teacher learner encounters as a means of recording, or capturing a personalized moment

of learning. The use of the Smartpen in this way transcended language levels of proficiency, as Berna, Dilara, Bikem, Sabiha, Lalehan, and Tanyeli all took a similar approach to help-seeking and clarification of math concepts for improving their math skills. Despite the differing math focus for these negotiated meaning-making opportunities, all learners followed a similar pattern regarding the order in which they sought out their co-author or co-participant. Results indicated that overwhelmingly, students looked toward their ESL specialist as the primary means of negotiating meaning and co-constructing understanding, followed by their mainstream teacher as a secondary source of assistance, and finally members within their home settings. This is demonstrated in the graph depicted in Figure 11, below, which displays the percentage of the co-constructed learning experiences by author.

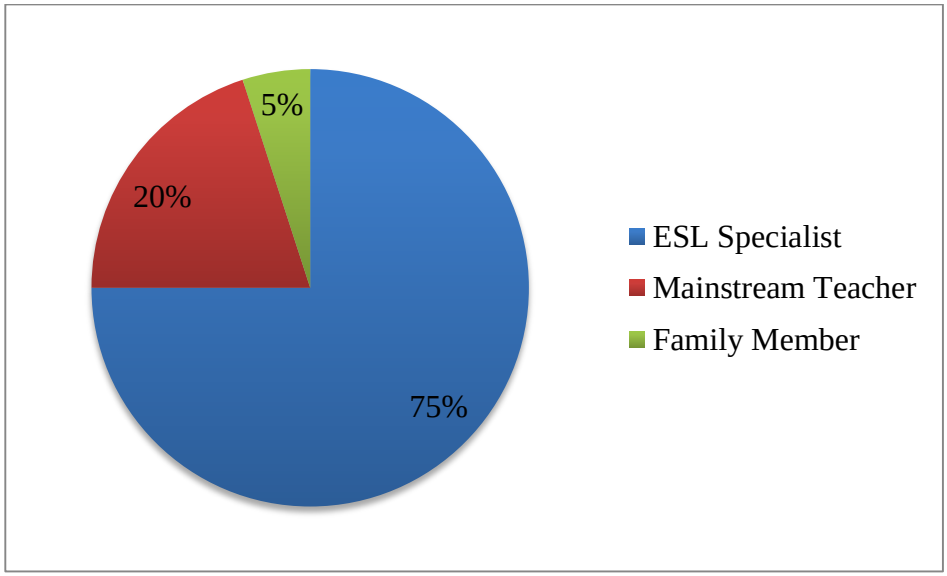


Figure 11. Breakdown of Co-Authored Learning Experiences by Author

To some extent the participants' heavy reliance on the ESL specialist for learning support is understandable and even expected given the level of trust that ELs develop with their ESL specialist. ELs often come to associate the ESL specialist as their main

advocate within the school setting, which may also have contributed to their enhanced willingness to work with her as opposed to the mainstream teacher (de Jong & Harper, 2013). In fact, students alluded to Ms. Chua's sensitivity toward their linguistic needs as L2 learners when asked to explain why they would ask for Ms. Chua's help rather than their mainstream math teacher. Berna said, "I don't understand if the teacher uses big words that I don't know yet and she says it and I don't understand what she's saying. It becomes hard cause when I raise my hand she doesn't call on me; but Ms. Chua doesn't use big words like that" (Interview, 2/13).

Here Berna also raised another issue relating the time constraints imposed upon the mainstream teacher in terms of being able to respond to individual students' inquiries or provide tailored explanations to individual students in light of her responsibilities as a mainstream teacher. The issue of time limitations upon the mainstream teacher was also raised by Mrs. Mitchell herself who at one point told the class, "I'm teaching everybody, I can't teach just one person. Not right now at least. Not until it's practice" (Math Class, 11/12). From these words it is clear that Mrs. Mitchell's time for individual instruction for all learners, not solely ELs, was at an absolute premium. This is not to say that Mrs. Mitchell did not structure any time into the schedule for helping students, but rather that the most readily accessible source for help within the classroom was the ESL specialist.

Similarly, as evidenced in the data, students commonly referred to the dilemma of having limited academic support within their home environments, making it an unpopular site for collaborative learning. Results suggested that the common reasons for the lack of learning support related to parents' work responsibilities, childcare responsibilities, and the English language barrier. As will be demonstrated below, parents were able to

support students' learning in certain ways, by using their L1 on some occasions. However, in some cases even after participants sought help within their homes, they circled back to the mainstream teacher for further assistance, which was predominantly language-specific. This process was described by Mrs. Mitchell:

> Sometimes if they don't understand something on the homework they'll bring it up and have me write it out. Or if mom or dad tries to explain something at home and they don't understand what it is they'll have me explain it.
>
> (Interview, 2/13)

Ultimately participants seemed to follow a temporal cycle for co-constructing learning experiences with the Smartpen. This cycle is depicted in Figure 12.

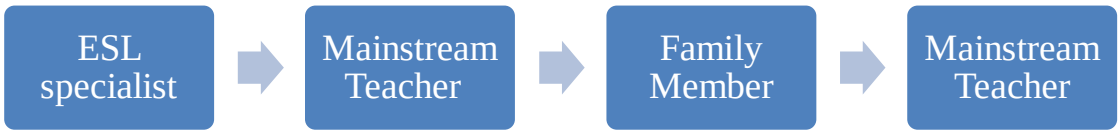


*Figure 12.*The Temporal Sequence of Co-Authorship

In sum, considering the various limitations on learning support for the ELs both within and outside of the classroom, an important contribution of the Smartpen seemed to be that it allowed them to take advantage of the help that was available to them at any given time, and to in a sense eternalize that help by creating a recording that could be later referenced.

4.4.3. A Space for Co-Construction: "Record. Hello. Ok, this is during lunch time so it is kind of noisy." (Ms. Chua)

The words above mark the beginning of a co-constructed recording and note-taking session between Ms. Chua and Berna. From the data it was apparent that the

participants were aware that they were recording the one-on-one interactions with their teachers and even strategic about doing it. At times it was the teacher who initiated the introduction to the recording, such as in the example above, but in other instances it was the student who referred to the premeditated nature of creating a co-authored recording and note-taking session. Common teacher introductions included phrases such as "Hello (student name), we are now doing your math. I'm helping you do your math." This mini-dialogue between Bikem and Tanyeli is a good example of students' awareness of their recording behavior when working individually with a teacher:

Bikem:	Are you recording it?
Tanyeli:	Yeah. Shh ((hushing students)). How do you do it Ms. Chua?

(Math Class, 10/12)

Dilara also made similar comments to Ms. Chua during a co-authored problem-solving session:

Dilara:	This recording is still going on.
Ms. Chua:	That's good because it's seeing how you're solving it.
Dilara:	Ok. Seeing me or hearing me? If you wanna listen to this, just click on the star right below the problem. Bye! Yep, it works.

(Math Class, 1/13)

Although very few patterns emerged to explain why some co-constructed learning experiences were teacher versus student initiated, the spaces where these experiences occurred were commonly present across all of the participants. For the learners, the most frequent site for engaging in the creation of a co-constructed artifact was within the mainstream classroom during individual practice time, followed by recess, and later within the home and other spaces. The chart in Figure 13 visually displays the percentage

of co-constructed learning experiences that occurred within each of the settings as revealed by the data. Encompassed within the category of "other" are before and after school free time that students took advantage of and reconfigured as instructional opportunities to be recorded.

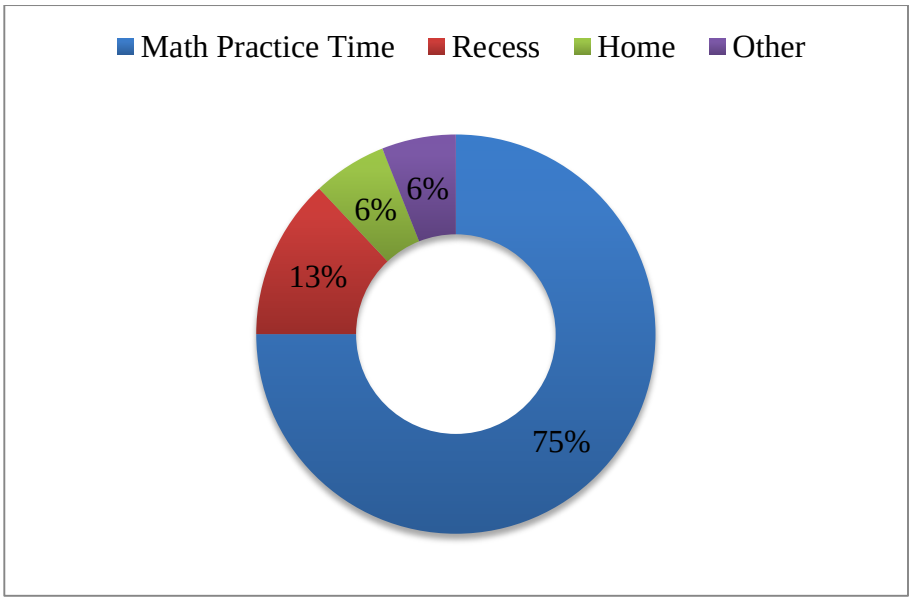


Figure 13. Breakdown of Co-Authored Learning Experiences by Setting

Given the allotted time for individual student practice during the mainstream math class, the majority of student-teacher recorded problem-solving sessions occurred within this frame of time. This seemed to have allowed learners a more immediate and contextualized learning experience, as the content of the sessions was aligned to the current classroom learning task. This was further evidenced in the content of the teacher-student discussions that often referenced the specific number of textbook problem, or a specific word from the math register that was focus vocabulary for the lesson.

Recess provided different affordances as a learning space for the participants. Dilara, Berna, and Bikem especially used recess, both indoor and outdoor, as an

opportunity for seeking assistance from their teachers. Both the mainstream teacher and ESL specialist took part in these recess-based learning opportunities. Recess was unique in that it allowed more time for the learner to work with the teacher and also because it permitted the playback aloud of previous recordings. Since the playback of previous recordings was often unfavorably viewed within the classroom as distracting to others, recess became a safe place for learning with the Smartpen. This was confirmed by Dilara, Berna, and Bikem, who expressed often listening to their recordings during recess and feeling most comfortable using their Smartpens during recess.

In general recess was a more ample setting than the mainstream classroom for reconstructing a lesson comprehensively. Below Berna recounts two instances when she requested a more thorough re-explanation of a lesson, once with Ms. Chua and once with Mrs. Mitchell.

> I use my pen at recess when I have to listen back. Sometimes I did it [at recess] because one time Ms. Chua helped me do it because I recorded a teacher, but I forgot to write something down and I couldn't find it, so Ms. Chua re-did the lesson. I sort of explained to Ms. Chua what she [mainstream teacher] was teaching and then Ms. Chua did the lesson while I was recording.
>
> (Interview, 1/13)

> One time at recess I couldn't write it down [lesson] cause she spoke too fast and I wasn't there for some of it. So at recess I asked her [mainstream teacher], so we sat on the curb and she taught me how to do it, and she wrote in my notebook, and she was like first you do this and then you do that.
>
> (Interview, 2/13)

In these excerpts Berna provided some insight into why she needed to create a personalized replacement for the original lesson material with her instructors. She cited both physical factors, such as losing the original lesson material or being absent from the

classroom, as well as input-based factors like the speed of the lesson delivery, that seemed to interfere with her ability to benefit from the lesson upon its first presentation. The ability afforded to the learners to re-create an instructional moment with either the original instructor or another instructor by using the Smartpen presents an extension of what would be the traditional learning experience as a singular occurrence and classroom-based. Therefore, some of the mediational potential of the Smartpen lies in its ability to extend learners' exposure to the instructional content giving them a second chance to make sense of or recover missed or poorly understood instruction.

Notably, Berna discursively signaled her role as an active participant in these learning encounters through the words "*I* sort of *explained* to Ms. Chua what she was teaching." Berna marked herself as an active contributor and implicitly referred to her own re-processing or re-visiting of the concepts initially presented through the social act of communicating this knowledge to Ms. Chua. In effect, Berna underwent a secondary learning experience through the communicative act. Likewise, she exhibited a level of agency in seizing the opportunity for additional instruction and orchestrating the process of lesson reconstruction as reflected in the words "so at recess *I asked her."* In considering the Smartpen's role in mediating learning experiences related to math, it is important to note that Berna's case is not unique from the others, but rather is used as an illustrative example of the collective experiences described by several participants.

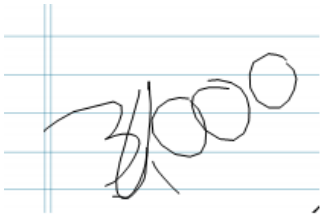
4.4.4. A Personalized Math Focus: "The Smartpen's gonna help me learn much better cause I don't know that much math. Like, I don't know that much divided." (Bikem)

The actual content of these co-constructed math learning opportunities can be grouped according to the three primary domains of math cognition: math register, math computation, and math reasoning. In brief, math register is the language used to talk about mathematics (Slavit & Ernst-Slavit, 2007), including specialized and technical vocabulary. Math computation refers to the ability to procedurally perform math calculations (addition, subtraction, multiplication, division), while math reasoning is applied problem-solving where the addition of linguistic information requires learners to construct a problem model before performing calculations (Fuchs, Fuchs, Hamlett, Lambert, Stuebing, & Fletcher, 2008). As revealed by the data, the instructional focus of the recorded problem-solving sessions was stratified by the level of English proficiency of the students. Conversations between the teacher and the developing level learners like Tanyeli, Lalehan, and Bikem, and to some extent the early expanding learners like Sabiha, centered upon the topics of math register and math computation. Late expanding and bridging learners like Dilara and Berna tended to engage in topics associated with their development of math reasoning skills, or applied problem-solving. To demonstrate this progression in the complexity of the math knowledge constructed during these personalized learning sessions, an example from each level of language proficiency is provided below.

The co-construction of math register through L1: Lalehan (Early developing)

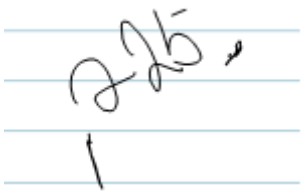
Lalehan was the learner who struggled the most not only academically, but also with the English language. Her English proficiency was the most basic of all of the participants in the study. During my time at the school, Ms. Chua expressed her belief that Lalehan had been assigned an individualized education plan (IEP) for her learning needs, although this was never officially confirmed. The following dialogue reflects a shared learning experience that occurred within the home setting between Lalehan, her mother, sister, and brother-in-law, the latter of whom guided the extended practice session on high frequency math vocabulary and notation related to counting money. This entire dialogued occurred in the student and family's native language, Meskhetian Turkish. Lalehan's accompanying math work is placed in chronological order above the dialogue to help contextualize her struggle with comprehending the terms dollars and cents.

1.

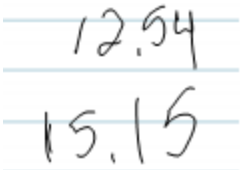


2.

3.



4.



(Notebook, 11/12)

2:34

Brother-in-law:	Ok. Write 300 dollars. It is 3 dollars. Two digits after the decimal means "cents." If you write cents, put a decimal. When I tell you 300 dollars, there are no cents, so just put a "0" for cents. Write 300, then a decimal, then two 0s.
	((sequence 1))
	In your example, your teachers says, he had 50$, and he spent $24 and $12. Add 12$ and 24$, then subtract from 50$. If you write dollars with "0s", you can subtract easily. You have to do the exercises yourself, and you have to learn how to write dollars and cents.
Sister:	Lalehan, write 20 dollars and 50 cents.
	(.08)
	((sequence 2))
Brother-in-law:	Do not make the same mistake as in the others. Why are you making this mistake again? What did your sister just tell you? Do not do the operation, just write it and learn how to write it. Do not subtract yet. Now, 12 dollars. Put a decimal and then fifty which means cents. Again, write 12 dollars 25 cents. Good.
	(0.9)
	((sequence 3))
Brother-in-law:	12 dollars 54 cents. Good. Now your mother will give you an example.
	(.10)
Mother:	15 and 15.
	(.15)
	((sequence 4))

5:42

This example clearly demonstrates the progression of Lalehan's learning that comes about as a result of her scaffolding in the L1 with her brother-in-law, sister, and mother. The stages of her development and comprehension of how to notate dollars and cents are visually evidenced as she completed her session able to properly notate the target terminology. As her brother-in-law mentioned, Lalehan was not equipped to begin her textbook examples that required applied problem-solving. First she needed to gain confidence and expertise with the terminology that would form the foundation for more

applied math skills. For Lalehan, this required mediation through her L1, or models of L1 support that she was able to capture using her Smartpen.

The co-construction of math register through L2: Bikem (Developing)

Like Lalehan, Bikem was of developing language proficiency and required more support from Ms. Chua than the intermediate ELs on issues of math register. Below is an excerpt from a recording that Bikem created with Ms. Chua in which she negotiated the meaning of specialized vocabulary words required for measuring angles. This recording did not have accompanying notes and occurred during individual practice time within the math classroom.

1:39
Bikem: So an acute angle is small?
Ms. Chua: An acute angle?
B: Like it opens wide right?
Ms. C: Yeah, here's the exact definition. An acute angle is any angle less than 90 degrees. An obtuse angle is any angle more than 90 degrees. Basically it is between 90 and 180.
B: Like 1000?
Ms. C: No.
B: 100?
Ms. C: I just said between 90 and 180.
B: So it would be 92, 98 :::
Ms. C: Yes, because it's more than 90 degrees.
2:15

(Recording, 10/12)

Here Bikem was able to negotiate the meaning of an obtuse angle in English under the guidance of Ms. Chua who provided not only a contextualized definition for the term, but also the clarification and reinforcement of Bikem's own examples. Bikem arrived at an understanding of these terms by the end of this exchange as demonstrated by her ability to give several examples of the measurements of obtuse angles.

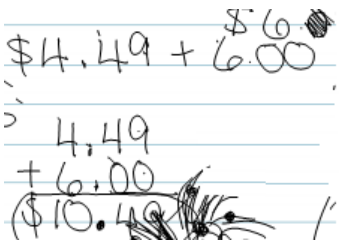
The co-construction of math computation: Sabiha (Early expanding)

Sabiha was of intermediate language proficiency and generally needed less support with the language than the calculations of math. Below is an example of a recorded note-taking session that occurred before math class in which she negotiated how to complete math addition calculations. Similar to Lalehan, Sabiha too struggled with the concept of money, but at a more advanced level. Unlike Lalehan, Ms. Chua wrote the example for Sabiha in her notebook. An excerpt from her notebook page is presented below the dialogue.

0:00

Ms. Chua:	So we're gonna do four dollars and thirty nine cents plus six dollars. That's pretty much how you start writing it first. (.04) Because this looks just like a six that [$6.00] is equal to that [$6] so when you add these two together it becomes like this $4.49 plus $ 6.00. Always line up the decimal points together. So what's nine plus eight? (.02)
Sabiha:	Nine.
Ms. C:	Four plus zero?
S:	Four.
Ms. C:	And then you just bring down the decimal point and then four plus six. (.04)
S:	Nine?
Ms. C:	No, try again. (.03)
S:	Ten.
Ms. C:	Ten, so now your answer is $10.49.

0:56



(Notebook, 10/12)

In this exchange Ms. Chua scaffolded the process of how to set up an addition model for beginning a math calculation. As can be seen, Sabiha experienced difficulty not only in preparing the model for the addition problem, but also in performing the addition procedure itself. Ms. Chua was instrumental in providing a step-by-step guide for Sabiha with respect to learning how to approach a similar problem in the future. She also played an important role in clarifying issues of math register associated with notating dollars as well as in disconfirming incorrect calculations that could interfere with Sabiha's ability to perform later math computations. From participating in this interaction, Sabiha was left with a multimedia "template" of a computational model for future reference.

The co-construction of math reasoning: Dilara (Late expanding)

Although Dilara was technically an intermediate EL, she was more advanced intermediate than Sabiha. Her math abilities extended beyond simple computations so that her main focus when working with her teachers was on developing her math reasoning skills, specifically with word problems. An example taken from the mainstream math classroom describes an interaction between Dilara and Ms. Chua as they co-constructed how to translate the language of a word problem into a problem model before performing math calculations. Here both Ms. Chua and Dilara made notations on the notebook, demonstrating a shift in regulation from other to self-regulated learning. The respective selections of the notes created by Ms. Chua and Dilara are denoted for clarity in the accompanying notebook page.

0:00

Ms. Chua: So we're gonna start with number one?
(.05)

Dilara: Look, I wrote it down here.

Ms. C: You already wrote it down?

D: Yeah. It's practice.

Ms. C: So in August, a bookstore owner purchases 810 books for a new store. In September she purchases 744 more books than she did in August. How many books did she purchase in those two months? ((reading the word problem))
((sequence 1))

D: Shh it's recording [to other students]. So I add them up?

Ms. C: It looks like it is. Let's see, September she bought that much and then August.
(.05)
Yeah, because in August this is August and then this is September so now it's asking how many books did she purchase in those two months.

D: So I add them up?

Ms. C: Yep.
(.18)
((sequence 2))

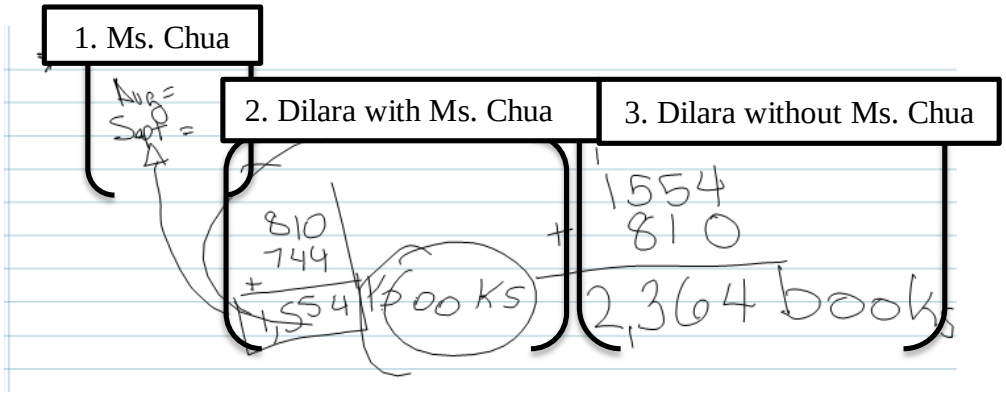
D: So wait don't go. And then we're gonna do that and then that. Guys, it's recording.
(.27)
Shh, it's recording [to other students].

Ms. C: I will do one more with you.

D: Can I do one by myself?

Ms. C: Yeah, and then I'll check it with you.
(1.14)
((sequence 3))

3:24



(Math Class, 11/12)

From this dialogue it is evident that Dilara experienced difficulty in connecting the language of the math-word problem with the mathematical operations that were required to complete the problem. She repeated her question several times, *So I add them up,* indicating a level of confusion surrounding what to do next. In the first stage of the problem Ms. Chua began by setting up the model for Dilara; however, her level of guidance gradually diminished as Dilara gained more confidence and understanding about how to proceed. This is seen in the shift from her original reluctance to let Ms. Chua move on to assist other students, to an emerging boldness in asking to complete a problem on her own without the help of Ms. Chua. The third section of her notebook illustrates Dilara's emerging independence as a problem-solving that transpired in the course of her interaction with Ms. Chua.

Another relevant aspect of this co-construction of knowledge is Dilara's attendance to the fact that it was recorded. At several points she interrupted neighboring students to remind them that she was recording this problem-solving session and required their silence. Assuring the quality and intelligibility of her recording is an indicator of Dilara's planning process to use this recording for future reference underscoring value that she attributed to being able to document it with the Smartpen.

4.4.5. A Negotiated Interaction: "Because teachers are students too." (Berna)

In the same way that the co-constructed learning experience of math was shaped by the level of math content appropriate for participants based on their level of English proficiency, their level of linguistic interaction varied by this criterion as well. While Berna overtly positioned both students and teachers as learners with their voices to contribute to the cooperative learning experience, not all learners interacted to the same

degree when co-constructing knowledge with their teachers. General patterns in the data marked a continuum of learner interaction, essentially the balance of negotiation that occurred between teacher and the learner based on the participants' level of English proficiency. For developing ELs, like Bikem, Sabiha, and Tanyeli, the interaction was characterized by more teacher-talk, meaning that they produced very limited linguistic output to help them make meaning of the target math concepts. In these instances, the teacher contributed most of the information to the dialogue with little resistance from the students in terms of discussion, disagreement, questioning, or clarification (e.g., limited negotiation). On the contrary, bridging ELs like Berna, or even late expanding learners like Dilara, more actively participated in the linguistic construction of knowledge by using speech to clarify the meaning of math terms and essential processes, ask questions about the information shared by the more knowledgeable other, and propose new information during the exchange (e.g., participatory negotiation). To illustrate this contrast, two examples of co-constructed recordings are displayed below. The first is a recorded exchange between Ms. Chua and Tanyeli, where the topic was the co-construction of math computational knowledge, while the second is of Mrs. Mitchell and Berna, where the focus was on the co-construction of math reasoning skills.

Limited negotiation: Tanyeli

0:00

Ms. Chua:	Number ten, so it says, six dollars minus sixty-five cents. What's another way we can do sixty-five cents?
	(.05)
Tanyeli:	Uh by putting a 20?
Ms. Chua:	Is it the same as this, correct?
	(.04)
T:	Yeah.

Ms. Chua: Because there's zero dollars in there, right? So now you're gonna convert this into this part. Six point zero zero minus zero point six five ok?
(.03)
Can we do zero minus five? No, so this will become a nine and this would become a five this will become a ten:::
Ms. Chua: So ten minus five is :::
(.03)
T: Five.
Ms. Chua: Nine minus six is:::
(.04)
T: Nine minus six is:::(.03) three.
Ms. Chua: And then we bring down the decimal point five minus zero is:::
T: Five.
Ms. Chua: And look, we just got your answer.
1:26

(Math Class, 10/12)

Participatory negotiation: Berna

0:00
Berna: I didn't understand it [measuring with a protractor] because I didn't know if you used the inner numbers or the outer?
Mrs. Mitchell: Well, look if you line it up here, I don't have the other line in my protractor to measure it with the protractor.
B: I lined it up the other way.
Mrs. M: Ok, so let's line it up the other way. So here's my zero, I am following my outside number all the way around.
B: But how do you know you need to use your outside numbers?
Mrs. M: Because the arrow is pointing to zero over here.
B: Ok. Yeah, but that arrow isn't that way.
Mrs. M: But if I was doing the other one, look (.05) if my arrow was pointing to zero over here I'd be using my inside numbers (.03).
B: Ah:::
1:34
(Recess, 10/12)

In the case of Tanyeli, much like in the earlier scenario presented of Sabiha, Ms. Chua did most of the talking in the interaction. She prompted Tanyeli to respond verbally with the numbers and essentially completed the problem for her. Here Tanyeli did not

challenge Ms. Chua's logic, but rather smoothly followed her lead, while Berna presented a counter scenario in her interaction with Mrs. Mitchell. In Berna's case, she questioned Mrs. Mitchell at several moments during the interaction and even challenged her response in saying, *but that arrow isn't that way.* Although in both examples the students arrived at a new understanding at the end of the encounter, the linguistic process by which they did so was somewhat different, with Berna clearly using much more scaffolding and questioning strategies to negotiate than Tanyeli.

Considering these students' differing command of English in terms of their ability to explain their own processes, it is somewhat to be expected that expanding and bridging learners would be able to engage in higher levels of interaction than developing learners. However, with respect to mediation, it is important that all participants were able to document these moments of co-constructed learning and models of problem-solving that were explained and conducted at their own linguistic level. The capacity of the Smartpen to archive customized encounters about math negotiated through the target language served a dual purpose: to benefit the learners' development of both math and language skills.

4.4.6. A Purpose for Recording: "I listen to it and then I do a different problem that's similar to it." (Dilara)

As mentioned earlier, all of the participants except for Sonay found this system of co-creating artifacts about math learning with their teachers helpful for their development of math skills. In fact, all of them reported similar motivations for embarking on these co-constructed experiences and numerous strategies for the later use of their recordings. The most common rationale for using the Smartpen to seek assistance from teachers at home

and within school was that these individuals provided *better, easier*, or *more specific explanations*. Dilara's words get to the heart of the participants' preference for scaffolded instruction as it related to seeking details. She stated that "Sometimes it's better because she [the teacher] writes more stuff about it, she makes us understand, she makes us understand more" (Interview, 2/13). Since participants believed their teachers had better explanations that improved their comprehension it seemed like they wanted to create an archive of these explanations, especially the ones that pertained mostly to their personal needs.

Relatedly, when asked how they used the recordings of their teachers working directly with them post-creation, they shared a similar logic. Like Dilara's introductory statement about using the recording to complete a similar problem on her own, Berna and Bikem spoke to this use of the recorded problem-solving sessions as well. They all referenced the act of listening to the recording as a way of stimulating their own independent problem-solving and example creation. Berna said:

> Sometimes I'll just be like listening and thinking about the stuff that I don't remember and sort of think about how I can try it again. Like I make a problem by myself and do it.
>
> (Interview, 1/13)

On account of having access to pre-recorded models of problem-solving that were both tailored to their individual math and language levels, the participants were able to extend their learning of math concepts even further on their own by using the recorded model as a guide to orient their thinking. Given the established difficulty of students' playback of their recordings during the school day (with the exception of recess) it can be assumed that most of these instances of example-creation occurred within settings outside

of the school, which was also supported by their time stamped notebook archives of self-narrated, independent problem-solving sessions.

Below in Figure 14 is an illustrative example from Dilara's notebook in which she guided herself through the process of setting up a word problem. Note that this word problem was similar to others completed during classroom sessions and those previously modeled in co-constructed problem-solving sessions.

Mr. Schneider's class reads 2, 692 pages. Mrs. Cruz's class reads 2, 059 pages. What is the total number of pages the three classes reads? So we take all of them 2, 4, 5, 3, 2, 6, 9, 2, 2, 0, 5, 9, add them, 7,204 is my answer. That's what you do, bye!

(Notebook, 11/12)

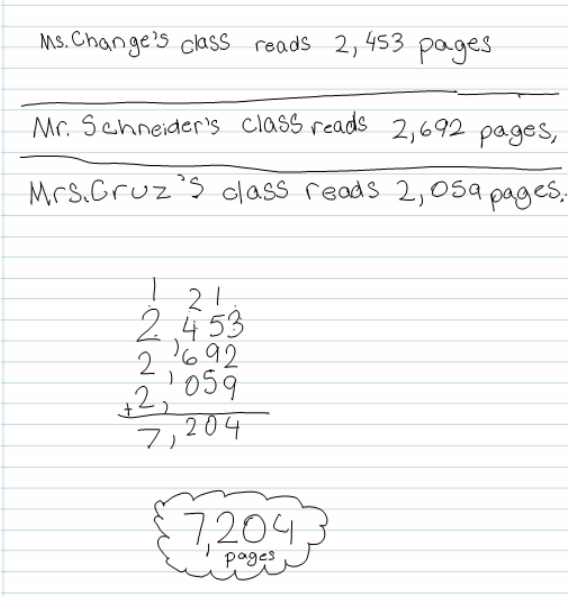


Figure 14. Dilara's Independent Problem-Solving Facilitated by the Smartpen

Dilara's accompanying self-narration here captured her transition from other-regulated to self-regulated as she confidently ended the recording with the words, "that's what you do." In a sense, she became a teacher herself by creating this tutorial on how to go about solving this particular word problem that she could previously only solve with the assistance of her teachers.

Thus, the ability of the Smartpen to transport collaborative models of math instruction across learning contexts fostered learning not only in the momentary sense of the real-time learning experience, but also broached a secondary type of learning

experience that occurred in the revision and re-creation of the learning at the individual level. The temporal model of the re-defining of the learning experience as it moved from present learning to the revision of past learning, which in turn informed the current learning, is depicted in Figure 15. This was a pattern common to all participants.

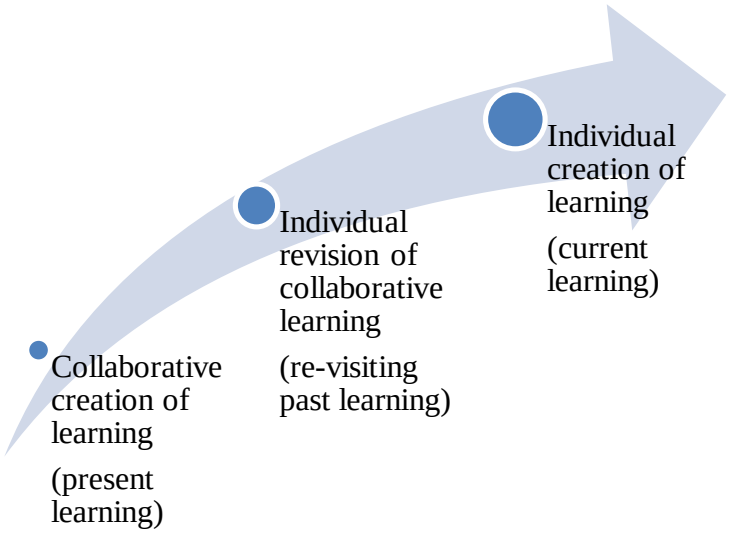


*Figure 15.*Temporal Sequence of Multiple Learning Experiences: Collaborative and Individual

4.4.7. Summary of Thematic Thread Two

This second thematic thread highlighted the potential of the Smartpen to extend opportunities for participants to learn math skills through the strategic co-construction of math artifacts. In collaboration with their ESL specialist, mainstream teacher, and family members, participants were able to create new learning spaces or pockets for learning within the mainstream classroom, at recess, at home, or in other parts of the school day using their Smartpen to record and document personalized learning moments that would otherwise be fleeting. Similarly, participants were able to overcome the ephemeral nature

of classroom instruction by re-constructing the learning outside of the classroom in alternative learning spaces with the help of the Smartpen and their instructors.

Some dimensions of this theme involved the co-authored experience, learning space, individualization of math instruction, level of linguistic negotiation, and strategic use of the co-constructed artifact. While collectively all learners shared a similar purpose and approach to learning math in collaboration with others regardless of their language level, their experience in learning math was customized according to their instructional needs and linguistic knowledge, as demonstrated by the classification of math knowledge as based on register, computation, or reasoning skills. All learners clearly demonstrated instances of growth in their math skills as a result of their collaboration with more expert others and pointed to their need for referring back to these recorded exchanges for further improvement.

In sum, this thematic thread of extending learning opportunity for ELs through the co-construction of multimedia math artifacts speaks to the inherent social dimension of learning and the need for providing ELs with repeated access to scaffolded and comprehensible models of instruction. It further highlights the need to make these models of learning accessible both within the context of traditional mainstream instruction and beyond in self-appropriated learning spaces.

4.5. Thematic Thread Three

Extending the Learning Self with the Smartpen

4.5.1. Overview of Findings for Research Question Three

Does the Echo Smartpen have any affective, cognitive, and metacognitive benefits for ELs? If so, what are some of these benefits?

> Yeah, like there's a new part of me that I never realized was there, like a different kind of Sonay out there, kinda like a new side of me. Having it makes me realize there's a new part of me that I never realized was there.
>
> (Sonay, Focus group interview, 12/12)

Sonay's words capture a thematic element common to all of the participants that was present in both interview and learning artifact data. Her words here refer to the emergence of an alter-ego or alternative *self* as L2 learners with and without the Smartpen. All of the participants reported instances of this process of becoming, describing themselves as feeling *different* or *unique* when using the Smartpen. Bikem summarized this experience in the words, "the Smartpen *makes me* special" (Interview, 10/12). Her words here reflect the transformational effect of the Smartpen on multiple aspects of her L2 self-systems (Dörnyei & Ushioda, 2009), describing it as having a direct impact [makes me] on her sense of self.

The specific dimensions of what it means to be a learner with and without the Smartpen can be categorized as (a) a better learner, (b) a more ready learner, (c) a more motivated learner, and (d) a more strategic learner. In what follows, each of these extensions of learner identity will be discussed as they correspond to specific affective and metacognitive benefits of using the Smartpen; namely factors that emerged, including beliefs about self-efficacy, motivation, anxiety, and learning strategies. Although

cognitive benefits were explored in the data set, no support for them was found, thus they have been excluded from the research findings. This null finding could suggest the Smartpen's lack of ability to support the different cognitive learning styles of L2 learners.

4.5.2. Affective Benefits

Self-Efficacy: "I think it's better for me to use it [the Smartpen]. (Dilara)

One of the main affective (factors relating to an individual's feelings and emotions) benefits for learners using the Smartpen relates to a change in their beliefs about self-efficacy, or the conception of themselves as *better learners* when using the device. This was specifically evident in their discussions about their course grades in which they attributed increased academic success to the use of the Smartpen. With the exception of Tanyeli, all of the participants expressed feelings of academic improvement relating to using the Smartpen. Common responses included "it helped me with my grades" and "it helped my grades because I remembered." Few of the participants were specific about the exact courses in which their grades improved; however, Sabiha mentioned "I felt like good because I was think every time I use it, I felt like I was getting better at some stuff, like math and reading" (Focus group interview, 12/12), suggesting math and reading as some possible examples. The effect of the Smartpen in contributing to positive beliefs about self-efficacy is best illustrated in Sabiha's learning artifact below, Figure 16.

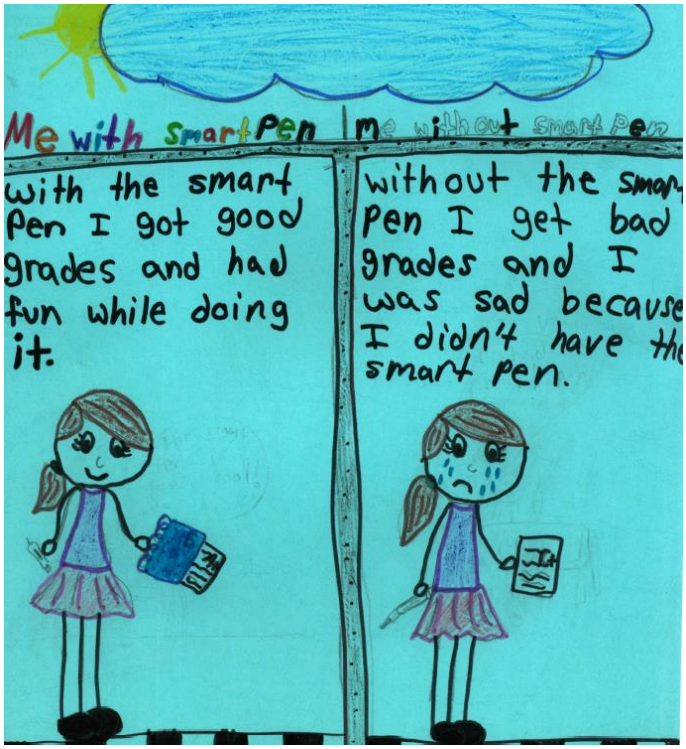


Figure 16. Sabiha's Vision of Learning With and Without the Smartpen

Here Sabiha visualized herself within two distinct roles, as two different learners, holding her Smartpen and notebook on the left and a traditional pencil on the right. The illustration on the left is one of success, a happy student and A^+ paper, while that on the right is a crying student with a C^+ grade. This transformation of self is also noted not only in the powerful caption she provides, but also the nuances of a sun shining over her while using the Smartpen with rainbow lettering (a hopeful landscape) and a cloud hovering over her in the absence of the Smartpen accompanied by black and white lettering (a dismal landscape). It is also important to note that Berna produced a similar artifact with the heading titles "with the Smartpen" and "without the Smartpen," depicting herself in math class within two different learning scenarios, one successful and one not, much like Sabiha. This dichotomous representation of self speaks to the temporal elements of life

during and *after* the Smartpen, underscoring a shift that occurred in the self-concept in relation to the Smartpen across time.

The development of a positive self-concept through academic successes is further described by Sonay who likened her use of the Smartpen to conquer academic feats with an analogy from the movie *How to Train Your Dragon*.

Sonay:	I actually watched a movie like this um there's like this kid, he trains dragons before that his dad really like thought he was worthless and he didn't care about him cause he wasn't a Viking kind of guy:::like he was weak. But now his dad is proud and you remember when he said, you're not a Viking and you're not my son? He his dad didn't listen to him ever...and now he does...and the dad believes in his son more than he usually did.
Researcher:	So how does that relate to you?
S:	Like, the pen it's kinda like a father to me ::: like::: a metaphor. And when I got it it's kinda get proud of me and I get better and better at it more than I usually do. I feel proud, proud ::: it's like my tests are the dragons and I try to ace them and that's like training them.

(Focus group interview, 12/12)

Here, Sonay alluded to herself as weak and in need of training that she is able to accomplish through the use of the Smartpen; the Smartpen was seen as a partner she worked with in tandem to conquer the figurative dragons of her tests. She reported feeling proud afterward, which points to a change in her affective state to a more self-assured and confident self when using the Smartpen. This change also seems be time-sensitive as she later added, "I felt more better than *I usually was* cause my grades got better and *now* they're kinda dropped, that's how I feel without the pen!" The present and past tense markers [usually was and now] connote this change in feelings about self-efficacy in a shift from the past success associated with the pen to the current lack of success without the pen.

Anxiety: "I think the smartpen is different because like, it just feels more comfortable." (Dilara)

Drawing upon Sonay's discussion of the role of test preparation in influencing L2 learners' affective responses, a secondary benefit for learners using the Smartpen relates to an enhanced sense of readiness that is associated with a reduced level of anxiety. From the data, the ability to record and review before taking a test seems to be a way of becoming a *more ready learner* as reported by Berna, Bikem, Dilara, and Sonay. This is noted in common patterns of responses such as "I listen to it [recording] because on Friday we'll have a test" and "normally when I go home, when I'm done with my homework I just listen to it [recording] just in case, because you might get quizzes, you never know, teachers do stuff." Most participants used the Smartpen as a means of preparing for future exams, or even the hypothetical possibility of one [*just in case*], by capturing an instructional moment in time. Learners seemed to benefit from the ability to prepare for the expected as well as the unexpected by using these recordings while also expressing feelings of security, comfort, confidence, and reassurance associated with the Smartpen. This is illustrated in a network view of Berna and Bikem's responses taken from a compilation of interview data in Figure 17.

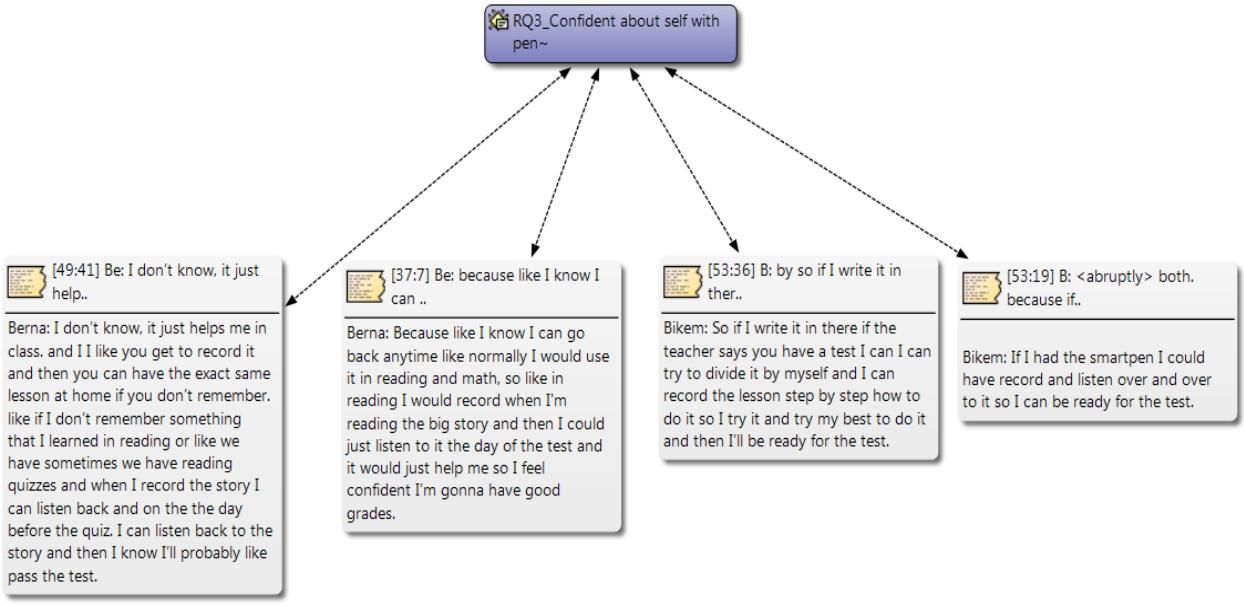


Figure 17. Network Diagram of Berna and Bikem's Discourse about Readiness and Confidence

In this graphic both Berna and Bikem associate the process of recording a lesson and reviewing it before a test as a means of becoming more prepared to succeed. The notion of readiness is expressed as a sense of *knowing* and of *confidence* in passing the test, which seems to replace the typical fear and apprehension of taking assessments, commonly known as text anxiety. At the discourse level, both Bikem and Berna indicate a nearly identical sequential flow of this process in the language they use to describe how they arrive at readiness for exams. This flow is depicted in Figure 18.

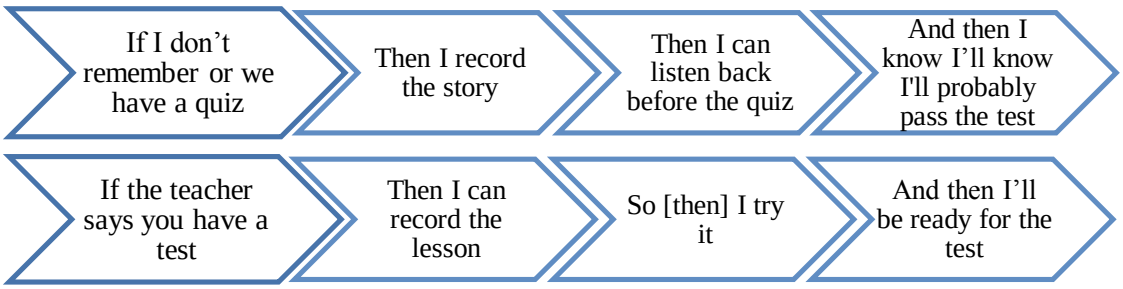


Figure 18. Temporal flow of Test Preparation

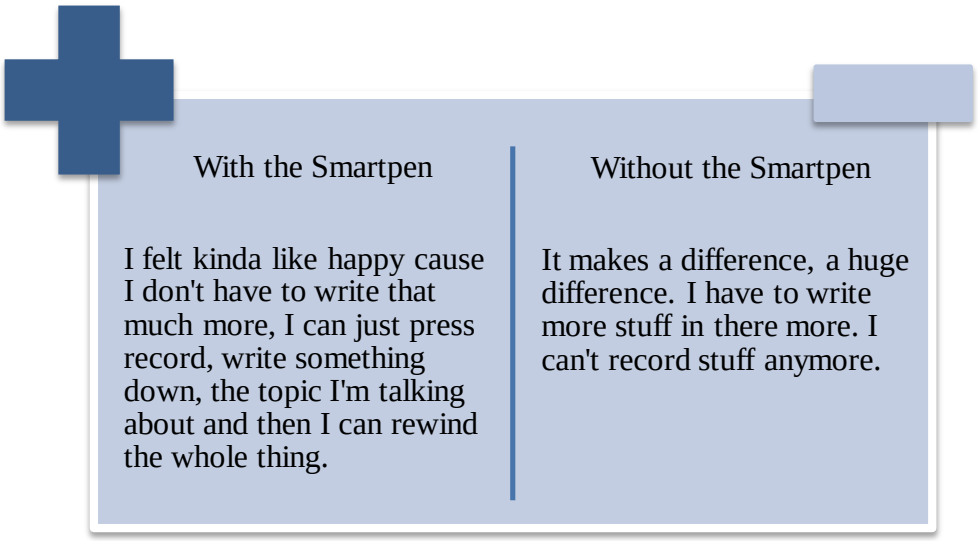
In addition, given that both of these participants express a reliance on listening and the auditory modality for becoming a more confident test-taker, it is possible that using the Smartpen may also contribute to a reduced level of listening anxiety (Elkhafaifi, 2005). This may specifically be related to their ability to repeat a listening text, as mentioned with their words *listen back* and *listening over and over*; repetition would hence allow the learners to become more familiar with the language and content encompassed within the recording, making them feel more at ease.

Motivation: "It's fun to learn Spanish with the Smartpen." (Sabiha)

Overall the participants in the study agreed that learning with the Smartpen was a motivational experience. The way in which they became *more motivated learners* through their use of the device is reflected in a common language surrounding the use of the pen as *fun* and *exciting*, terms that are often used in motivation research in SLA (Deci & Ryan, 1985). In particular, several participants mentioned a change in their motivational state resulting from the use of pen, from bored to happy. A typical response included "it made me happy instead of bored." At one point Bikem expressed more negative sentiment about the device and talked about growing bored with using the pen and complained that it "was not fun anymore." After asking to discontinue her participation in the study and returning the Smartpen to the researcher she decided to resume participation after a one-week period. Therefore, not all learners experienced enhanced motivation as a result of using the pen. This also seemed to suggest that at least in her case part of what contributed to this motivational aspect was the novelty or entertainment value of the technology itself (Sharples et al. 2009) which is rather superficial. This was also exemplified by Sabiha's comment, "it's cool to have something

to use electric" (Record, week two); however, there was also an academic component at work. Like in the introductory quotation, Sabiha associated her enjoyment of learning activities, both language and content-based, with the use of the Smartpen. She specifically mentioned "I love doing *math* with the Smartpen," "*reading* with the Smartpen is fun," (Record, week five) and "it's exciting *to write* about things in nature with the Smartpen (Record, week two). Lalehan's reflection also supported the Smartpen as a language learning tool, "it was really fun because using it and *writing* in the notebook" (Journal entry). Considering that overall the participants' motivation appeared to be specifically linked to learning tasks, rather than the entertainment value of the device, they clearly ascribed some importance to the act of learning with the Smartpen or associated it with their learning goals, which could be considered as forms of identified or integrated regulation described in the self-determination theory (SDT) (Deci & Ryan, 2010).

The data offered some limited insight into why participants might enjoy learning more with the Smarpen in terms of the facilitative properties of the pen. Four participants, Berna, Bikem, Dilara, and Sonay agreed that using the pen made learning easier, specifically because it required them to write less while allowing them to record more. This was reflected in responses such as "I take less notes, but I record more," and "I like the pen better cause I don't have to write a lot more." Sonay's description contextualized this better within the temporal flow and dichotomous distinction of learning with and without the Smartpen as displayed in Figure 19.



(Interview, 1/13)

Figure 19. Temporal Flow of Smartpen Facilitation

In this example Sonay equated the ease of learning with the Smartpen in her use of the word *just*, describing the process of recording as an easy way of capturing information about a topic that can be later reviewed. It is unclear as to whether Sonay took notes at a later moment in time to accompany the recording, or if she relied solely on the recording for learning. However, the ability to record without copious writing seemed to make learning easier for her, as she lamented the loss of this ability in the absence of the pen. Conceptualizing learning as an easier process with the pen could explain the participants' motivation for using it, which would qualify as a more externally motivated behavior characterized by the evasion of challenging work. This would contrast the notion of intrinsic motivation and participants' personal identification with the concept of learning with technology.

4.5.3. Metacognitive Benefits

Learning strategies: "It [the Smartpen] helps me with everything, like I get organized." (Bikem)

The primary metacognitive (thinking about and making appropriate changes in own learning behavior) benefit for most of the participants using the Smartpen entailed becoming a *more strategic learner* (Chamot, 1996) in the sense of developing new learning strategies or in some cases, enhancing underdeveloped ones. For all of the participants in the study except Berna, who was a more advanced language learner than the others, note-taking was a new learning habit that came about in conjunction with their Smartpen use. Dilara's response summarized the condition of most of the learners prior to using the Smartpen:

> Oh no, I don't take notes, I don't know, but this time I just took notes on the Smartpen. I never like took notes, except for like diaries and all that stuff.
>
> (Focus group, 12/12)

Discussions with Mrs. Mitchell, the students' mainstream teacher, and Ms. Chua, the ESL specialist, as well as researcher's observations all pointed to a lack of direct instruction and encouragement for note-taking at the classroom level. Mrs. Mitchell attributed note-taking behavior to students' "self-motivation," and expressed some of the underlying socioeconomic factors inhibiting note-taking as a learning strategy.

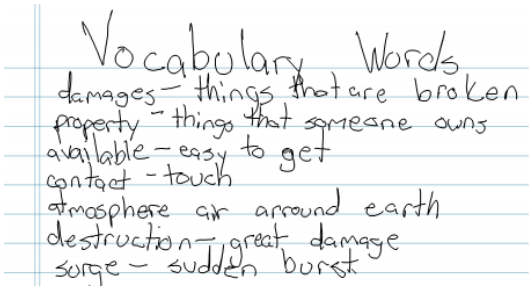
> The difficulty with these students is a lot of them don't have supplies they need to succeed in schools, notebooks and things. When you ask them to write something it's the worst thing you could ask them to do…they tear pages out and write on them, I couldn't tell you how many kids have sketchbooks.
>
> (Interview, 2/13)

In this instance Mrs. Mitchell not only underscored the lack of economic resources in terms of students' notebook ownership as prerequisite for note-taking behavior, but also noted the lack of organizational skill that accompanies using individual sheets for making notes. This type of disorganization was characteristic of all learners, including Berna, who before using the Smartpen did make an effort to take notes, but did so using individual index cards that she often lost or misplaced. In describing the change in her note-taking behavior before and after using the Smartpen, Ms. Chua said, "I think she was ok to begin with. The pen enhanced her study skills" (Interview, 2/13).

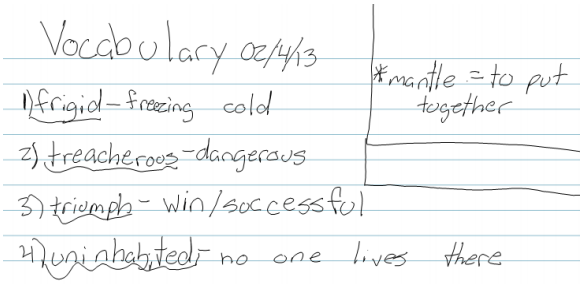
The way in which the Smartpen promoted note-taking as a new skill or improved students' current note-taking abilities, in the case of Berna, was evident in the evolution of the quality of their notes over time. Regardless of their language level as developing, expanding, or bridging, participants' use of headers in their notes became increasingly detailed over the course of their Smartpen use with routine engagement in note-taking behavior. In fact, when shown the students' notebooks during an individual interview, Mrs. Mitchell was surprised to see the level of organization apparent in the notes. Illustrative examples of the developmental trajectory of note-taking skill across three levels of language proficiency in the cases of Berna, Dilara, and Tanyeli have been included in Figure 20 below.

Berna (Bridging)

11/12

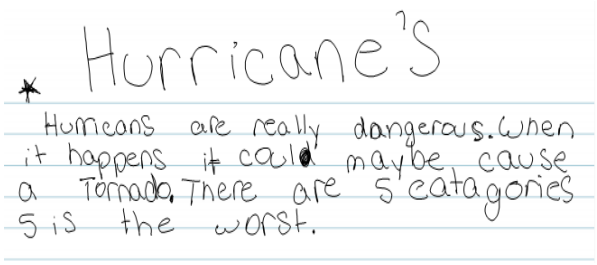


2/13

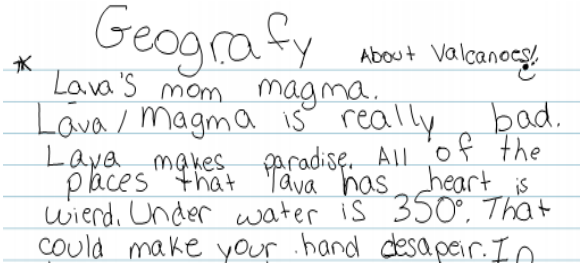


Dilara (Expanding)

11/12

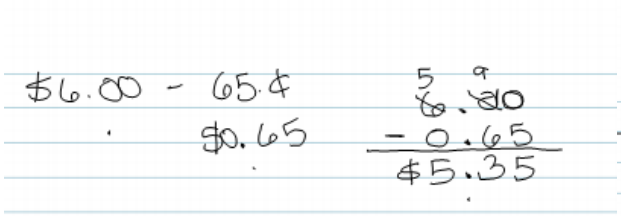


12/12



Tanyeli (Developing)

10/12



11/12

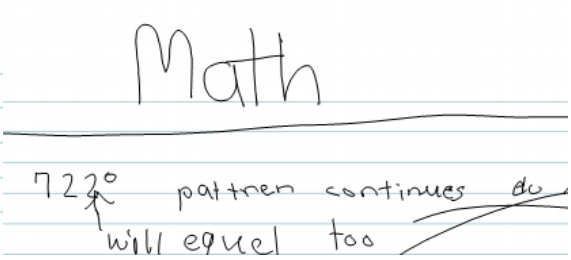


Figure 20. Temporal Development of Notes

All of the cases above demonstrated different levels of exactness in the headers applied over time. In the case of Berna, her headings became more specific by adding the date of instruction, while for Dilara, she began adding more detail relevant to the content of the instruction (about volcanoes). For Tanyeli, she began note-taking without any headers and began using them as organizational tools as time progressed. This use of organizational headers also compliments other data that revealed that learners began to change the structure of their notes as time transgressed, moving from including multiple

subject area disciplines on one page, to allotting a separate page for each content area. The development and advancement of note-taking as a metacognitive skill is very important for L2 learners given the role of note-taking in the strategic planning, organization, and processing of lesson materials (Chamot & O'Malley, 1996; Oxford, 2003).

Along similar lines, the data also revealed that learners became more strategic not only in their intentional note-taking but also about recording. Five students, Berna, Dilara, Bikem, Sabiha, and Sonay, developed their own system of notation for designating a set of notes with a synchronized recording as opposed to a traditional set of notes. Some of these notations were textual such as *recorded, rec*, while others were visual icons like a star, button, or microphone. These bookmarks only appeared on notes accompanied by recordings, suggesting that learners were conscious when they were recording and differentiated their use of the Smartpen as a recording device versus as a traditional writing implement. Although it is unclear precisely what motivated learners to differentiate between the various types of notes that they took (recorded versus non-recorded), it is apparent that they customized the use of the Smartpen according to their needs and perhaps began to use recording as a learning strategy unto itself. This addition of recording to their repertoire of learning strategies points to their transition into more strategic learners, who have been found to be more successful language learners (Cook, 2001).

4.5.4. Summary of Thematic Thread Three

To summarize, this final thematic thread emphasized the dichotomous self-image that learners with the Smartpen projected as it related to both affective and metacognitive

aspects of learning. This sense of self or identity as an L2 learner with the Smartpen was characterized by several key features, namely the becoming of a better, more prepared, more confident, more motivated, and more strategic learner. For instance, the learners highlighted their self-perceptions of academic achievement with the Smartpen as well as their increased assurance in preparing for assessments by reviewing with the device. They also expressed their enjoyment of learning with the device, which prompted them to use it regularly.

An analysis of their notebooks and learning artifacts suggested that these learners arrived at new metacognitive learning strategies through participating in the study. In addition to acquiring note-taking behaviors within the classroom, they gradually demonstrated an increasing level of sophistication in their notes, underscoring some potential long-term effects of working with the Smartpen. Finally, the data revealed that learners added recording to their repertoire of learning strategies and began to exercise new systems of notation for learning. In sum, working with the Smartpen allowed the learners to redefine the concept of what it meant to be an EL in the classroom on multiple planes.

Chapter V

Discussion and Implications

5.1. Overview

In this chapter I present an interpretation of the research findings contained in Chapter IV, with a focus on situating these findings both within the broader context of previous research in the field of MALL and within the theoretical framework of SCT. To this end, the chapter is divided into two major sections, the first of which addresses a discussion of the findings by research question, drawing comparisons and contrasts to relevant previous studies, and using the Vygotskian constructs of artifact and tool mediation, private speech, languaging, regulation, and internalization to explain and elucidate specific findings relative to the three major themes and subthemes presented in Chapter IV. The second section of this chapter is used to build connections from the research findings to practical and theoretical implications of this study, including pedagogical considerations for L2 learning with mobile devices.

Discussion of Sub-thematic Thread

5.2. The mediation of time and microgenesis. The concept of time travel that derived from participants' experiences is vital to appreciating the potentiality of the Smartpen and other mobile devices as mediational tools for L2 learners. From the findings, two primary underlying temporal processes were uncovered: a) participants' governance of time and b) participants' development over time.

This first process implies that the Smartpen was used to mediate learners' experience of time, by allowing them to freeze or harness it through recording, and later travel back through it in the playback mode. Participants essentially experienced and re-

experienced the same event multiple times, in multiple places, and in multiple ways. They seemed to especially rely on the Smartpen as a mediational tool for memory to help them encode and recall specific meaningful events (e.g., holiday break) and necessary instructional content (e.g., the details of stories). Using the pen in this way to restructure their experience of time and reorganize their memories is an example of how the Smartpen as a tool refined the participants' agency of learning (Kozulin, Gindis, Ageyev, & Miller, 2003), allowing them to become architects of their ideal social learning environments. While the phenomenon of time-shifting as a revision mechanism for learning has been widely documented in research on mobile devices relative to academic podcasting (Ormond, 2008), it has not been shown to pervade other language skills (e.g., speaking, reading, writing, vocabulary) or the entire experience of learning with mobile technology (e.g., learner before/after Smartpen), as was the case in this study. Hence, time-shifting as a global quality of mobile device use with L2 learners appears to be an extension of prior MALL research.

Moreover, the second way in which time characterized ELs' learning with the Smartpen relates to Vygotsky's perspective on the socio historical development of higher order psychological functions at the microgenetic level. From a sociocultural theoretical perspective, time is central to all learning and development, which is often most apparent at the level of microgenesis, known as the short-term development of a psychological process (Wertsch, 2009). Therefore, the change in participants' language skills over the course of an 8-month experience (i.e., short period of time) with the Smartpen was noted on several levels, most obviously in the development of their note-taking abilities and writing skills and within the content area of math. Although concrete longitudinal

development was not evidenced in the other language skills or in other content areas during the course of the study, it is possible that more time was needed for evidence of learning to occur, or that the design of the study was not suited for collecting data of this kind.

5.3. Mediation of the "linguistic self."

5.3.1. The listener. This study provides evidence that learners used the Smartpen to enable repetitious listening for the purpose of remembering the content of mainstream classroom instruction. These results are well-aligned with prior research that has emphasized the role of self-paced listening practice beyond the classroom for facilitating listening comprehension with mobile devices (Al-Jarf, 2012). They are also consistent with the line of research on academic podcasting that has highlighted the importance of listening anytime and anywhere (i.e., extended access) for developing receptive language skills and internalizing instructional content (Demouy & Kukulska-Hulme, 2010; Heilesen, 2010; Nah, 2008; Oberg & Daniels, 2013; Rahimi & Katal, 2010).

An important distinction between this study and the many others relating to the effects of podcasting on listening comprehension is that the recordings created by the participants with the Smartpen contained student versus teacher-authored content. Thus, their recordings were based on an instructional moment they had already experienced, and had the opportunity to re-experience when reviewing (e.g., multiple personal exposures), as opposed to a teacher-developed podcast that would not necessarily reflect their personal classroom experience. Alternatively, it is also possible that teacher-generated podcasts would be more comprehensive and useful since developing ELs could lack the experience and foresight to make accurate decisions about which content is

essential to record. In fact, several participants initially experienced technical difficulty with the recording function of the pen and created several incomplete recordings that were missing valuable lesson content. These participants believed the pen was recording when it was not, which affected the quality and completeness of their recordings. Therefore, although there is no concrete evidence to suggest that student versus teacher recordings differ in their value for assisting listening comprehension, findings from this study suggest that student recordings of academic instruction could also be helpful in some circumstances and could provide an alternative to teacher-created podcasts.

Perhaps the most significant contribution from this study for understanding mobile assisted listening development is not so much in viewing *what* students did with the Smartpen for listening, but rather *how* these behaviors contributed to learning. From a sociocultural theoretical perspective, the Smartpen acted as a mediational tool for listening on several levels. First, it allowed the participants to record the content of their classroom instruction and create a "listening artifact" that extended their physical ability to comprehend the listening task in real-time. This listening artifact (i.e., the recording), when reviewed, then served as a symbolic tool for mediating memory, allowing them to return to the exact classroom moment that they recorded and review the meaning again. On a tertiary level, repetition itself seemed to act as a cognitive tool to assist learners as an internal attentional process (Roebuck & Wagner, 2004), which is important for active listening and meaning-making of listening materials. Therefore, this study underscores the ability for L2 learners to be active listeners with mobile devices.

Results from this study also provide some evidence for the benefits of listening playback in mediating listening comprehension for ELs. While previous studies have

pointed to the limited functionality of iPods and mobile phones for enabling listeners to control the speed and playback of their audio lessons (Demouy & Kukulska-Hulme; 2010; Thorton & Houser; 2005), the Smartpen seemed to adequately meet the listening needs of the participants. The notion of providing listeners with greater control over what they listen to and how they listen to it (i.e., pacing) through mobile devices is consistent with the findings of previous research studies on mobile listening, especially in podcasting (Heilesen, 2010; Rahimi & Katal, 2010). Examining customized listening playback from a Vygotskian standpoint further highlights the ability of the some mobile devices like the Smartpen to equip learners to self-monitor, or self-regulate their learning. This demonstrates the participants' use of the Smartpen as a physical tool to exert control over their listening in a way that could not occur with real-time speech, or in other words to master their learning environment.

5.3.2. The vocabulary user. A central contribution of the findings of this study on the Smartpen as a tool for aiding vocabulary learning for ELs was the participants' creation of multimedia vocabulary glosses from academic language used within the classroom. As was shown earlier in Chapter IV, learners created multimodal artifacts for themselves of important terminology used particularly in math class that incorporated audio, textual, and visual representations of the target words. From a Vygotskian perspective, these artifacts served as signs, or psychological tools for helping the participants master their higher order cognitive processes (i.e., language learning), on multiple levels. Signs can include, "language; various systems for counting; mnemonic techniques; algebraic symbol systems; works of art; writing; schemes, diagrams, maps, and mechanical drawings; all sorts of conventional signs; etc." (Vygotsky, 1981, p.137).

As evident in the students' digital notebooks, many of these types of signs were embedded within the participants' vocabulary artifacts, showing the multi-layered mediational potential of these vocabulary glosses.

In addition to the learning benefits associated with the reflective properties of reviewing the vocabulary gloss, a sociocultural perspective would also support the mediation of cognition through the use of language as a semiotic tool. For example, several participants engaged in private speech or meta-talk when notating vocabulary words, pronouncing the words as they wrote them. This form of language directed towards oneself is a common pathway for the internalization of scientific concepts (Lantolf, 2000), and one of the most powerful ways for learners to attempt self-mediation (Daniels, 2005). Therefore, it may be possible to interpret the creation and use of multimedia glosses as learners' gravitation toward self-regulated forms of learning. Importantly, this contribution to L2 learning is not limited only to the Smartpen, but can relate to any device that facilitates the creation of vocabulary-based artifacts. To a large extent, the textual and visual components of the vocabulary glosses that accompanied this self-talk could also be obtained using traditional paper and pencil techniques. Only in the audio component was the pen somewhat unique.

The learner creation of vocabulary glosses is not an entirely new concept in MALL research. Several studies have shown the positive effect of allowing learners to create personally meaningful representations of vocabulary words for both explicit and incidental vocabulary learning with mobile devices (Song & Fox, 2008;Wong & Looi, 2010; Wong, Song, Chai, & Zhan; 2011). However, in these studies, learners created somewhat one-dimensional representations of target lexical units that were pictorially or

photo-based, which may be attributed to the functionality of the focal technology. In contrast, the Smartpen allowed for the creation of multidimensional artifacts that included the rich linguistic component of words represented in textual, audio, and oral forms. This seemed to play an especially important role for learners in terms of their ability to *listen back* to the words and establish or reinforce word-meaning associations.

The current study also extended the findings of previous works in several other ways. First, learners in these aforementioned studies were free to fabricate or replicate what they believed to be an authentic or contextualized use of a target vocabulary word with their mobile devices, whereas with the Smartpen, they were able to capture a word and its meaning within its original instructional context. This implies that vocabulary learning with the Smartpen may be more contextualized and authentic than with other mobile devices. Another important distinction to make between the current study and most other vocabulary studies, with the exception of Song and Fox's (2008) work on incidental vocabulary learning, is that participants in this study were not assigned specific vocabulary words that they were required to learn. This meant that they could create vocabulary artifacts that were personalized to their own individual learning needs, creating glosses for only those words that they felt were most relevant for their personal meaning-making. Indeed, one could interpret this kind of student investment in L2 vocabulary learning as evidence for identified forms of intrinsic motivation (Polat, Mancilla, Mahalingappa, 2013).Therefore, learner-generated vocabulary support with the Smartpen or devices with similar capabilities may in fact be more meaningful and motivating for learners with respect to needs-based and authentic uses of language.

5.3.3. The speaker. According to Vygotsky (1987), language plays a central role in all human learning, making all learning socially mediated. This concept of SCT was at work in the learners' use of the Smartpen to extend their communicative circles, allowing them to simulate communication through the Smartpen with an audience of English speakers or listeners not physically present or accessible to them. Through the use of the pen, participants authored a learning space in which to host multiple forms of oral languaging and speech work. Some of this work entailed interactional speech acts, in which learners attempted to make contact with other English speakers outside of their physical proximity (intermental functioning), yet others were transactional speech acts, which can be interpreted as self-directed speech (intramental functioning; e.g., Sabiha's reminders to self).

The participants' use of the Smartpen to envision new audiences with which to communicate can be understood in light of Norton-Peirce's (1995) idea of "imagined communities." Imagined communities are groups of people who are intangible, yet able to be accessed through the power of imagination. Thus, the participants imagined themselves as a part of a virtual speech community facilitated by the Smartpen. Within this virtual community, learners could safely take on new and imagined roles, as was demonstrated by the playful language activities and role play exercises that some students performed while using their pens (e.g., weather girl). Although on the surface these playful activities may not appear as valuable opportunities for learning, they represent "play *in* and play *with* the L2" (Bell, 2012, p. 190) that is essential for L2 development (Cook, 2000). Vygotsky himself emphasized the indispensable role of creative and imaginary play in fostering children's language acquisition (Vygotsky, 1967), which

supports the learners' use of the Smartpen to enact opportunities for using language that may otherwise not be supported in their actual speech communities.

Unlike in previous research on mobile assisted speaking development, learners did not seem to actively engage in self-monitoring their oral language use (e.g., pronunciation). The playful nature of the participants' speech acts foregrounds the notion that they were unconsciously practicing their speech through oral languaging, which contrasts research that documented L2 learners' active attempts to improve pronunciation and oral language skills through mobile podcasting or phone recordings (Ducate & Lomicka, 2009; Gromik, 2012; Lord, 2008). While these previous lines of research have looked at languaging as the conscious self-rehearsal and imitation of model speakers (perfecting oral language), adopting Lantolf's (1997) view on languaging as mastery training, this study reveals that the use of mobile languaging is considered by L2 learners as playful and fun, which is better aligned with Cook's (2000) definition.

5.3.4. The reader. Findings from this study are well aligned to previous research on mobile assisted reading that has highlighted the ability of digital pen technology to facilitate meaningful reading activities for ELs through the repeated reading strategy (Chen et al., 2012). Unlike in Chen and associates' work with the Qu-voice digital pen, the Smartpen allowed learners to capture contextualized, spontaneous, and authentic models of reading delivered by their teachers and peers as they occurred within the classroom setting. This is in contrast to the pre-designed reading modules that were presented as supplementary reading practice in the aforementioned study. The ability to record readings of familiar texts and actual instructional materials utilized within the classroom supposes that this form of repeated reading strategy is more meaningful,

authentic, and relevant to ELs' learning of language and content than those previously documented in MALL research.

Although there is no across-participant evidence to support gains in oral reading fluency, as was the case in the aforementioned work, the participants' ability to scaffold themselves beyond the classroom space through reviewing and rehearsing the captured reading models appeared to benefit their development of fluency skills and perhaps other language skills. This was most readily seen in Bikem's read aloud on colonial times. For example, Hwang and Chen (2013) documented vocabulary gains for learners who listened to peer-recorded models of reading with an interactive mobile listening system. Thus, it is possible that the repeated strategy served multiple L2 learning purposes for the participants.

In particular, the use of Smartpen to record more expert readers is a means of learners' extending their own physical capabilities in multiple ways through tool mediation. For instance, the findings pointed to a lack of exposure to English speakers within the participants' home environments. They also indicated limited literacy in both L1 and L2 for family members. Therefore, the use of the Smartpen to acquire models of reading to follow and imitate demonstrates its ability to physically provide learning resources that would not otherwise be accessible to them (Lantolf & Thorne, 2006). Within their homes and other settings beyond the classroom, participants reviewed their recordings and created their own oral reading practices in which they attempted to approximate the linguistic level of the expert reader (i.e., other-regulation). Given that these readers were well-known teachers or peers (as opposed to automatized voices), this form of learning is inherently social in nature (Vygotsky, 1978), despite the lack of

physical proximity between the student and more knowledgeable other. For participants learning to read with the Smartpen, they experienced an asynchronous and mobile ZPD, a finding which contributes to the understanding of mobile devices as conducive to interpersonal forms of learning across time.

5.3.5. The writer. To the best of my knowledge, no previous study has exclusively considered writing development through the use of mobile devices for L2 learners. Findings from this study contribute to this area of research as they revealed that the Smartpen provided ELs with the opportunity to engage in extended structured writing opportunities through note-taking. Most of their notes represented formulaic forms of writing and were based heavily on teacher models, meaning that the Smartpen did not support L2 writing development through expressive or free-writing opportunities. However, the extended practice of writing seemed to lead to improvement in their written language production. It is possible that this form of written langauging (meta-notes) permitted them to notice their linguistic gaps and improve their spelling, as was evidenced from their notebooks. This is especially true when considering the mediational potential of language as a semiotic tool in which "using language to reflect on language produced by others or the self, mediates second language learning" (Swain, 2005, p. 478).

Previous studies on written languaging have noted that it is more prevalent in L2 learners of higher language proficiency (Suzuki & Itagaki, 2009), which is consistent with the results from this study, particularly the extensive note-taking behavior of Berna and Dilara. Similar to other studies on written languaging (not conducted with mobile devices), participants seemed to need more note-taking training in terms of demonstration and practice to possibly maximize the effect of meta-notes, seeing that they were novice

note-takers (Ishikawa, 2012). Contrary to these previous investigations that focused on growth in L2 grammatical skills, the findings from this study indicated some development for ELs in their lexical associations that came about through written languaging. Therefore, the role of training in facilitating L2 learning through written languaging with mobile devices should be considered, especially as it relates to structured versus unstructured forms of meta-notes.

Discussion of Thematic Thread Two

5.4. Mediation of the "teacher/learner self." In SCT, "the learner comes to terms with what he is (his actual developmental level) and strives to become what he not yet is through collaboration with more skilled peers (his level of potential development)" within the ZPD (Mirzaei & Eslammi, 2014, p. 2).This intermediary state of regulation is not only important for the development of scientific concepts, but also the development of language, as the ZPD is dialogically mediated through language, which engages learners' awareness of their linguistic knowledge through L2 production (Swain, 2006). The use of the ZPD as a mediational space for learning the scientific concepts of math through English was consistently evident in the findings of this study. Although this was only observed in math, the concept of ZPD development with mobile devices may be applicable to other content area disciplines and could be conceptualized more broadly.

Consistent with the literature on mobile learning for L2 learners, the students' use of the Smartpen to create and record a math-based ZPD with their mainstream, ESL, and home instructors, underscores the personalized and customizable nature of learning with mobile devices (Chen & Chung, 2008). In particular, the ZPDs that the students co-constructed with more skilled teachers from home and school settings were customized

not only in the sense of math knowledge (e.g., register, computation, reasoning), but also according to their level of English proficiency (e.g., negotiated interaction). These ZPDs were also nontraditional in that they were not limited to the physical location or temporal moment in which they occurred, which is rarely the case. For instance, participants reported re-accessing the recorded mediational moment they experienced with their teachers during recess and while at home. This indicates that with mobile devices, the ZPD can also become mobilized or transportable to transcend time and space when it is captured with a mobile device. This finding constitutes a new discovery for research on mobile learning and perhaps for SCT.

The transportation of the ZPD across educational contexts and temporal boundaries was shown as important in providing the learner multiple learning experiences, thereby shifting their role from learner to teacher. As was the case for many participants, they were first mediated by more knowledgeable "others" to the point of arriving at a new developmental level of self-regulation within co-constructed ZPD in real-time. For example, Lalehan was able to complete math notation on her own at the end of a dialogical meaning-making session with her brother-in-law that occurred in her L1. However, the recording (i.e., symbolic tool) created of the co-constructed mediation had a secondary function that occurred when learners revisited the scaffolding. Through revisiting the original instructional moment via the artifact, learners began to experience a shift in roles from student to teacher or non-expert to expert. This was exhibited in Dilara's notebook when she created new, self-mediated examples based on the models available in the transported ZPD that was archived on the Smartpen (e.g., self-teaching). Since participants were intentional about seeking these learning experiences with more

expert others and recording them, they seemed to be aware of the multiplicity of the learning experience and the helpfulness of having extended access to scaffolded models of learning math and language. Thus, with the Smartpen, participants were able to exercise a certain degree of individual agency over shaping their experience of learning math by initiating the co-construction of knowledge, perhaps even allowing them to take more ownership over their education. Given SLA research on the role of autonomy in L2 attainment and development (Murray, Gao, & Lamb, 2011), such findings are quite noteworthy.

Previous research on using mobile devices for L2 learners in content area courses has been limited to the learning of science register. Although some of the findings concerned the learning of math register, which may be considered akin to science register, the Smartpen seemed to foster the learning of math knowledge in more comprehensive ways. Moreover, most studies on science vocabulary learning have utilized mobile devices as delivery tools with pre-packaged content intended for supplementary self-study (Billings & Mathison, 2012; Cruz, 2012), making it is difficult to compare them with the Smartpen. This is due to the fact that the Smartpen is a more versatile tool in that it allows users to generate as well as receive content. Therefore, while the findings of this study coincide to some degree with the work by Billings and Mathison (2012), especially the ability of mobile devices (iPods) to provide L1 support for learners, many of the findings from this study on content area learning add to the literature on mobile learning.

Discussion of Thematic Thread Three

5.5. Mediation of the "affective and metacognitive self."

5.5.1. The affective self. From a sociocultural theoretical perspective, the process of identity formation runs parallel to the learning of scientific concepts in that it too is mediated by physical and psychological tools. The use of tools therefore can allow conceptualizations of alternate selves to emerge and be internalized as higher-order psychological functions (Holland & Lachicotte Jr., 2007), which is especially relevant to the case of ELs who often harbor deficit perspectives of themselves as incompetent or unsuccessful (Reis, 2011). The findings of this study provide compelling evidence for the beginnings of internalization of ulterior identities or inter-subjectivities for the participants as better and more academically successful learners with the Smartpen. Despite the lack of concrete evidence in support of actual academic improvement, students' shift in their self-perceptions from low to high academic achievers (i.e., "A" students) was made manifest in their dichotomous self-representations, such as Sabiha's illustration. The notion that learners began to view themselves in a more favorable light, as empowered L2 learners with the Smartpen, is germane considering the motivational research literature linking self-efficacy beliefs to academic performance (Graham & Weiner, 1996). Thus, it is possible that the viewing of themselves as successful learners could translate into the actual being of successful learners.

The degree to which the participants' strides in re-actualizing their new inter-subjectivities remained exclusively tied to the Smartpen as a mediational tool itself was somewhat apparent from the data. Given Sonay's description of an almost immediate regression back to a state of underachievement after discontinuing the use of the

Smartpen, it is reasonable to assume that the emergent self-conceptions the participants experienced were in their nascent phases and reflective of object-regulation. Nonetheless, considering the Vygotskian continuum of regulation from object to self, it is possible that learners would depend less on the Smartpen over time to mediate their feelings of academic accomplishment.

Within the field of mobile learning, some prior research has addressed the issue of users coming to identify with their mobiles devices, most commonly in the case of mobile phones (Vincent, 2006). However, these studies have approached the question of identity not necessarily as the development of an L2 or learner identity, but instead as a matter of embodiment relations focused on users' relationship with their phones as an appendage of self or other (Idhe, 2010). Moreover, since the mobile phone has become an integral part of the fabric of social communication on an international scale, it is difficult to assimilate such a widespread tool with the Smartpen. Hence, insofar as educational applications of mobile devices and L2 learning is concerned, this finding is markedly new and can be considered a promising effect of Smartpen use for ELs, with noteworthy implications for online-learning environments, like cyber schools.

For Vygotsky, thought, affect, language, and consciousness are dialectically related and mutually inclusive (Mahn & John-Steiner, 2002). In other words, "the affective and volitional tendency stands behind thought" (Vygotsky, 1987, p. 282), supposing that the satisfaction of learners' emotional needs is prerequisite for learning. Findings from this study support this interrelationship between affect and cognition in terms of learners' use of the Smartpen as a physical and psychological tool for mediating their planning for test preparation. Through the ability to review prior to taking exams,

learners garnered a sense of confidence, security, and preparedness as test-takers, which is another indicator of affective mediation associated with the Smartpen.

The ability of the Smartpen to enable this "gift of confidence" (Mahn & John-Steiner, 2002) for participants is an example of how mobile devices can help ELs modulate their own emotional states, which coincides with previous findings regarding the affective benefits of mobile technologies for L2 learning. For instance, several studies have underscored the usefulness of the self-paced rehearsal of oral language in private spaces with mobile devices for building L2 learners' confidence in their speaking ability and reducing their feelings of speaking anxiety (Chen et al., 2012; Gromik, 2012; Lui & Chui, 2010). Although not specifically tied to oral communication or to the learning of L2 skills, this finding contributes to a more global understanding of how mobile devices can be used to help L2 learners manage listening anxiety and test anxiety through opportunities for self-directed extended review.

Findings from this study also suggest that participants used the Smartpen to mediate their own motivational needs related to the enjoyment of learning. In Vygotskian terms, tools are a means for learners to interact with, change, and exercise control over their external environments. From this perspective, motivation should also progress from a state of being motivated by tools to eventually motivating oneself (Aidman & Leontiev, 1991). In this study participants expressed the common sentiment of having fun when learning with the Smartpen and using it to accomplish the purpose of making learning "easier" for them, by allowing them to take fewer notes while still capturing the main content of the lesson by recording. This is an example of how learners used the device to take control over their learning experience and to simplify it through object mediation or

the appropriation of different functions of the tool. This finding also replicates the interview data published by Swan and associates (2005) where middle school students preferred using mobile devices over writing by hand because they made writing assignments easier and more fun. The fact that participants alluded to the technological novelty of learning with the Smartpen is reminiscent of "the wow effect" (Sharples et al., 2009) frequently documented in the literature on mobile learning, and could be indicative of an object-oriented motivational regulation. However, since learners continued to use their Smartpens over 8-months and did not lose interest in learning with the device, as would be the case with a technological toy, it is possible that they began to become more self-motivated learners.

5.5.2. The metacognitive self. Regarding metacognition, Vygotsky's views suppose that "consciousness takes possession of cognitive processes, but does not create them" (1986, p. 168). Therefore, learners' deliberate control of a tool or cognitive process is a sign of the advanced development that occurs once a tool has been practiced and appropriated over time. This conscious or strategic use of the Smartpen that developed over the course of the study is precisely what was demonstrated by the participants in terms of both note-taking and recording. MALL literature has highlighted the ability of devices to promote metacognitive awareness, or the "planning and consciously executing appropriate actions to achieve a particular goal'' (Sheorey & Mokhtari, 2001, p. 432), especially in terms of listening strategies (Rahimi & Katal, 2012; Weinberg, Knoerr, Vandergrift, 2011). Participants' development of a recording notation system indicates the planning process associated with goal-oriented behavior. Although the focus of these previous inquiries was the use of podcasting to enhance awareness and strategy use, this

study is somewhat aligned to these studies in that participants engaged in similar behavior by recording to create their own personalized podcasts of classroom material with the Smartpen. Thus, the findings of this study extend previous work on podcasting as a means of deepening metacognitive learning strategies, introducing the possibility of student-generated podcasts as a metacognitive device.

Similarly, previous MALL research on mobile devices noted their ability to promote learners' self-monitored oral language use. These studies focused on learners' increasing awareness of their own pronunciation and productive uses of features of the target language that occurs through hearing their voices recorded and played back (Ducate & Lomicka, 2009; Kukulska-Hulme, 2009; Lord, 2008). This study extends this line of research by demonstrating participants' noticing of not only oral language but also written language production. The microgentic development of learners' written notes indicated by students' self-corrected spelling is one way that the Smartpen acted as a mirror of some sort, allowing learners to reflect on their personal language use and "notice" areas for improvement. This finding echoes previous findings reported by Swan et al. (2005) where students reported improvements in their spelling as a result of learning with mobile devices; however, it is important to note that these participants were not ELs, but rather mainstream middle school learners for whom these benefits (learning content or any foreign language) of Smartpen are yet to be explored. Similarly, participants in the aforementioned work also reported some organizational benefits of learning with mobile devices in terms of not losing homework papers. This finding was also consistent with the case of Berna and a few others whose note-taking strategies were improved with the Smartpen as they transitioned from using individual note cards to

bound notebooks. Again, the development of metacognitive awareness in written language production for ELs through mobile technology is an important contribution of the current work.

5.6. Pedagogical Implications for MALL

Findings of this study broach several pedagogical implications regarding the implementation of mobile technology for ELs within K-12 mainstream settings. These implications for mobile assisted language learning (MALL) will be discussed as they apply to the three major stakeholders present in schools: L2 learners, classroom practitioners, and school policymakers respectively.

5.6.1. L2 learners. The premise for piloting the Smartpen as a mobile tool for use with ELs in the K-12 educational setting was to discover more about how learners who traditionally do not have access to mobile devices for learning can use them to meet their needs in both English and content learning. Data from classroom observations and student and teacher interviews indeed confirm the fact that this group of ELs did not have previous exposure to mobile devices such as the Smartpen prior to their enrollment in the study. Most of the participants were members of large immigrant households with limited economic means, which is also typical of the socioeconomic barrier to technology access that has been documented in the literature on technology integration with L2 learners (Cattagni & Westat, 2001; Kleiman, 2004; Warschauer & Matuchniak, 2010). Moreover, even within the mainstream classroom at the school level, minimal technology was used for instruction, which underscores the importance of including ELs in future studies that explore the use of technology both for L2 learning and as a means for preparing 21st century learners (e.g., digital literacy).

This study verifies what has already been somewhat-documented for ELs with respect to their complex positioning with mainstream classrooms and their dual responsibilities of mastering both the language and content of academic course disciplines. In particular, it underscores the need for ELs to have additional time to process information, multiple exposures to linguistic and academic content, and help with the acquisition of academic register. Moreover, it also reinforces what is known in the literature on linguistically and culturally diverse learners in terms of their limited resources for learning relative to material resources such as school supplies, as well as effective study habits (e.g., note-taking) and assistance with homework outside of school.

Findings suggest that mobile technology was effective in ameliorating some of these issues for the learners. However, like any kind of tool, some features of the Smartpen seemed to be more useful for L2 and content area learning than others and should be recognized. For instance, with respect to L2 learning, the recording function of the pen appeared to be the most helpful for supporting the development of both listening and speaking skills. This implies that any technology or mobile device that can extend students' audio access to classroom content and to a real or imagined audience of English-speakers may render similar findings. Such devices may include handheld audio recorders or downloadable audio recording applications (apps) available for smartphones and tablet PCs. For enhancing speaking, L2 learners could even record themselves on a laptop or desktop computer using freeware such as Audacity sound recorder. Regarding writing, the act of taking regular notes seemed to contribute most to the learners' development as opposed to the technology itself, which implies that even traditional

writing instruments (e.g., pencil, pen) can have the same effect when learners are motivated to take notes.

In addition, several note-taking apps for use on mobile devices also exist that could serve similar purposes. These include Evernote, Onenote, or Springpad, which also combine technology with traditional note-taking. Finally, in terms of vocabulary acquisition, the Smartpen did seem to be somewhat unique from other mobile devices in that it allowed for the creation of audiovisual and textual glosses. Even so, some paid apps with similar functionality like Audionote to incorporate a voice recorder with textual note-taking to allow written notes to be synchronized with audio. This type of app could also be useful for supporting the learning of math content, since the ability to record and synchronize the written notes was the most relevant for learners. In sum, the successful use of the Smartpen in these ways reaffirms the need for researchers to continually seek out new technological solutions (e.g., mobiles devices or applications with similar functionality) for improving the learning experience of ELs in schools.

Regarding the formation of new and empowering inter-subjectivities for ELs through mobile devices, this study speaks to the unanticipated effects of using mobile devices for ELs in terms of their ability to foster learning on multiple fronts. While the focus of integrating mobile devices into classrooms for L2 learners to date has been to develop their language skills with a recent shift to considering the development of content area knowledge, little research has taken into consideration the development of emotional or affective competency. This study not only confirms some of the deficit perspectives that ELs may maintain of themselves, but more importantly signals the ability of mobile devices to mediate these perspectives. Therefore, there is a need to re-

think the purpose of mobile devices for ELs as having a more global impact than simply for linguistic skill or knowledge development.

Finally, as models of mobile learning continue to evolve, and shift from teacher or activity-directed to more autonomous or learner-directed ways using mobile devices, this study presents evidence in support of conceptualizing the design of mobile learning as belonging to the student. For example, participants were not instructed to use the Smartpen in any particular way or for accomplishing any particular instructional goal, yet they made choices about using the device that can be considered educational in nature (e.g., recording for test preparation). Some data even implies that playful activities with mobile devices can have educational value for learners whether or not they are consciously aware of it (e.g., speaking skills). Thus, these findings counter the notion that students must be given strict guidelines or specific activity designs in order to learn from mobile devices. Rather, it supports student ownership of the learning experience with mobile technology through the personalization that it affords.

5.6.2. Classroom practitioners. A concern presented in this study was the restriction of the Smartpen's use by some of the student participants' classroom teachers. Although the Smartpen was never officially banned at the school level, teachers of various subject areas enacted no-use policies. From the data, several features of the pen seemed problematic from the teachers' perspectives. First, many teachers did not want their own voices to be recorded for posterity, especially in classrooms with management or disciplinary issues. Secondly, they did not want students to replay their recordings aloud during class to avoid distracting other learners who were not using the device. This suggests that teachers, like students, must feel safe and non-threatened in order for

mobile technology to be seamlessly used within schools. Therefore, steps must be taken within schools to create a climate conducive for mobile learning. This would entail ensuring the protection of teachers from any evaluations based on the content of students' classroom recordings.

From the findings of this work, it is also recommended that teachers' voices need to become a more central part of larger school-wide discussions with respect to the praxis of integrating mobile devices into classrooms. Given their sustained daily interaction with the participants, teachers' concerns about the misuse of the Smartpen for entertainment purposes and its distraction to other learners are informative for understanding which devices support learning, and in which academic disciplines. For example, teachers' decisions to limit Smartpen use in foreign language study may reflect the device's lack of relevance or compatibility with the content or methods of these courses, which could possibly be addressed by a different type of technology. Likewise, although the students' mainstream teacher did not restrict their use of the device for science or social studies learning, they did not make extensive use of the pen during these class periods, which may indicate its lack of usefulness for learning these content areas. Since off-task behavior with the pen was not observed during field work visits (suggesting the potential presence of an observer's effect), teachers are primary informants in the search for mobile technology interventions.

Further, the experience of these teachers highlights an emerging pedagogical skill set respective to the classroom management of mobile devices. Teachers in this study felt uncomfortable with the playback feature of the Smartpen because of the effect it had on other students' learning. Essentially non-mobile learners engaged in off-task behavior

when they overheard the recordings of others, which resulted in classroom management problems. This issue calls into question if devices with audio playback functions should be integrated into classrooms because of the potential they may have to distract other learners, and if so, how they can be best used to avoid such effects. While this specific issue may be easily remedied with an audio headset or ear buds provided to each pen user in this instance, the broader question of how teachers can be prepared to manage classrooms full of learners working at their own pace with perhaps different mobile devices is pressing. Since the phenomenon of mobile learning is relatively new, preparing teachers to adapt their current strategies or develop new classroom management techniques will be a growing concern and perhaps a process of trial and error.

Finally, findings of this study validate the role of the classroom teacher in facilitating some of the benefits of learning with mobile devices, especially in content area courses. Students benefited from the ability to transport recordings of their teachers' voices, instructional models, and personalized scaffolds into new physical settings with the Smartpen, particularly for math learning. While the students' use of the Smartpen in this way did not add to the teachers' workload, it did allow them to make greater use of their teachers' individual and group instruction without them being physically present. Therefore, in implementing mobile devices for educational purposes, teachers should be aware that mobile devices and teachers' instruction are not mutually exclusive entities and can act in cooperation with one another. This implies that mobile devices can be used to enhance the role of teachers in the classroom rather than threatening to substitute them, at least for content area learning.

5.6.3. School policymakers. In the age of a national impetus for preparing 21st century learners (or millennials) through mobile technology initiatives, this study has important implications regarding feasible and economical ways to support the growing population of ELs within schools through mobile devices. Findings suggest that a relatively inexpensive piece of mobile technology was effective in promoting the development of language skills for ELs in the domains of reading, writing, speaking, listening, and vocabulary. Similarly, it was also effective in providing personalized learning support for math content area courses, which may also be the case for other academic disciplines that require intensive reasoning skills. Moreover, the Smartpen device is an example of a tool that did not require much technical training for learners or teachers in order to function as an instructional support. Therefore, as school policymakers make choices regarding the selection of or integration of mobile technology into their schools, they should bear in mind that not all one-to-one initiatives will require complex or expensive devices such as tablet pcs or laptops to promote educational outcomes. This is particularly important if policy is to make an impact on the widening achievement gap between ELs and their English-speaking counterparts on national tests (NCES, 2011).

As many schools continue to adopt "bring your own device" (BYOD) policies for their students to accommodate the increasing ownership of mobile devices and potential educational applications of them, findings from this study recommend the parallel development of anti-bullying or zero-tolerance policies. It seems like participants' experiences with peer scrutiny and bullying prevented them from taking full advantage of their mobile devices in school. Therefore, school administrators may need to implement

policies to protect mobile learners and their devices, as well as provide training for all students on how to be sensitive to the use of mobile devices in classrooms. For example, participants often had trouble with the quality of their audio recordings due to the background noise and interference of other students' close proximity to the Smartpen's microphone. This could indicate a shortcoming of the device in terms of its ability to capture audio, but could also be a concern addressed through some student training and classroom management policies that prepare learners to be considerate of others learning with mobile technology. These changes in creating a mobile-friendly classroom culture in schools must begin at the policy level.

Finally, as schools seek ways to build greater cooperation between educational stakeholders in the students' home and school learning environments, findings indicate that mobile devices may be one such bridge. For instance, especially in the content area of math, participants benefited from receiving additional L1 support from family members on concepts instructed upon in school. While it is not always possible for schools to provide extensive resources within schools in their students' L1, especially for uncommon or minority home languages, such as was the case in this study (e.g., Turkish), mobile technology may be one way to integrate home-based L1 support and encourage parental involvement. Making the classroom content available and accessible to parents and family members through mobile devices can help encourage multiple parties to take ownership of students' education and foster positive educational outcomes.

Chapter VI

Conclusions

6.1. Overview

The core of this inquiry was to better understand how the Smartpen could be used as a mediational tool for ELs situated in mainstream classroom settings where they were expected to concurrently learn linguistic skills and instructional content. Drawing from Vygotskian sociocultural theory, this study explored the case of 7 ELs at varying levels of English proficiency as they appropriated the mobile device both as a physical and psychological tool for mediating their learning in self-directed ways. A secondary goal of the study was to uncover potential affective, cognitive, and metacognitive benefits of using the device for L2 learning and across content area disciplines. The research followed a quasi-ethnographic and longitudinal design, with data collected from multiple sources, including individual and focus group interviews, students' digital notebooks, and learning artifacts over an 8-month period.

The procedures for data analysis and interpretation were outlined in Chapter 3, which rendered three primary thematic threads and one sub-thematic thread expounded upon in Chapter 4. These thematic threads described the use of the Smartpen to extend opportunities for learning language and content through self and co-constructed artifacts, as well as an extended sense of self related to being a Smartpen-user. In Chapter 5, I presented a discussion of the findings as they revealed the underlying mechanisms of cognitive mediation from a sociocultural stance, which were both consistent with and divergent from current research on mobile assisted language learning. This chapter also outlined in multiple layers the implications of these research findings as consequential for

the field of mobile learning, in addition to the potential pedagogical ramifications of integrating the Smartpen in K-12 educational settings for ELs, teachers, and policymakers.

In this final chapter, I share limitations and areas for future research that could be pursued based on individual and collective experiences of the student participants in this study. I close this dissertation with a section that elucidates my reflections as the researcher.

6.2. Limitations

As is the case with most research, there are some limitations that must be acknowledged. First, although one of the main goals of the study was to explore how students used the Smartpen for learning in all content area disciplines covered in their school curriculum, it was difficult to translate this goal into practice due to some teacher constraints on the use of the device. At several points in the study several mainstream course instructors (e.g., Spanish, Turkish) banned the use of the Smartpen within their classrooms, making it impossible to collect sufficient data on the use of the device in their content areas. Some teachers provided the rationale that the device was disruptive to other learners or that they simply felt uncomfortable having their teaching recorded by the participants. Therefore, it is possible that in actuality additional uses for the Smartpen exist in other content areas not represented in the data from this study. In any case, since the prohibition of the device was not enacted immediately, some data from the initial phases of the study were helpful in providing a glimpse into possible applications of the Smartpen for learning in these areas, although not plentiful enough to include in the final

write-up of findings. Yet, such data did help with the initial identification of some of the research themes and categories explored here.

Yet another limitation relates to the logistical complications involved in gathering data from multiple student and teacher participants longitudinally. On account of the busy academic schedules of students and teachers alike, as well as the intensive standardized testing blocks and holidays programmed into the main school schedule, it was difficult to accrue an equal amount of data from each participant due to schedule conflicts. Similarly, student participants utilized their Smartpens in very personalized ways, meaning that some students' recordings were longer or more abundant than others, which made hard to make between-student comparisons. Although a definite shortcoming in terms of achieving the same depth of understanding about each participant, the data collected was nonetheless suitable for an instrumental case study in terms of looking across various aspects of collective cases.

Finally, it is worth noting the role that initial English proficiency may have played in the student participants' ability to adequately communicate their experiences, thoughts, and opinions associated with using the Smartpen. Given their status as ELs, it is possible that students could not always sufficiently or precisely communicate all of their thoughts about how they used the Smartpen during individual and focus group interviews. For this reason student learning artifacts (e.g., sketches) were collected in order to enable the visual expression of what could not be expressed verbally. In general, a close examination of the students' digital notebooks seemed to reflect similar patterns of behavior described during their interviews indicating a minimal effect, if any, of a language barrier on the interactional data.

6.3. Areas for Further Research

Given the generative nature of subjective understanding that emerges from qualitative inquiry, this study represents one small facet of what remains to be understood about applications of the Smartpen for learning. Specifically in relation to L2 learning and ELs, the following are some potential directions for future research.

6.3.1. Seamless learning. Seamless learning environments bridge private and public learning spaces, such as in-school and after-school spaces, or school and home spaces (Looi et al., 2009). An in-depth understanding of the seamless uses of the Smartpen, particularly within the home environment was beyond the scope of this study. While the time-stamped digital notebook archives and participant retrospective interviews provided some insight into informal uses of the Smartpen, to achieve greater clarity on this issue would require the participation of individuals within the home environment or researcher's observations of learner behavior within informal learning spaces. Thus, the study could be expanded to include home-based perspectives and a greater consideration of the types of learning materials that learners create within informal learning settings for transportation into the classroom.

6.3.2. Products of learning. By design, the focus of this study was on gaining an understanding of the underlying cognitive processes and mediational means and spaces that learners participated in while using the Smartpen. Although the goal of this study was never to collect concrete products of learning, such as evidence of the device's effect on course grades or assessments, some learning or internalization of scientific concepts was nonetheless demonstrated at the microgenetic level in the improvement of certain skills (e.g., writing, note-taking) over time. Therefore, future studies could take a product

versus process-orientation to examine concrete ways in which the Smartpen affects or relates to academic achievement.

6.3.3. English proficiency. The "current examples of autonomous and learner-directed activity tend to relate to high achievers and learners at more advanced stages of education" (Kukulska-Hulme, 2010, p. 125). However, some of the findings from this study suggest that middle school ELs of all levels of language proficiency from developing to bridging can benefit from using the Smartpen to learn both language and academic content in self or other-directed ways. The extent to which developing and expanding ELs may require more scaffolding for mobile learning than bridging learners was unclear from this investigation, which also constitutes an avenue for future research. By extension, more research is needed to explore the intersection of English proficiency and patterns of learning activities that learners at different linguistic abilities engage in with the Smartpen across distinct content areas. Viewing Smartpen use across multiple groups of ELs of more robust numbers could promote this type of understanding.

6.3.4. A focus on communication. A common phenomenon associated with utilizing mobile devices for learning is the unpredictable nature of what students will do with them when given the opportunity to exert control over their use. As was the case in this study, the Smartpen was not necessarily intended as a communication tool, but rather as a note-taking tool. However, students appropriated the use of the Smartpen as a medium for communication with themselves and with others. Thus, further research may delve into additional non-conventional uses of the Smartpen for facilitating communication in both verbal and written forms. Moreover, future studies could also investigate more thoroughly the learners' awareness of their self-communication via the

device (e.g., language play, self-talk) and how metacognitive awareness of recording as a learning strategy may impact learning outcomes. Based on research on intentional versus incidental learning (Ortega, 2009), such incidentally self-directed contributions of this tool need more research in the field.

6.3.5. Sustainability. Finally, "the extent to which mobile technologies can motivate and sustain deep levels of engagement with language learning or language use is perhaps questionable" (Ushioda, 2013, p.3). As the findings from this study indicated, ELs experienced several affective and metacognitive advantages when using the Smartpen during an 8-month time frame (e.g., anxiety, motivation). However, whether these benefits were transient and localized to the period of Smartpen use, or reflective of a more permanent change is unknown. Thus, further inquiry on the Smartpen could focus on exploring the sustainability of changes in affect and metacognition in a longitudinal design.

6.4. Concluding Thoughts

As I close this study, I would like to mention the usefulness of meshing ethnographic methods with a Vygotskian lens for researching mobile devices for ELs in the classroom. By taking up an ethnographic design with student participants at the heart of it, I have been able to truly engage in the type of socially mediated learning that allows a deep understanding of the "larger dynamic texture of actors, objects, connections, social practices and meanings in particular contexts" that mobile technologies are embedded in when it comes to education (James & Busher, 2013, p.200). The sociocultural lens was especially useful in helping me to delve into the participants' experiences beyond the

observable, and to make sense of the underlying motives and processes driving mobile technology use that may be relevant for other mobile devices with similar functions.

Thus, I greatly benefited from allowing the student participants in this study to scaffold and transform my thinking about how mobile devices can be used for learning. Admittedly, I was pleasantly surprised by some of the discoveries made throughout the research process and enlightened by the new and unanticipated ways that students chose to appropriate the Smartpen that had not been previously documented. As was my experience, I believe that in order to truly respond to the call to prepare learners, native or nonnative, for the 21st century through mobile devices, we must first recognize our own positioning as the often "non-expert other" when it comes to mobile learning and allow students to become our teachers within the "mobile ZPD".

References

Abbott, M. (2002). Using music to promote L2 learning among adult learners. *TESOL Journal*, *11*(1), 10-17.

Abdous, M. H., Camarena, M. M., & Facer, B. R. (2009). MALL technology: Use of academic podcasting in the foreign language classroom. *ReCALL*, *21*(1), 76-95.

Agar, M. (1996). *The professional stranger: An informal introduction to ethnography. Academic Press.* American Heritage Dictionary. Houghton Mifflin.

Aidman, E. V., & Leontiev, D. A. (1991). From being motivated to motivating oneself: A Vygotskian perspective. *Studies in Soviet Thought*, *42*(2), 137-151.

Alemi, M., Sarab, M. R. A., & Lari, Z. (2012). Successful learning of academic word list via MALL: Mobile assisted language learning. *International Education Studies*, *5*(6), 99-109.

Al-Jarf, R. (2012). Mobile technology and student autonomy in oral skill acquisition. In J.E. Díaz-Vera (Ed.), *Innovation and leadership in English language teaching: Left to my own devices: Learner autonomy and mobile-assisted language* learning (pp. 107-132). Bingley, United Kingdom: Emerald.

Anderson, L. (2008) 'Reflexivity.' In R. Thorpe & R. Holt (Eds.), *The Sage Dictionary of Qualitative Management Research* (pp. 183-185). London, England: Sage.

Anderson, N. J. (2002). The Role of Metacognition in Second Language Teaching and Learning. ERIC Digest.

Anzai, Y. (2013). Applying the basics to design innovative learning with ICT: mobile learning with mobile picture-notes. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications, Victoria, Canada,* 1720-1723.

Aydingün, A., Harding, Ç. B., Hoover, M., Kuznetsov, I., & Swerdlow, S. (2006). *Meskhetian Turks: An introduction to their history, culture and resettlement experiences* (Culture Profile No. 20.) Retrieved from World Relief Organization website: http://worldrelief.org/Document.Doc?id=393

Baleghizadeh, S., & Oladrostam, E. (2011). The effect of mobile assisted language learning (MALL) on grammatical accuracy of EFL students. *MEXTESOL Journal*, *34*(2), 1-10.

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4, pp. 71-81). New York, NY: Academic Press.

Batalova, J., & McHugh, M. (2010*). Number and growth of students in US schools in need of English instruction.* Washington, DC: Migration Policy Institute. Retrieved from http://www.migrationinformation.org/ellinfo/FactSheet_ELL1.pdf

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544-559.

Bell, N. (2012). Formulaic language, creativity, and language play in a second language. *Annual Review of Applied Linguistics*, *32*, 189-205.

Billings, E. S., & Mathison, C. (2012). I get to use an iPod in school? Using technology-based advance organizers to support the academic success of English Learners. *Journal of Science Education and Technology*, *21*(4), 494-503.

Boling, E. C., & Spiezio, C. (2012). Technology and the Common Core Standards. In L.M. Morrow, K. K. Wixson, & T. Shanahan (Eds.), *Teaching with the common core standards for English Language Arts, grades 3-5* (pp.154-171). New York, NY: Guilford Press.

Bowles, M. A. (2010). Concurrent verbal reports in second language acquisition research. *Annual Review of Applied Linguistics, 30*(1), 111-127.

Broner, M. A., & Tarone, E. E. (2001). Is it fun? Language play in a fifth-grade Spanish immersion classroom. *The Modern Language Journal, 85*(3), 363-379.

Brown, G., & Yule, G. (1983). *Teaching the spoken language* (vol. 2). New York, NY: Cambridge University Press.

Burnard, P. (2004). Writing a qualitative research report. *Accident and Emergency Nursing, 12*(3), 176-181.

Calderón, M., Slavin, R., & Sánchez, M. (2011). Effective instruction for English learners. *The Future of Children, 21*(1), 103-127.

Cameron, D. (2001). *Working with spoken discourse*. Thousand Oaks, CA: Sage.

Carlson, J. K. (2011). What do you do with a Digital pen? In J. Aitken, J. Fairley, & J. Carlson (Eds.), *Communication technology for students in special education and gifted programs*, (pp.303-308). Hershey, PA: IGI Global.

Casey, M. A., & Krueger, R. A. (1994). Focus group interviewing. In H. J. H. Macfie & D.H.M. Thompson (Eds.), *Measurement of food preferences* (pp. 77-96). New York, NY: Springer.

Cavus, N., & Ibrahim, D. (2009). M-learning: An experiment in using SMS to support learning new English language words. *British Journal of Educational Technology*, *40*(1), 78-91.

Chamot, A.U. (1996). Learning strategies of elementary foreign language immersion students. In J. E. Alatis (Ed.), Georgetown University Round Table on Languages and Linguistics 1995 (pp. 300-310). Washington, DC: Georgetown University Press.

Chamot, A. U., & O'Malley, J. M. (1996). The cognitive academic language learning approach: A model for linguistically diverse classrooms. *The Elementary School Journal*, 259-273.

Chang, K. E., Lan, Y. J., Chang, C. M., & Sung, Y. T. (2010). Mobile-device-supported strategy for Chinese reading comprehension. *Innovations in Education and Teaching International*, *47*(1), 69-84.

Chang, A., & Read, J. (2006). The effects of listening support on the listening performance of EFL learners. *TESOL Quarterly*, *40*, 375-397.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Thousand Oaks, CA: Pine Forge Press.

Chen, C. M., Tan, C. C., & Lo, B. J. (2013, in press). Facilitating English-language learners' oral reading fluency with digital pen technology. *Interactive Learning Environments*, 1-23.

Chen, I.J., Chang, C.C., & Yen, J.C. (2012). Effects of presentation mode on mobile language learning: A performance efficiency perspective. *Australasian Journal of Educational Technology, 28*(1), 122-137.

Chen, N. S., Hsieh, S., & Kinshuk, A. (2008). Effects of short-term memory and content representation type on mobile language learning. *Language Learning & Technology*, *12*(3), 93-113.

Cheung, W. S., & Hew, K. F. (2009). A review of research methodologies used in studies on mobile handheld devices in K-12 and higher education settings. *Australasian Journal of Educational Technology*, *25*(2), 153-183.

Chinnery, G. M. (2006). Emerging technologies. Going to the mall: mobile assisted language learning. *Language Learning & Technology*, *10*(1), 9-16.

Chiseri-Strater, E. (1996). Turning in upon ourselves: Positionality, subjectivity, and reflexivity in case study and ethnographic research. *Ethics and Representation in Qualitative Studies of Literacy*, 115-133.

Choi, F., & Chen, M. (2008). Enhancing English listening skills by using mp3. *International Journal of Learning*, *14*(12), 193-200.

Christensen, P. H. (2004). Children's participation in ethnographic research: Issues of power and representation. *Children & Society*, *18*(2), 165-176.

Chun, D. M., & Plass, J. L. (1996). Effects of multimedia annotations on vocabulary acquisition. *The Modern Language Journal*, *80*(2), 183-198.

Cole, M. (1995). Culture and cognitive development: From cross-cultural research to creating systems of cultural mediation. *Culture & Psychology*, *1*(1), 25-54.

Cole, M., & Wertsch, J. V. (1996). Beyond the individual-social antinomy in discussions of Piaget and Vygotsky. *Human Development*, *39*(5), 250-256.

Comas-Quinn, A., Mardomingo, R., & Valentine, C. (2009). Mobile blogs in language learning: making the most of informal and situated learning opportunities. *ReCALL*, *21*(1), 96-112.

Cook, G. (2000). *Language play, language learning*. Oxford, English: Oxford University Press.

Cook, G. (1997). Language play, language learning. *ELT journal*, *51*(3), 224-231.

Cook, V. (2001). Using the first language in the classroom. *Canadian Modern Language Review/La Revue Canadienne des Langues Vivantes*, *57*(3), 402-423.

Crabtree, B. F., & Miller, W. L. (1999). Using codes and code manuals: a template organizing style of interpretation. *Doing Qualitative Research*, *2*, 163-177.

Creswell, J. W. (2012). *Qualitative inquiry and research design: Choosing among five approaches*. (3rd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice*, *39*(3), 124-130.

Cruz, M. B. (2012). *Student and teacher perceptions of a mobile-based vocabulary study tool for English language learners*. (Unpublished doctoral dissertation). George Mason University, VA.

Cummins, J. (1979). Cognitive/academic language proficiency, linguistic interdependence, the optimum age question and some other matters. Working Papers on Bilingualism, No. 19, 121-129.

Cummins, J. (2008). BICS and CALP: Empirical and theoretical status of the distinction. In *Encyclopedia of language and education* (pp. 487-499). New York, NY: Springer.

Daniels, H. (Ed.). (2005). *An introduction to Vygotsky* (2nd ed.). New York, NY: Routledge.

Daniels, H. (2008). *Vygotsky and research*. New York, NY: Routledge.

Deci, E. L., & Ryan, R. M. (2010). *Self-determination*. Philadelphia, PA: John Wiley & Sons.

Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York, NY: Plenum.

deJong, E. & Harper, C. A. (2013). Preparing Standard Curriculum Teachers for All Learners. In M. Brisk (Ed.), *Language, culture, and community in teacher education*, (pp. 127-148). Mahwah, NJ: Lawrence Erlbaum.

Demouy, V., & Kukulska-Hulme, A. (2010). On the spot: Using mobile devices for listening and speaking practice on a French language programme. *Open Learning*, *25*(3), 217-232.

Dörnyei, Z. (2005). *The psychology of the language learner: Individual differences in second language acquisition*. Mahwah, NJ: Lawrence Erlbaum.

Dörnyei, Z., & Ushioda, E. (Eds.). (2009). *Motivation, language identity and the L2 self* (vol. 36). Bristol, England: Multilingual Matters.

Drever, E. (1995). *Using semi-structured interviews in small-scale research. A teacher's guide*. Edinburgh, Scotland: Scottish Council for Research in Education.

Ducate, L., & Lomicka, L. (2013). Going mobile: Language learning with an iPod Touch in intermediate French and German classes. *Foreign Language Annals*, *46*(3), 445-468.

Ducate, L., & Lomicka, L. (2009). Podcasting: An effective tool for honing language students' pronunciation? *Language Learning & Technology*, *13*(3), 66-86.

Duff, P. A. (2008). Language socialization, participation and identity: Ethnographic approaches. In *Encyclopedia of language and education* (pp. 860-872). New York, NY: Springer.

Durgunoğlu, A. Y., & Hughes, T. (2010). How prepared are the US preservice teachers to Teach English Language Learners? *International Journal of Teaching and Learning in Higher Education*, *22*(1), 32-41.

Easton, K. L., McComish, J. F., & Greenberg, R. (2000). Avoiding common pitfalls in qualitative data collection and transcription. *Qualitative Health Research*, *10*(5), 703-707.

Elkhafaifi, H. (2005). Listening comprehension and anxiety in the Arabic language classroom. *The Modern Language Journal*, *89*(2), 206-220.

Ernst-Slavit, G., Moore, M., & Maloney, C. (2002). Changing lives: Teaching English and literature to ESL students. *Journal of Adolescent & Adult Literacy*, *46*(2), 116-128.

Etherington, K. (2004). *Becoming a Reflexive Researcher-Using Our Selves in Research*. Philadelphia, PA: Jessica Kingsley Publishers.

Evans, C. (2008). The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers & Education*, *50*(2), 491-498.

Face the Facts USA, (2012). Limited-English students test public schools [Web log comment]. Retrieved from http://www.facethefactsusa.org/facts/limited-english-students-test-public-schools

Facer, B.R., Abdous, M. & Camarena, M. (2009). The impact of academic podcasting on students: Learning outcomes and study habits. In R. de Cassia Veiga Marriott, & P. Lupion Torres (Eds.), *Handbook of research on E-learning methodologies for language acquisition* (pp. 339-351). Hershey, PA: IGI Global.

Facer, B. R., & Yen, C. J. (2012). Academic effectiveness of podcasting: A comparative study of integrated versus supplemental use of podcasting in second language classes. *Computers & Education*, *58*(1), 43-52.

Farstrup, A. E., & Samuels, S. J. (Eds.). (2008). *What research has to say about vocabulary instruction*. Newark, DE: International Reading Association.

Fisher, T., Sharples, M., Pemberton, R., Ogata, H., Uosaki, N., Edmonds, P., & Tschorn, P. (2012). Incidental second language vocabulary learning from reading novels: A comparison of three mobile modes. *International Journal of Mobile and Blended Learning (IJMBL)*, *4*(4), 47-61.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, *12*(2), 219-245.

Franklin, T., & Peng, L. W. (2008). Mobile math: Math educators and students engage in mobile learning. *Journal of Computing in Higher Education*, *20*(2), 69-80.

Freire, P. (1970). Pedagogy of the Oppressed, trans. *Myra Bergman Ramos.* New York, NY: Continuum.

Friese, S. (2013). *ATLAS.ti 7 user guide and reference*. Retrieved from http://www.atlasti.com/uploads/media/atlasti_v7_manual_201301.pdf

Fuchs, L. S., Fuchs, D., Stuebing, K., Fletcher, J. M., Hamlett, C. L., & Lambert, W. (2008). Problem solving and computational skill: Are they shared or distinct aspects of mathematical cognition?. *Journal of Educational Psychology*, *100*(1), 30.

Gee, J. P. (2013). *An introduction to discourse analysis: Theory and method*. (3rd ed.). New York, NY: Routledge.

Gibbons, P. (2003). Mediating language learning: Teacher interactions with ESL students in a content-based classroom. *TESOL Quarterly, 37*, 247-273.

Gomez Jr, R., Parker, R., Lara-Alecio, R., & Gomez, L. (1996). Process versus product writing with limited English proficient students. *Bilingual Research Journal*, *20*(2), 209-233.

Grantmakers for Education. (2013). *Educating English Language Learners: Grantmaking strategies for closing America's other achievement gap*. Retrieved from http://edfunders.org/sites/default/files/Educating%20English%20Language%20Learners_April%202013.pdf

Glesne, C. (2006). *Becoming qualitative researchers: An introduction*. Boston, MA: Pearson Education.

González, N., Andrade, R., Civil, M., & Moll, L. (2001). Bridging funds of distributed knowledge: Creating zones of practices in mathematics. *Journal of Education for Students Placed at Risk, 6*(1-2), 115-132.

Graham, S., Weiner, B. (1996). Theories and principles of motivation. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 63-84). New York, NY: Simon & Schuster Macmillan.

Gromik, N. A. (2012). Cell phone video recording feature as a language learning tool: A case study. *Computers & Education*, *58*(1), 223-230.

Hagen, P., Robertson, T., Kan, M., & Sadler, K. (2005). Emerging research methods for understanding mobile technology use. *Proceedings of the 17th Australia Conference on Computer-Human Interaction: Citizens Online: Considerations for Today and the Future*, *Narrabundah, Australia*, 1-10.

Hammersley, M. (1990). *Reading ethnographic research: A critical guide*. New York, NY: Longman.

Heilesen, S. B. (2010). What is the academic efficacy of podcasting? *Computers & Education*, *55*(3), 1063-1068.

Hew, K. F. (2009). Use of audio podcast in K-12 and higher education: a review of research topics and methodologies. *Educational Technology Research and Development*, *57*(3), 333-357.

Holland, D., & Lachicotte, W. (2007). Vygotsky, Mead, and the new sociocultural studies of identity. In H. Daniels, M. Cole, & J.V. Wertsch (Eds.). *The Cambridge companion to Vygotsky*, (pp. 101-135). New York, NY: Cambridge University Press.

Honigsfeld, A. (2009). ELL Programs: Not 'One Size Fits All'. *Kappa Delta Pi Record*, *45*(4), 166-171.

Horwitz, E. K. (2008). *Becoming a language teacher*. Boston, MA: Pearson Education.

Horwitz, E. (2001). Language anxiety and achievement. *Annual Review of Applied Linguistics, 21*, 112-126.

Hsu, C. K., Hwang, G. J., & Chang, C. K. (2012). A personalized recommendation-based mobile learning approach to improving the reading performance of EFL students. *Computers & Education*.

Huang, L. L., & Lin, C. C. (2011). EFL learners' reading on mobile phones. *The JALT CALL Journal*, *7*(1), 61-78.

Hull, D. M., & Saxon, T. F. (2009). Negotiation of meaning and co-construction of knowledge: An experimental analysis of asynchronous online instruction. *Computers & Education, 52*(3), 624-639.

Hwang, W. Y., & Chen, H. S. (2013). Users' familiar situational contexts facilitate the practice of EFL in elementary schools with mobile devices. *Computer Assisted Language Learning*, *26*(2), 101-125.

Hwang, G. J., & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, *56*(4), 1023-1031.

Hwang, W.Y., Wu, S.Y., & Su, J.H. (2008). A study of listening diversity and speaking for English learning with mobile device supports. *Proceedings of Advances in Multimedia Processing Pacific Rim Conference, Tainan, Taiwan,* 748-757.

Ihde, D. (2010). A phenomenology of technics. In Craig Hanks (Ed.), *Technology and values: Essential readings* (pp. 134-156). Philadelphia, PA: Wiley-Blackwell.

Ishikawa, M. (2013). Examining the effect of written languaging: the role of metanotes as a mediator of second language learning. *Language Awareness, 22*(3), 220-233.

James, N., & Busher, H. (2013). Researching hybrid learning communities in the digital age through educational ethnography. *Ethnography and Education, 8*(2), 194-209.

Jenks, C. J. (2011). *Transcribing talk and interaction: Issues in the representation of communication data*. Philadelphia, PA: John Benjamins Publishing.

Johnson, I. D., & Naresh, N. (2011). Using a computer pen to investigate students' use of metacognition during mathematical problem-solving. HTW: Dresden. Retrieved from http://directorymathsed.net/download/DeLoach.pdf

John-Steiner, V., & Mahn, H. (1996). Sociocultural approaches to learning and development: A Vygotskian framework. *Educational Psychologist, 31*(3-4), 191-206.

Kennedy, C., & Levy, M. (2008). L'italiano al telefonino: Using SMS to support beginners' language learning. *ReCALL, 20*(3), 315-330.

Kern, R. (2006). Perspectives on technology in learning and teaching languages. *TESOL Quarterly, 40*(1), 183-210.

Knox, S., Herrington, A., &, Quin, R. (2011). Smartpens in second or other language learning environments. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunication, Lisbon, Portugal,* 2736-2741.

Kondo, M., Ishikawa, Y., Smith, C., Sakamoto, K., Shimomura, H., & Wada, N. (2012). Mobile assisted language learning in university EFL courses in Japan: Developing attitudes and skills for self-regulated learning. *ReCALL, 24*(02), 169-187.

Kozulin, A. (2003). Psychological tools and mediated learning. In A. Kozulin, B. Gindis, V. Ageyev, & S. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 15-38). New York, NY: Cambridge University Press.

Kozulin, A., Gindis, B., Ageyev, V. S., & Miller, S. (2003). Sociocultural theory and education: Students, teachers, and knowledge. In A. Kozulin, B. Gindis, V. Ageyev, & S. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 1-11). New York, NY: Cambridge University Press.

Krashen, S. (2004). The case for narrow reading. *Language Magazine*, *3*(5), 17-19.

Krashen, S. (1982). *Principles and practice in second language acquisition* (pp. 65-78). Oxford, NY: Pergamon Press.

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. *The American Journal of Occupational Therapy*, *45*(3), 214-222.

Kukulska-Hulme, Agnes (2010). Charting unknown territory: Models of participation in mobile language learning. *International Journal of Mobile Learning and Organisation*, *4*(2), 116–129.

Kukulska-Hulme, A. (2009). Will mobile learning change language learning. ReCALL, 21(2), 157-165.

Kukulska-Hulme, A., & Bull, S. (2009). Theory-based support for mobile language learning: Noticing and recording. *International Journal of Interactive Mobile Technologies*, *3*, 12-18.

Kukulska-Hulme, A., Sharples, M., Milrad, M., Arnedillo-Sánchez, I., & Vavoula, G. (2009). Innovation in mobile learning: a European perspective. *Mobile and Blended Learning, 1*(1), 13-35.

Kukulska-Hulme, A., & Shield, L. (2008). An overview of mobile assisted language learning: From content delivery to supported collaboration and interaction. *ReCALL*, *20*(03), 271-289.

Kukulska-Hulme, A., Traxler, J., & Pettit, J. (2007). Designed and user-generated activity in the mobile age. *Journal of Learning Design, 2*(1), 52–65.

Lan, Y. J., Sung, Y. T., & Chang, K. E. (2007). A mobile-device-supported peer-assisted learning system for collaborative early EFL reading. *Language Learning & Technology*, *11*(3), 130-151.

Lantolf, J. P. (2006). Sociocultural theory and L2: State of the art. *Studies in Second Language Acquisition*, *28*(01), 67-109.

Lantolf, J. P. (2000). Second language learning as a mediated process. *Language teaching*, *33*(2), 79-96.

Lantolf, J. (1997). The function of language play in the acquisition of L2 Spanish. In W. R. Glass & A. T. Perez-Leroux (Eds.), *Contemporary perspectives on the acquisition of Spanish* (pp. 3-24). Somerville, MA: Cascadilla Press.

Lantolf, J. P., & Pavlenko, A. (1995). Sociocultural theory and second language acquisition. *Annual Review of Applied Linguistics*, *15*(1), 108-124.

Lantolf, J. P., & Thorne, S. L. (2006). *Sociocultural theory and the Genesis of L2 development*. Oxford, England: Oxford University Press.

Lazarín, M., &Ortiz Licon, F. (2010). Next generation charter schools: Meeting the needs of Latinos and English Language Learners. Washington, DC: Center for American Progress and National Council of La Raza.

Lee, L. (2009). Promoting intercultural exchanges with blogs and podcasting: A study of Spanish–American telecollaboration. *Computer Assisted Language Learning*, *22*(5), 425-443.

Levitan, M., Mathison, C., & Billings, E. S. (2010). The effect of primary language podcasts on third grade English Language Learners‟ performance in English-only science education contexts. *Electronic Journal of Literacy Through Science*, *9.* 1-30. Retrieved from http://ejlts.ucdavis.edu/sites/ejlts.ucdavis.edu/files/articles/EJLTS_Mathison_Billings_finalb.pdf

Liu, T. Y. (2009). A context-aware ubiquitous learning environment for language listening and speaking. *Journal of Computer Assisted Learning*, *25*(6), 515-527.

Lomicka, L., & Lord, G. (2011). Podcasting–Past, Present and Future: Applications of Academic Podcasting In B. Faucer & M. Abdous (Eds.), *Academic Podcasting and Mobile Assisted Language Learning: Applications and Outcomes* (pp. 1- 17). Hershey, PA: IGI Global.

Lomicka, L. (1998). "To gloss or not to gloss": An investigation of reading comprehension online. *Language Learning & Technology*, *1*(2), 41-50.

Lord, G. (2008). Podcasting communities and second language pronunciation. *Foreign Language Annals*, *41*(2), 364-379.

Looi, C. K., Seow, P., Zhang, B., So, H. J., Chen, W., & Wong, L. H. (2010). Leveraging mobile technology for sustainable seamless learning: a research agenda. *British Journal of Educational Technology*, *41*(2), 154-169.

Looi, C. K., Wong, L. H., So, H. J., Seow, P., Toh, Y., Chen, W., Zang, B., Norris, C., & Soloway, E. (2009). Anatomy of a mobilized lesson: Learning my way. *Computers & Education*, *53*(4), 1120-1132.

Lu, M. (2008). Effectiveness of vocabulary learning via mobile phone. *Journal of Computer Assisted Learning, 24*(6), 515-525.

MacIntyre, P. D., & Gregersen, T. (2012). Affect: The role of language anxiety and other emotions in language learning. In S. Mercer, S. Ryan, & M. Williams (Eds.), *Psychology for language learning: Research, theory and pedagogy* (pp. 103-118). London: Palgrave.

Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U. (2013). *Teens and technology 2013. Pew Internet & American Life Project*. Retrieved from http://www.pewinternet.org/Reports/2013/Teens-and-Tech.aspx

Mahn, H., & John-Steiner, V. (2002). The gift of confidence: A Vygotskian view of emotions. *Learning for life in the 21st century: socio-cultural perspectives of future education* (pp. 46-59). Oxford, New York: Blackwell.

MALL Research Project Report. (2009). *Mobile application for language learning*. Curriculum Corporation: The Learning Federation. Retrieved from http://www.ndlrn.edu.au/verve/_resources/MALL_Report_2009.pdf

Mancilla, R. (2013). Getting smart about split attention. In B. Zou, M.Xing, C. H. Xiang, Y. Wang, & M. Sun (Eds.), *Computer-assisted foreign language teaching and learning* (pp. 2010-2029). Hershey, PA: IGI Global.

Maneesriwongul, W., & Dixon, J.K. (2004). Instrument translation process: a methods review. *Journal of Advanced Nursing, 48*(2), 175-186.

Martin, S., Diaz, G., Sancristobal, E., Gil, R., Castro, M., & Peire, J. (2011). New technology trends in education: Seven years of forecasts and convergence. *Computers & Education, 57*(3), 1893-1906.

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (vol. 41). Los Angeles, CA: Sage.

Maxwell, J. A. (1992). Understanding and validity in qualitative research. *Harvard Educational Review, 62* (3), 279–300.

Maxwell, L. (2011, June 4). Long-Term ELLs more likely to drop out, study finds. *Education Week*. Retrieved from http://blogs.edweek.org/edweek/learning-the-language/2011/12/long-term_ells_more_likely_to.html

McCafferty, S. G. (1994). Adult second language learners' use of private speech: A review of studies. *The Modern Language Journal, 78*(4), 421-436.

McFarlane, A., N. Roche, and P. Triggs. (2007). *Mobile learning: Research findings.* Report to Becta. Bristol, England: University of Bristol.

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. *Australasian Journal of Educational Technology, 25*(3), 309-321.

Mellow, P. (2005). *The media generation: Maximise learning by getting* mobile. Retrieved from http://www.ascilite.org.au/conferences/brisbane05/blogs/proceedings/53_Mellow.pdf

Meyer, C. B. (2001). A case in case study methodology. *Field Methods, 13*(4), 329-352.

Miles, M. B., and A. M. Huberman. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage.

Mirzaei, A., & Eslami, Z. R. (2013, in press). ZPD-activated languaging and collaborative L2 writing. *Educational Psychology*. Retrieved from

http://www.tandfonline.com/doi/abs/10.1080/01443410.2013.814198#.U88ut7Hde-k

Mishler, E. G. (1990). Validation in inquiry-guided research: The role of exemplars in narrative studies. *Harvard Educational Review*, *60*(4), 415-443.

Mohsen, M. A., & Balakumar, M. (2011). A review of multimedia glosses and their effects on L2 vocabulary acquisition in CALL literature. *ReCALL*, *23*(2), 135-159.

Moll, L. C. (1992). Literacy research in community and classrooms: A sociocultural approach. In R. Beach, J.L. Green, M.L. Kamil, & T. Shanahan (Eds.) *Multidisciplinary perspectives on literacy research* (pp. 211-244). Urbana, IL: National Council of Teachers of English.

Muhr, T. (1991). Atlas/ti—a prototype for the support of text interpretation. *Qualitative Sociology*, *14*(4), 349-371.

Murphy, P., Bollen, D., & Langdon, C. (2012). Mobile technology, collaborative reading, and elaborative feedback. In J.E. Díaz-Vera (Ed.), *Innovation and leadership in English language teaching: Left to my own devices: Learner autonomy and mobile-assisted language* learning (vol. 6) (pp. 131-159). Bingley, UK: Emerald.

Murray, G., Gao, X., & Lamb, T. (Eds.). (2011). *Identity, motivation and autonomy in language learning* (Vol. 54). Bristol, England: Multilingual Matters.

Murtagh, L. (2007). Implementing a critically quasi-ethnographic approach. *The Qualitative Report*, *12*(2), 193-215.

Nah, K. C., White, P., & Sussex, R. (2008). The potential of using a mobile phone to access the Internet for learning EFL listening skills within a Korean context. *ReCALL*, *20*(3), 331-347.

Naismith, L., & Corlett, D. (2006). Reflections on success: A retrospective of the mLearn conference series 2002-2005. In *mLearn 2006: Across generations and cultures, Banff, Canada*, 118-120.

Namey, E., Guest, G., Thairu, L., & Johnson, L. (2007). Data reduction techniques for large qualitative data sets. In G. Guest & K. MacQueen (Eds.), *Handbook for team-based qualitative research* (pp. 137-162). Lanham, MD: Altamira Press.

National Center for Education Statistics (NCES) (2011). *The condition of education: English Language Learners*. Retrieved from http://nces.ed.gov/programs/coe/indicator_cgf.asp

Nikolova, O. R. (2002). Effects of students' participation in authoring of multimedia materials on student acquisition of vocabulary. *Language Learning & Technology*, *6*(1), 100-122.

Norbrook, H., & Scott, P. (2003). Motivation in mobile modern foreign language learning. In J. Attewell, G. Da Bormida, M. Sharples, & C. Savill-Smith (Eds.), *mLearn 2003: Learning with mobile dev*ices (pp. 50-51). London, England: Learning and Skills Development Agency.

Oberg, A., & Daniels, P. (2013). Analysis of the effect a student-centred mobile learning instructional method has on language acquisition. *Computer Assisted Language Learning*, *26*(2), 177-196.

Ormond, P. R. (2008). Podcasting enhances learning. *Journal of Computing Sciences in Colleges, 24*(1), 232-238.

Ortega, L. (2009). *Understanding second language acquisition*. New York, NY: Hodder Education.

Oxford, R. L. (2003). Language learning styles and strategies: Concepts and relationships. *IRAL, 41*(4), 271-278.

Oxford, R. L. (2002). Language learning strategies in a nutshell: Update and ESL suggestions. In J. Richards & W. Renandya (Eds.), *Methodology in language teaching* (pp. 124-132). New York, NY: Cambridge University Press.

Pachler, N. (2009). Research methods in mobile and informal learning: some issues. In G. Vavoula, N. Pachler, & A. Kukulska-Hulme (Eds.), *Researching mobile learning: Frameworks, tools, and research designs* (pp. 1-15). New York, NY: Peter Lang.

Pachler, N., Cook, J., & Bradley, C. (2009). 'I don't really see it': Whither case-based approaches to understanding off-site and on-campus mobile learning? In G. Vavoula, N. Pachler, & A. Kukulska-Hulme (Eds.), R*esearching mobile learning: Frameworks, tools and research designs* (pp. 77-95). New York, NY: Peter Lang.

Patton, M.Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage.

Peirce-Norton, B. (1995). Social identity, investment, and language learning. *TESOL Quarterly*, *29*(1), 9-31.

Peng, H., Su, Y., Chou, C. & Tsai, C. (2009). Ubiquitous knowledge construction: Mobile learning re-defined and a conceptual framework. *Innovations in Education and Teaching International, 46*(2), 171–183.

Pettit, S. K. (2011). Teachers' beliefs about English Language Learners in the mainstream classroom: A review of the literature. *International Multilingual Research Journal*, *5*(2), 123-147.

Pica, T. (1994). Research on Negotiation: What does it reveal about second language learning conditions, processes, and outcomes? *Language Learning*, *44*(3), 493 – 527.

Piper, A. M., Weibel, N., & Hollan, J. D. (2011). Write-N-Speak: Authoring multimodal digital-paper materials for speech-language therapy. *ACM Transactions on Accessible Computing (TACCESS)*, *4*(1), 2.

Polat, N. (2010). A comparative analysis of pre-and in-service teacher beliefs about readiness and self-competency: Revisiting teacher education for ELLs. *System*, *38*(2), 228-244.

Polat, N., & Mahalingappa, L. (2013). Examining service and gender effects on teacher beliefs about ELLs in content area classes: A case for inclusion, responsibility and instructional support. *Teaching Education, 24, 58-83.*

Polat, N., & Schallert, D. L. (2013). Kurdish adolescents acquiring Turkish: Their self-determined motivation and identification with L1 and L2 communities as predictors of L2 accent attainment. *The Modern Language Journal*, *97*(3), 745-763.

Polat, N., Mancilla, R., & Mahalingappa, L. (2013). Anonymity and motivation in asynchronous discussions and L2 vocabulary learning. *Language Learning & Technology, 17*(2), 57-74.

Platt, E., Harper, C., & Mendoza, M. B. (2003). Dueling philosophies: Inclusion or separation for Florida's English language learners? *TESOL Quarterly, 37*(1), 105-133.

Puentedura, R. (2010). SAMR and TPCK: intro to advanced practice. Retrieved from http://hippasus.com/resources/sweden2010/SAMR_TPCK_IntroToAdvancedPractice.pdf

Rahimi, M., & Katal, M. (2012). The role of metacognitive listening strategies awareness and podcast-use readiness in using podcasting for learning English as a foreign language. *Computers in Human Behavior, 28*(4), 1153-116.

Reinders, H., & Cho, M. (2010). Extensive listening practice and input enhancement using mobile phones. *TESL-EJ, 14*(2), 1-7.

Reis, D.S. (2013*)*.Transformative Teacher Education in Action: Supporting Pre-Service Teachers to Support English Language Learners. In S.B. Said & L.J. Zhang (Eds.), *Language Teachers and Teaching: Global Perspective, Local Initiatives* (pp. 89-105). New York: Routledge.

Reis, D. S. (2011). Non-native English-speaking teachers (NNESTs) and professional legitimacy: A sociocultural theoretical perspective on identity transformation. *International Journal of the Sociology of Language, 208,* 139-160.

Report of the National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.* Retrieved from http://www.nichd.nih.gov/publications/pubs/nrp/Pages/report.aspx

Riding, R. J., Glass, A., & Douglas, G. (1993). Individual differences in thinking: Cognitive and neurophysiological perspectives. *Educational Psychology, 13* (3 & 4), 267-279.

Riessman, C.K. (2008). *Narrative methods for the human sciences.* Los Angeles, CA: Sage.

Robottom, I., & Hart, P. (1995). Behaviorist EE research: Environmentalism as individualism. *The Journal of Environmental Education*, *26*(2), 5-9.

Roebuck, R. F., & Wagner, L. C. (2004). Teaching repetition as a communicative and cognitive tool: evidence from a Spanish conversation class. *International Journal of Applied Linguistics, 14*(1), 70-89.

Saldaña, J. (2009). *The coding manual for qualitative researchers*. Los Angeles, CA: Sage.

Samuels, J. (1979). The method of repeated readings. In T. Rasinski (Ed.), *Essential readings on fluency* (pp.21-25). Newark, DE: International Reading Association.

Samson, J. F., & Collins, B. A. (2012). Preparing All Teachers to Meet the Needs of English Language Learners: Applying Research to Policy and Practice for Teacher Effectiveness. *Center for American Progress*. Retrieved from http://files.eric.ed.gov/fulltext/ED535608.pdf

Sandberg, J., Maris, M., & de Geus, K. (2011). Mobile English learning: An evidence-based study with fifth graders. *Computers & Education*, *57*(1), 1334-1347.

Scott, K. W. (2004). Relating categories in grounded theory analysis: Using a conditional relationship guide and reflective coding matrix. *The Qualitative Report*, *9*(1), 113-126.

Schmidt, R., & Frota, S. (1986). Developing basic conversational ability in a second language. A case study of an adult learner of Portuguese. In R. Day (Ed.), *Talking to learn: Conversation in second language acquisition*, (pp. 237-326). Rowley, MA: Newbury House.

Schreiner, K. (2008). Uniting the paper and digital worlds. *Computer Graphics and Applications, IEEE, 28*(6), 6-10.

Sharples, M., Taylor, J., & Vavoula, G. (2005). Towards a theory of mobile learning. Retrieved from http://kn.open.ac.uk/public/document.cfm?docid=8558

Sharples, M., Taylor, J., & Vavoula, G. (2009) A Theory of Learning for the mobile age. In R. Andrews & C. Haythornthwaite (Eds.), *The Sage Handbook of Elearning Research* (pp. 221-47). London, England: Sage.

Shea, A. (2011). Teaching Japanese writing with a Smartpen. *World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Honolulu, HI,* 401-403.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*(2), 63-75.

Sheorey, R. A., & Mokhtari, K. (2001). Differences in the metacognitive awareness of reading strategies among native and non-native readers. *System, 29*(4), 431-449.

Slavit, D., & Ernst-Slavit, G. (2007). Teaching mathematics and English to English language learners simultaneously. *Middle School Journal, 39*(2), 4-11.

Song, Y., & Fox, R. (2008). Using PDA for undergraduate student incidental vocabulary testing. *ReCALL, 20*(03), 290-314.

Spradley, J. P. (1979). *The ethnographic interview*. New York: Holt, Rinehart and Winston.

Stake, R. E. (2010). *Qualitative research: Studying how things work*. New York, NY: Guilford Press.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Stead, G. (2006). Mobile technologies: Transforming the future of learning. In A. Pinder (Ed.), *Emerging Technologies for Learning*, (pp. 6–15). Coventry, UK: British Educational Communications and Technology Agency. Retrieved from http://webarchive.nationalarchives.gov.uk/20101102103654/http://research.becta.org.uk/upload-dir/downloads/page_documents/research/emerging_technologies.pdf

Stockwell, G. (2010). Using mobile phones for vocabulary activities: Examining the effect of the platform. *Language Learning & Technology*, *14*(2), 95-110.

Stockwell, G. (2007). Vocabulary on the move: Investigating an intelligent mobile phone-based vocabulary tutor. *Computer Assisted Language Learning*, *20*(4), 365-383.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Procedures and techniques for developing grounded theory*. Thousand Oaks, CA: Sage.

Suzuki, W., & Itagaki, N. (2009). Languaging in grammar exercises by Japanese EFL learners of differing proficiency. *System*, *37*(2), 217-225.

Swain, M. (2011). The inseparability of cognition and emotion in second language learning. *Language Teaching*, *1*(1), 1-13.

Swain, M. (2006). Languaging, agency and collaboration in advanced language proficiency. In H.Byrnes (Ed.), *Advanced language learning: The contribution of Halliday and Vygotsky* (pp. 95–108). London, England: Continuum.

Swain, M. (2005) The output hypothesis: theory and research. In E. Hinkel (Ed.), *Handbook of research in second language teaching and* learning (pp. 471–84) Mahwah, NJ: Lawrence Erlbaum.

Swain, M., Kinnear, P., & Steinman, L. (2010). *Sociocultural theory in second language education: An introduction through narratives* (vol. 7). Bristol, England: Multilingual Matters.

Swan, K., van t Hooft, M., Kratcoski, A., & Unger, D. (2005). Uses and effects of mobile computing devices in K-8 classrooms. *Journal of Research on Technology in Education, 38*(1), 99-112.

Thornton, P., & Houser, C. (2005). Using mobile phones in English education in Japan. *Journal of Computer Assisted Learning*, *21*(3), 217-228.

Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative Inquiry*, *16*(10), 837-851.

Traxler, J. (2007). Defining, Discussing and Evaluating Mobile Learning: The moving finger writes and having writ.... *The International Review of Research in Open and Distance Learning*, *8*(2), 1-12.

Traxler, J. (2009). Current state of mobile learning. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training* (pp. 9-24). Vancouver, Canada: Marquis Book Printing.

United States Department of Education. (2010). *National education technology plan.* Washington DC: Government Printing Office. Retrieved from http://www.ed.gov/sites/default/files/NETP-2010-final-report.pdf

Van Roekel, N. P. D. (2010). English language learners face unique challenges. *National Education Association.* Retrieved from http://www.achievementgaps.org/assets/docs/HE/ELL_Policy_Brief_Fall_08_%282%29.pdf

van Zeeland, H., & Schmitt, N. (2013). Incidental vocabulary acquisition through L2 listening: A dimensions approach. *System, 41*(3), 609-624.

Vandergrift, L. (2002). Listening: theory and practice in modern foreign language competence. *Subject Centre for Languages, Linguistics and Area Studies Guide to Good Practice*. Retrieved from https://www.llas.ac.uk/resources/gpg/67

Viberg, O., & Grönlund, Å. (2012). Mobile assisted language learning: a literature review. *Proceedings of the 11th International Conference on Mobile and Contextualised Learning, Helsinki, Finland*, 9-16. Retrieved from: http://ceur-ws.org/Vol-955/

Viberg, O., & Grönlund, Å. (2013). Cross-cultural analysis of users' attitudes toward the use of mobile devices in second and foreign language learning in higher education: A case from Sweden and China. *Computers & Education*, *69*, 169-180.

Vincent, J. (2006). Emotional attachment and mobile phones. *Knowledge, Technology & Policy*, *19*(1), 39-44.

Vygotsky, L. S. (1987) Thinking and speech. In R.W. Reiber & A. S. Carton (Eds.), *The collected works of L.S. Vygotsky: vol. 1. Problems of general psychology* (N.

Minick, Trans.) (pp. 39-285). New York, NY: Plenum Press. (Original work published 1934).

Vygotsky, L. S. (1981). The genesis of higher mental functions. *The Concept of Activity in Soviet Psychology*, 144-188.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Walker, A., Shafer, J., & Iiams, M. (2004). "Not in my classroom": Teacher attitudes towards English language learners in the mainstream classroom. *NABE Journal of Research and Practice*, *2*(1), 130-160.

Warschauer, M., & Healey, D. (1998). Computers and language learning: An overview. *Language teaching*, *31*(2), 57-71.

Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education*, *34*(1), 179-225.

Watson-Gegeo, K. A. (1997). Classroom ethnography. In *Encyclopedia of language and education* (pp. 135-144). Houten, Netherlands: Springer.

Watson-Gegeo, K. A. (1988). Ethnography in ESL: Defining the essentials. *TESOL Quarterly*, *22*(4), 575-592.

Weinberg, A., Knoerr, H., & Vandergrift, L. (2011). Creating podcasts for academic listening in French: Student perceptions of enjoyment and usefulness. *CALICO Journal*, *28*(3), 588-605.

Wells, G. (1994). Learning and teaching 'scientific concepts': Vygotsky's ideas revisited. Paper presented at the *Vygotsky and the Human Sciences Conference Moscow,*

Russia, 1-22. Retrieved from http://people.ucsc.edu/~gwells/Files/Papers_Folder/ScientificConcepts.pdf

Wertsch, J. V. (1985). *Vygotsky and the social formation of mind*. Harvard: Harvard University Press.

WIDA Consortium (2007). *English language proficiency standards and resource guide: PreKindergarten–Grade 12*. Madison: WI: Board of Regents of the University of Wisconsin System, on behalf of World-Class Instructional Design and Assessment (WIDA) Consortium. Retrieved from http://www.wida.us/standards/RG_Performance%20Definitions.pdf

Willis, J. W. (2007). *Foundations of qualitative research: Interpretive and critical approaches*. Thousand Oaks, CA: Sage.

Wolcott, Harry F. (2008). *Transforming qualitative data: Description, analysis, and interpretation* (3rd ed.). Thousand Oaks, CA: Sage.

Wong, L. H., & Looi, C. K. (2010). Vocabulary learning by mobile-assisted authentic content creation and social meaning-making: two case studies. *Journal of Computer Assisted Learning*, *26*(5), 421-433.

Wong, L. H., & Looi, C. K. (2011). What seams do we remove in mobile-assisted seamless learning? A critical review of the literature. *Computers & Education*, *57*(4), 2364-2381.

Wong, L. H., Song, Y., Chai, C. S., & Zhan, Y. (2011). Analyzing students' after-school artifact creation processes in a mobile-assisted language learning environment. *Proceedings of the International Conference on Computers in Education, Chiangmai, Thailand*, 349-356.

Wray, A. (2005). *Formulaic language and the lexicon*. New York, NY: Cambridge University Press.

Wu, W. H., Jim Wu, Y. C., Chen, C. Y., Kao, H. Y., Lin, C. H., & Huang, S. H. (2012). Review of trends from mobile learning studies: A meta-analysis. *Computers & Education*, *59*(2), 817-827.

Yin, R. K. (Ed.). (2003). *Case study research: Design and methods* (vol. 5). Los Angeles, CA: Sage.

Zhao, Y. (2003). Recent developments in technology and language learning: A literature review and meta-analysis. *CALICO Journal*, *21*(1), 7-27.

Appendix A

Glossary of Terms

IPod: A mobile electronic device used for playing and storing digital audio and video files transferred from a CD or downloaded from the Internet.

Mp3: A portable media player capable of storing and playing digital audio, video files and storing images and other document formats.

Pencast: A digital version of the Smartpen notebook that becomes an interactive document in which text and audio come to life. Pencasts allow the user to hear, see and relive notes

as they were captured (Livescribe website, 2014).

Podcast: A broadcast of digital audio designed for replay on a portable media players, computers, and stereo systems (Rosell-Aguilar, 2007).

Appendix B

Classroom Observation Guide

1. Does student appear to be paying attention to the lecture or discussion? What indicators do you notice?
2. Does student appear to be focused more on understanding the lecture/lesson and less on note-taking? What indicators do you notice?
3. Do you notice any off-task student behavior during the lesson? What kind?
4. When does the student appear to use the Smartpen? (e.g., types of classroom learning tasks going on, specific time during class, reading/writing/speaking/listening skill)
5. When using the Smartpen, what type of content is the student writing? (e.g., doodles, sketches from the lesson, text, etc.)
6. How does the student use the Smartpen during class time? (e.g., lack of use, use for review, use for note-taking, etc.)
7. How do surrounding students appear to react to the student's use of the Smartpen? (e.g., ignore, notice, gesture, call attention to, etc.)
8. How does the teacher appear to react to the student's use of the Smartpen?
9. Do you observe any technical difficulties or obstacles to the student's use of the Smartpen in class?
10. How does the student appear to manage the Smartpen tool? (i.e., how comfortable does the student appear when using it?

Appendix C

Student Tally Sheet

How to Use This Sheet:

Please record for each day of the week your activity with the Smartpen. If you do not use the Smartpen at all during a day, please mark 0 and write in the reflection why you didn't need to use it, or chose not to use it.

Thank you again for your participation.

Day	What time of day did you use your Smartpen?	For how long did you use your Smartpen?	Where did you use your Smartpen?	What did you do with your Smartpen?	How many times did you listen to/review the recordings on the Smartpen?	Why did you use your Smartpen?	Personal thoughts/ feelings/notes about using the Smartpen.

Appendix D

Concurrent Verbal Report

1. Can you tell me about the notes that you are making here [referring to notebook page]?
2. Why are you writing this information down in your notebook?
3. What are you planning to do with these notes?
4. How will you use these notes to learn?
5. Why is the information in these notes important to you?

Appendix E

Semi-Structured Teacher Interview Protocol

1. Do you believe that technology is a way to help students learn a language?
2. Can you tell me about ways that you have used technology in the classroom to help English Language Learners?
3. Can you describe any instances that you remember of when the Smartpen was a help or a hindrance in the classroom?
4. Are there specific subject areas or contents where you noticed students using their Smartpens more frequently?
5. Can you give an example of when you saw a student using the Smartpen for an academic purpose?
6. In your opinion, did using the Smartpen make a difference in student achievement? (e.g., tests, grades, participation, etc.)
7. What advice would you give to teachers who are considering using Smartpens in the classroom?
8. What are some advantages and disadvantages that you see in students using the Smartpen during class?
9. Can you describe a time when you noticed a student doing something with the Smartpen that they couldn't do with a traditional pen?
10. What are some typical language-related problems that ELLs have with the content area that you teach? Do you think the Smartpen has helped them overcome any of these issues?

Appendix F

Semi-Structured Individual Student Interview Protocol

1. What about the Smartpen has been the most useful for you? What have you used it most for doing? Can you give me some specific examples?
2. Can you tell me if/how the pen has helped you in school/home/outside of school?
3. Are there times when the Smartpen has not been useful for your learning? Can you tell me about these?/show me an example in your notebook
4. Can you tell me about a time you used the Smartpen to do something that you could not do without it?
5. If you could tell someone the most important thing you have done with your Smartpen, what would it be?
6. Where did you find yourself using your Smartpen the most often? What were you using it for during these times?
7. Are there classes or specific subject areas where the Smartpen has helped you more with your learning?
8. How does using the Smartpen feel/not feel like using traditional pen and paper?
9. What about the Smartpen would you miss if it were taken away today? What changes would you have to make?
10. Were there specific places you felt more comfortable using your pen in, or where you felt it might be more important/necessary for you to use your pen? What were these and why?

Appendix G

Semi-Structured Focus Group Interview Protocol

1. How do you feel about using the Smartpen in class? Outside of class? Any specific times or examples you'd like to discuss?
2. Have you ever felt self-conscious while using the Smartpen in class? Outside of class?
3. How do you think your teachers have reacted to you using the Smartpen in class? How does this make you feel?
4. What about the Smartpen has been the most useful for you? What have you used it most for doing? Can you give me some specific examples?
5. Can you tell me how the pen has helped you academically? Has the Smartpen helped you review for exams? Add to your notes? Guided your studying? Work on your pronunciation? Etc.
6. Do you feel that using the Smartpen has helped you become more independent in class? If yes, how so? If not, why not?
7. Would you say the Smartpen has helped you become a better participant in class? Why/why not? OR How has the Smartpen made a difference in how you participate in class?
8. Has the Smartpen affected your use of class time? How has it affected the time you spend taking notes in class?
9. Do you feel in control of your learning and/or listening when you use the Smartpen?

10. Have you noticed any changes in your use of the Smartpen since you started using it? (i.e., using it more in the beginning, more in class, etc.?)
11. Are there times when the Smartpen has not been useful for your learning? Can you tell me about these?
12. Are there classes or specific subject areas where the Smartpen has helped you more with your learning?
13. Do you think the Smartpen has made it easier for you to understand more information/content presented in class?
14. How does using the Smartpen feel/not feel like using traditional pen and paper?
15. What about the Smartpen makes it easy, or not so easy for you to use?
16. How would you say that the Smartpen has helped you in your writing/reading/speaking/listening skills?
17. Can you describe any technical problems or frustrations that you had when using the Smartpen either in class or out of class?
18. Overall, if another student asked your opinion about the Smartpen, would you recommend it? Why/why not?
19. If you had the opportunity to continue using the Smartpen in your classes, would you? Why/why not?
20. Can you draw a picture of what the Smartpen means to you?