Direct and Indirect Effects of Textbook Modality on Adolescents' Reading

Engagement and Comprehension

A Dissertation
SUBMITTED TO THE FACULTY OF
UNIVERSITY OF MINNESTOA
BY

Sarah E. Scholin

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGRE OF
DOCTOR OF PHILOSOPHY

Matthew Burns, Advisor

May 2013

Acknowledgements

I would like to express sincere gratitude for the support and guidance I have received while writing this dissertation. Specifically, I am grateful for opportunity to have worked with my advisor, Dr. Matthew Burns, who has provided me with invaluable knowledge, guidance, and experiences that have shaped my professional values, perspectives, and goals. I would also like to thank the rest of my dissertation committee, Dr. Mark Davison, Dr. Sandy Christenson, and Dr. David O'Brien for their contribution of ideas, constructive feedback, thought provoking questions, and encouragement. Lastly, I owe my deepest appreciation to my Fiancé, Brad Swehla, for his unwavering support, love, and patience over the last six years.

Dedication

I dedicate this dissertation to my parents, Betty and Michael Scholin, who continue to teach me the definition of hard work and determination. To my father, for telling me I could do whatever I wanted to do in life, but encouraged me to do it with a doctorate. And to my mother, for never letting me believe I was anything short of accomplishing those dreams.   Thank you for your unconditional support, love, and guidance.

Abstract

This research evaluated the affordances of iPads related to adolescent comprehension and engagement. Specific research questions were guided by a framework of reading engagement in which classroom practices are theorized to have both a direct and indirect effect on comprehension through the mediating roles of motivations and strategic interaction with text (Guthrie, Wigfield, & You, 2012). Participants consisted of 281 9th grade students from two rural Midwest high schools with one-to-one iPad initiatives. Using a between-participants experimental design, students were randomly assigned to read informational text on either an iPad or paper and completed comprehension questions and motivation questionnaires. Half of the students in each modality condition were randomly assigned to receive a review lesson on strategy use and annotation to encourage strategy use while reading. The effects of text modality and strategy review on comprehension of text, observable strategy use, and motivation variables were examined. Results revealed no differences in comprehension or motivational variables among students who read on iPads and students who read on paper. However, students who read on paper were more likely to use observable strategies while reading, with this difference decreasing among students who received a strategy review lesson. Implications for theory and practice are discussed.

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

We have entered an era in which students and adults expect to be able to work and learn whenever and wherever they want, without the bounds of a classroom, office, or power cord (Johnson, Adams, & Cummins, 2012a). The ability to effectively use rapidly changing technology to access information and communicate with others is necessary for 21st century learners to be successful in a global economy (Partnership for 21st Century Skills, 2011). Multiple forms of digital technology are already at the core of current adolescents' lives outside of the classroom and future careers (Rideout, Foehr, & Roberts, 2010), and it has been argued that schools must attempt to mirror students' daily lives outside of school in order to engage and prepare a generation of technology savvy students (Rosen, 2010; US Department of Education, Office of Technology).

An emerging trend in K-12 and higher education is the incorporation of tablets, a class of mobile technology that is distinct from other mobile devices and defined by characteristics of portability, large touch screens, and Internet connectivity (Johnson et al., 2012a). This trend was likely propelled, in part, by the 2010 release of Apple's iPad, with tablet ownership among college-bound high school seniors tripling in 2011 (Finkel & Aspey, 2011). Tablets provide the opportunity for mobile learning (m-learning) environments that afford anytime, anywhere learning, without the constraint of a physical connection (Georgiev, Georgieva, & Smirkarov, 2004).

A potential outcome of the tablet trend is the increased opportunity for the use of digital textbooks. Although digital textbooks have been around for quite some time, traditional textbooks have largely remained the preferred modality (Gregroy, 2008;

1

Shepperd, Grace, & Koch, 2008). Poor portability, accessibility and screen resolution associated with digital books have been cited as reasons for preferring traditional books. However, there has been a recent growth in the development of software and hardware to support electronic documents such as e-readers, tablets, personal digital assistants (PDAs) and smart phones (Landoni, 2008). Currently, over 50% of college students and college-bound seniors prefer to read digital textbooks, and the large majority believe tablet computers will result in even more students preferring digital textbooks to print (Pearson Foundation, 2011). Greater portability, storage capacities, and processing speeds of current mobile devices address several concerns that have been previously expressed with e-books. It has been argued that the emergence of handheld readers has rejuvenated digital books, and that tablet computers will replace textbooks in future years (Abbot & Kelly, 2004; Obst, 2010).

The study of digital technologies and reading is often studied in terms of affordances, or actions or outcomes enabled in certain environments (O'Brien & Voss, 2011). In the last several decades, the concept of literacy has been continuously changing as new technologies rapidly emerge (Leu, 2000). As with earlier technologies, the prospect for mobile devices, including tablets, to replace paper as a textbook modality in schools has potential implications for the process and outcomes traditionally associated with reading. The emergence of mobile devices in educational settings and their use for reading prompts questions regarding the affordances of mobile devices related to supporting or hindering reading comprehension and engagement. Given that the trend of tablet computers in education was accelerated by the success of Apple's iPad, which was

introduced in 2010, research on the use of tablets in educational settings is limited by the short duration in which they have been available and integrated into classrooms.

Research on the effects of mobile technologies on learning is further challenged in that mobile learning is dynamic and likely dependent on contextual factors (Sharples, Milred, & Vauoula, 2009). For example, the construct of reading changes depending on how an e-book is defined and features of the text, including the degree of multimedia and hyper links incorporated into the text, which have all been shown to affect reading comprehension (Destefano, & LeFeure, 2007; Zucker, Moody, & McKenna, 2009). Although limited in breadth, available research suggests reading tasks on mobile devices in which textual features are similar to print text has little or no effect on comprehension among elementary-age students (Grace, 2011; Milone, 2011), which is consistent with research on electronic text presented on earlier technologies (Dillon, 1992).

Research on the affordances of mobile devices related to reading comprehension and engagement are limited, but hypotheses can be generated by considering features of mobile devices in the context of a framework of reading engagement in which classroom practices are theorized to have both a direct and indirect effect on comprehension through the mediating roles of motivations and strategic interaction with text (Guthrie, Wigfield, & You, 2012).

One of the reported affordances of digital text is that it allows students to mark up text and take notes, an option that generally is not available to high school students renting books from their school (Clarke & Bensory, 2010). Note-taking and annotation while reading represent cognitive learning strategies, or behaviors or thoughts that help students to learn, remember, or understand material (Weinstein & Mayer, 1983). The use

of strategies while reading is consistent with Guthrie and colleague's framework of reading engagement (Guthrie et al., 2008) as well as models of comprehension that emphasize the importance of active construction of meaning (Wittrock, 1989) and has been repeatedly cited as a critical component in improving reading comprehension (Alvermann, 2001; Dole, Duffy, Roehler, & Pearson, 1991; Kamil, Borman, Dole, Kral, Salinger, & Torgesen, 2008; Torgesen, Houston, & Rissmann, 2007; Vaughn et al., 2008). While paper text has historically been perceived as superior to computer-based text in supporting active reading (O'Hara & Sellen, 1997), more recent work has found tablet computers to be rated as comparable or superior to paper in regards to active reading, annotating, and note taking (Morris, Brush, & Meyers, 2007). Thus, text modality would theoretically support both reading comprehension and engagement to the extent that it affords the opportunity for active reading.

The use of tablet devices in classrooms could also affect reading outcomes through changes in student motivation. Within an expectancy-value model of student motivation, motivation is dependent on students' perceptions of their abilities to successfully complete tasks and the degree to which tasks are perceived to be interesting, useful, and meaningful (Eccles et al., 1983). Given the saliency of mobile technology in students' lives outside of school, it is hypothesized that students may perceive reading tasks on mobile technology as more interesting or meaningful than paper-based reading tasks. This hypothesis is supported by survey results in which more than 80% of college bound high school seniors perceived tablets as contributing to their educational success and increased enjoyment in learning (Pearson Foundation, 2011). Further, early research on the use of tablets on college campuses suggests students are optimistic regarding the

potential academic value of iPads and other mobile devices (Gupta & Koo, 2010; Kinash, Brand, & Mathew, 2012; Maremarelli & Ringle, 2009, 2011; Weisburg, 2011). Considering the potential effects on motivation in conjunction with the opportunity for active reading previously described, text modality could have a significant effect on reading engagement.

Statement of the problem

The use of mobile devices and digital textbooks in schools is expected to continue to grow dramatically in the near future (Obst, 2010; Johnson et al., 2012b). Too often, past e-learning initiatives in schools have been driven by technology rather than theoretical or empirical evidence of educational effectiveness (Ravenscorft, 2001). Although evidence of increased acceptability and perceived usefulness of mobile devices in education is emerging, particularly among college-students, more research is necessary to systematically explore the effects on specific learning outcomes and the pathways by which these effects occur. As mobile devices are infused into educational environments and used as platforms for digital textbooks, more theory-based research is necessary to understand subsequent effects on reading outcomes and how they can best be used to support learning.

A challenge associated with studying the degree to which mobile devices can be used to support reading is the dynamic conceptualization of reading on mobile devices. In its simplest form, an iPad is merely a platform for static presentation of digital text, but additional features such as touch screens, Internet connectivity, and availability of countless apps introduce additional variables that affect the construct validity of reading. Recognizing this challenge, Sharples and colleagues presented a framework for studying

the educational use of mobile devices that incorporates micro research in which the use of

mobile technology for individual learning activities is evaluated for usability,

effectiveness, and satisfaction in addition to research exploring the larger impact of

mobile devices on learning experiences as a whole (Sharples et al., 2009). In doing so,

programs of research can systematically evaluate affordances of specific features of

mobile devices and their use in different learning tasks.

Purpose

The current study is intended to contribute to the emerging body of literature on

the use of mobile devices in education by evaluating the affordances of the iPad as a

reading modality among adolescent students. The advanced features of new tablets,

including iPads, are believed to provide opportunities for increased active learning

(Melhuish & Fallloon, 2010; Murphy, 2011; Johnson et al., 2012a, 2012b). Considered

within a theoretical framework of generative comprehension and reading engagement

(Guthrie et al., 2004; Guthrie et al., 2006; Linden & Wittrock, 1981;Wittrock &

Alesandrini, 1990;Wittrock, & Marks, 1978), these features are hypothesized to support

reading comprehension and engagement. Similarly, within an expectancy-value theory of

motivation (Eccles et al., 1983), tasks presented on mobile technology may be more

aligned with students' lives outside of school and is theorized to further support

motivation and reading engagement to the extent that it is perceived to be more

important, useful, or interesting to students.

The current study compares adolescents' comprehension and engagement when

reading text on iPads and paper. Further, this study seeks to contribute to the general

understanding of how tablets can affect reading outcomes by examining the individual

contributing roles of student values, self-efficacy, and use of annotation tools. The following research questions guided the study:

1. What is the effect of text modality on student comprehension of text?

2. What is the effect of text modality on students' self-efficacy and subjective task value?

3. What is the effect of text modality on the use of cognitive strategies?

4. If the effect of text modality on the use of cognitive strategies is significant, to what extent is this relationship mediated by self-efficacy and subjective task value?

5. If the effect of text modality on comprehension is significant, to what extent is the relationship mediated by the use of cognitive strategies?

Definition of Key Terms

There are several key terms that are central to the study development and interpretation of results. These terms are defined below.

      Annotation. Annotation has been operationally defined as writing brief summaries in text margins, listing ideas or concepts in margins, putting key information on graphs or charts, noting possible test questions and confusing ideas, and selectively underlining key words or phrases (Simpson & Nist, 1990).

      Cognitive learning strategies. Cognitive learning strategies are behaviors or thoughts that help students to learn, remember, or understand material and are primarily classified as rehearsal, elaboration, or organizational strategies (Weinstein & Mayer, 1991).

Rehearsal strategies. Rehearsal strategies are used to keep information in working memory and include recitation or repetition of information, copying materials, writing down keywords, and underlining, highlighting or marking text.

Elaboration strategies. Elaboration strategies are used to make information more meaningful by relating the text to other parts of text or existing knowledge and include summarizing, paraphrasing, creating analogies, generative note-taking, and generating questions.

Organizational strategies. Organizational strategies involve transforming information into another form in order to create meaning and move into long-term memory and include selecting and organizing main ideas from text, outlining, and mapping.

Mobile learning environments. Mobile learning environments are environments that enable students to learn anywhere, any time, without the constraint of a physical connection, through the use of mobile devices such as laptops, tablets, personal digital assistants (PDAs), or smart phones (Georgiev et al., 2004).

Motivation. Motivation is a theoretical construct used to explain the direction, intensity, persistence, and quality of behavior (Maehr & Meyer, 1997). The current study utilizes an expectancy-value theory of motivation in which achievement performance, persistence, and choice are explained in terms of individuals' expectancy and value beliefs for a specific task (Wigfield, Tonks, & Klauda, 2009).

Reading comprehension. Reading comprehension has been defined as the process of simultaneously extracting and constructing meaning from text and is dependent on characteristics of the text, task, and reader (Snow, 2002). The current study

utilizes a generative model of comprehension in which comprehension involves the active generation of relations among parts of text and between text and what we already know (Wittrock, 1989).

Reading engagement. In the current study, reading engagement is conceptualized in terms of the expectancy-value theory of motivation and strategic interaction with text (Guthrie et al., 2004; Guthrie et al., 2006).

Self-efficacy. Self-efficacy is defined as one's perceptions of his or her ability to successfully complete a task and is theorized to affect motivation, behavior, and persistence when faced with a challenge (Bandura, 1977; 1989).

Subjective task value. Subjective task value refers to the degree to which a task meets the needs of an individual and reflects the likelihood an individual would select the task (Wigfield & Eccles, 1992). In the current study, subjective task value is measured by interest, utility value, and attainment value (Eccles & Wigfield, 1995; Wigfield & Eccles, 2000).

Interest. Interest is an affective state that represents a student's subjective experience and is derived from either individual or situational factors (Ainley, 2006). Within the expectancy-value theory literature, interest is often used interchangeably with the subjective conceptualization of intrinsic value, which has been defined as the enjoyment, or anticipated enjoyment associated with engaging in a task (Eccles, 2005).

Utility Value. Utility value is the degree to which participating in the task contributes to the attainment of short or long-term goals (Eccles, 2005).

Attainment value. The degree to which engaging in the task is personally important to the individual and consistent with one's self- image (Eccles, 2005).

Tablets. The term tablet is used to describe a modern class of mobile technology that is distinct from other mobile devices such as smart phones, laptops, and earlier versions of tablet PCs and is defined by characteristics of portability, large touch screens, and Internet connectivity (Johnson et al., 2012a).

Limitations

The results of the current study should be interpreted within the context of study limitations. At the time this study was designed, iPads had been on the market for only 1 year, and very few high schools in the nation had implemented one-to-one iPad initiatives. The current sample is a convenience sample in that it includes the only two high schools in the state that were known to have one-to-one iPad initiatives at the time. The sample includes students from two rural Midwest high schools, and study results may not generalize to different populations of students.

Additional limitations exist in the use of two schools. Two schools were selected in order to increase the study sample size. However, the use of two different schools resulted in unforeseen differences in student populations, school structure, and attrition. These differences are further discussed in the methodology section of this paper and are addressed by analyzing data from schools both individually and combined.

Delimitations

The current study was designed within the limits of specific frameworks and conceptual definitions selected by the researcher. The study involves students reading electronic text from iPads, which are mobile devices, but participants in the study read in stationary positions in their classrooms and were not provided the opportunity to take advantage of several of the mobile and ubiquitous learning features of the device.

Limiting the time frame of the study to two 40-50 minute class periods was necessary in order to increase the feasibility of the study and control for confounding variables. Similarly, the potential affordances of tablets in education are immeasurable. With increased Internet connectivity and countless applications (apps), tablets open up doors to new literacies involving hyper links, cloud computing, and social media. In order to limit the scope of this study and attempt to contribute to the understanding of how specific features of tablet devices support or hinder reading comprehension and engagement, the current study only involves static text.

The scope of the study was further limited by the use of annotation as a measure of strategy use. While limited, this construct was chosen because it is an observable and concurrent measure of strategy use. Concurrent measures of strategy use provide a measure cognitive activity while an individual is actually engaging in an activity, which have been found to be superior to prospective or retrospective measures of strategy use in predicting reading comprehension (Cromley & Azvedo, 2006). However, this conceptualization of strategy use does not take into account less observable reading strategies such as pre-reading, prediction, visualization, or thought processes are not annotated. Future research may consider incorporating both observable and retrospective student report measures to account for less observable methods of strategy use.

Assumptions

The design and methodology of the current study were based on several assumptions, that if proven false may affect the interpretation of student results. At the time of the study, participants had been using the iPads regularly for 3 months and it was assumed that students would be familiar with the basic functions of the devices.

Moreover, when participants were asked to complete a motivational questionnaire regarding their perceptions of a reading task completed on either an iPad or paper, it was further assumed that their answers to these questions would reflect their experience with assigned modality.

Organization of document

The remainder of this document is organized around five distinct chapters. Chapter One provided background information, a statement of the problem, and the purpose of the study. Chapter Two describes the theoretical frameworks underlying this research and provides a review of relevant literature. Chapter Three describes the study design and methodology. The results are presented in Chapter Four and are further discussed in Chapter Five.

Chapter 2

Literature Review

Educational policy makers and researchers have been calling for increased application of technology in classrooms (International Society for Technology in Education, 2005; U.S. Department of Education, Office of Educational Technology, 2010; Sharples, Taylor, & Vavoula, 2010). Students today must be able to use and adapt to rapidly changing technology in order to be successful in a global economy (Partnership for 21st Century Skills, 2011). Although the Association of Educational Communications and Technology (AECT) defines educational technology as the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological process and research (Januszewski & Molenda, 2008), recently the study of educational technology has placed more of an emphasis on digital technologies that contribute to student learning (Selwyn, 2010).

One way educators have been meeting the call for increased digital technology in classrooms is through one-to-one computing initiatives, or learning environments in which students have individual access to personal computers (Penuel, 2006). One-to-one computing initiatives began in the 1990's with studies of laptops and personal computers, which found student access to personal computers was related to increased collaboration among students, use of active learning strategies, project base learning, and improved quality of writing (Rockman et al., 1997, 1998, 2000). Personal computing devices are believed to have a unique effect on student outcomes in that they allow for increased access, a greater sense of ownership, autonomy, independence, and opportunities for self-paced or individualized instruction (Rockman, 2007).

A more recent trend in the application of digital technologies and one-to-one computing initiatives in K12 and university classrooms is tablet devices (Johnson et al., 2012a, 2012b). Lead by the development of Apple's iPad, the term tablet is used to describe a modern class of mobile technology that is distinct from earlier versions of tablet PCs and other digital technologies including laptops and smart phones (Johnson et al., 2012b; Murray & Olcese, 2011). Recent tablet computing devices, such as the iPad, have been argued to provide new opportunities to facilitate learning through advanced features such as increased portability, connectivity, screen size, interactivity, and potential for customization that distinguish them from other computing devices (Melhuish & Fallloon, 2010; Murphy, 2011; Johnson et al., 2012a, 2012b). Although the iPad is still leading the tablet market, other tablets including Amazon's Kindle Fire, Samsung Galaxy Tab, and Acer Iconia are also gaining in popularity (Lipsman & Acqunio, 2013).

In addition to the opportunities provided by specific features of the tablet device, the tablet trend in education represents a movement toward mobile learning (m-learning), or environments that enable students to learn anywhere, anytime, without the constraint of a physical connection, through the use of mobile devices such as laptops, tablets, personal digital assistants (PDAs), or smart phones (Georgiev et al., 2004). While interest in mobile learning is not new, interest has been rejuvenated with the introduction of modern tablets (Brand, Kinash, Matthew, & Kordyban, 2011). With the increase in mobile learning, learning is predicted to move increasingly out of the classroom and into students' own individual learning environments (Naismith, Lonsdale, Vavoula, & Sharples, 2004). Current mobile devices differ from personal computers and laptops in

that they have greater storage capacities and processing speeds, improved Internet bandwidth, and greater portability (Low & O'Connell, 2006). Features of these advanced mobile devices are believed to enable learning that is student centered, constructive, collaborative, incidental, and situated within an authentic context (Corbeil & Valdes-Corbiel, 2007; Low & O'Connell, 2006; Naismith et al., 2004).

Implications for Digital Books

The recent surge of tablet devices in education opens up new opportunities for digital books. Although digital textbooks have been around for quite some time, traditional textbooks have largely remained the preferred modality (Gregroy, 2008; Shepperd, Grace, & Koch, 2008). The threat for digital publishing to replace paper text has been present since early models of digital books on floppy disks and initial mobile reading devices (Marshal, 2010). While earlier mobile reading devices were found to be bulky with disappointing battery life, current electronic reading devices (e-readers) allow for more ubiquitous use in that they are wireless and have improved screen resolution, storage capacity, battery life, and portability (Marshal). Current e-readers typically present static digital text, but often have additional features such as high lighting tools, dictionaries, and search tools (Cardullo, Zygouris-Coe, Wilson, Craanen, & Stafford, 2012).

Despite improved technology, e-books have yet to surpass paper text in popularity (Rainie & Duggan, 2012). While the overall percentage of adults reading print books is 3 times that of e-book users, the percentage of e-book users has increased between 2010 and 2012, while the percentage of adults reading print books has decreased during this time frame (Rainie & Duggan). It has been argued that the recent emergence of handheld

readers has rejuvenated digital books, and that tablet computers will replace textbooks in future years (Abbot & Kelly, 2004; Obst, 2010). With the increased use of mobile technology and digital books in education, it is important to consider the effect of text modality on reading comprehension and engagement. Therefore, the following review will address the theories, contextual factors, and empirical findings related to reading on tablets and other mobile devices.

Reading on Mobile Devices: Theoretical Underpinnings

        A theory of mobile learning. Tablets represent a class of mobile devices that allow for ubiquitous learning, without the constraint of a physical connection (Georgiev et al., 2004). Mobile devices are believed to have an impact on education that is distinct from other learning technologies in that they afford opportunities for portability, ubiquitous access, situated learning opportunities, increased connectivity, and individualized learning experiences (Melhuish & Falloon, 2010). Despite the widespread belief that current mobile devices can support student learning, theoretical pathways underlying those beliefs have not been well established (Park, 2011; Uden, 2007). A current theory of mobile learning must be distinct from current theories of classroom learning, account for the mobility of learners, reflect informal and formal learning, conceptualize learning as a social and constructive process, and analyze learning as a situated activity that is mediated by technology (Sharples, Tayler, & Vavoula, 2007).

        In the last decade, multiple theoretical frameworks have been suggested to guide the implementation of mobile technology in learning environments. For example, the Framework for the Rational Analysis of Mobile Education (FRAME) model describes mobile learning as occurring at the intersection of device, learner, and social aspects of

16

information (Koole, 2009). Therefore, learning with mobile devices is dependent on the physical and functional device characteristics such as size, weight, speed, storage, and input and output capabilities, the learner characteristics, including an individual's prior knowledge, attitudes, motivation, and cognitive abilities and social processes of interaction and collaboration. According to the FRAME theory, the interactions of these aspects govern mobile learning. For example, device usability occurs at the intersection of device and learner characteristics. The intersection of device and social aspects describe how specific mobile devices afford collaboration and interaction among learners. Lastly, the intersection of learner and social aspects represents a social constructivist view, emphasizing the importance of collaboration and interaction to learning. Similarly, Uden (2007) offered a framework for mobile learning using activity theory, suggesting that learning activity consists of interactions between a user and an objective that is mediated by a tool (e.g. mobile technology) and situated within a social and cultural context. What these suggested frameworks have in common is the emphasis on the consideration of interactions between characteristics of the learner, device, and contextual factors.

      Generative theory of comprehension. Reading comprehension has been defined as the process of simultaneously extracting and constructing meaning from text and is dependent on characteristics of the text, task, and reader (Snow, 2002). Specifically, given fluency of decoding, comprehension is the product of well-written texts, compatibility of readers' knowledge & text content, and use of active strategies. The inclusion of strategy use in the definition of comprehension represents the conceptualization of reading as an active task. Early models of reading conceptualized

comprehension as the product of mastering a succession of sub-skills with the assumption those students would be able to obtain meaning from text once sub-skills were mastered (Dole, Duffy, Roehler, & Pearson, 1991). Current conceptualizations of comprehension are based on generative models of reading in which comprehension requires the active generation of connections among parts of text and background knowledge (Wittrock, 1989). Moreover, teaching students to generate analogies, summaries, or connections to prior knowledge has been shown to increase students' comprehension and retention of text (Doctorow, Wittrock, & Marks, 1978; Linden & Wittrock, 1981; Wittrock & Alesandrini, 1990). Thus, environments in which students are afforded increased opportunities to interact with text would theoretically support comprehension.

Engagement theory. Reading engagement is an outcome variable related to reading comprehension that has gained recent attention in the literature (Wigfield et al., 2008). Broadly, engagement is a multi-dimensional construct that includes academic, behavioral, cognitive, and affective subtypes (Appleton, Christenson, Kim, & Reschly, 2006). Specifically, engagement has been described as behavior, emotions, and cognitions that represent the manifestation of motivations (Skinner, Kindermann, Connell, & Wellborn, 2009). Indicators of academic and behavioral engagement are described as observable variables such as homework completion, time on task, attendance, and behavioral incidences. Indicators of cognitive and affective engagement are less observable variables including values, goals, feelings of autonomy, sense of belonging and relationships with peers (Appleton et al., 2006). In the domain of reading, Guthrie and Wigfield (2003) have proposed a framework for reading engagement that draws from fields of motivation, literacy, and cognitive strategies. Specifically, reading

18

engagement has been defined as the joint functioning of motivation and strategic interaction with text (Guthrie et al., 2004; Guthrie et al., 2006).

Motivation. Motivation is a theoretical construct used to explain the direction, intensity, persistence, and quality of behavior (Maehr & Meyer, 1997). Several theories of motivation have been presented to explain human behavior in achievement situations, and inconsistencies exist in the way in which motivation is defined and conceptualized (Murphy & Alexander, 2000). Recently there has been a call for the integration of theoretical models (Martin, 2007; Pintrich, 2003). Pintrich and DeGroot (1990) describe how core features of most social-cognitive theories of student motivation are reflected in the expectancy-value theory of motivation, which describes how choice, persistence, and academic performance on a task is predicted by individuals' expectancies and subjective task values (Eccles et al., 1983). The model has two primary components: a) an expectancy component, regarding expectations for an academic outcome, and b) a subjective value component, describing the degree to which a student perceives a task as important, useful and interesting.

Task expectancies. In the expectancy-value theory of motivation proposed by Eccles and colleagues (1983), the expectancy component largely refers to efficacy expectations, or an individual's expectations in obtaining a given task outcome (Wigfield, 1994). Beliefs about one's ability have been central to several theories of motivation. In his social cognitive theory, Bandura defined self-efficacy as one's perceptions of his or her ability to successfully complete a task and theorized self-efficacy to affect motivation, behavior, and persistence when faced with a challenge (1977, 1989). Moreover, self-determination theory posits that competence, conceptualized as having

control over outcomes, being self-efficacious, and having strategies and capabilities for success, is a basic need that must be fulfilled in order to be motivated (Deci, Vallerand, Pelletier, & Ryan, 1991).

Theories relating self-efficacy to academic achievement are well supported by empirical evidence (Multon, Brown, & Lent, 1991). However, the relationship between self-efficacy and academic achievement is not entirely straightforward. Self-efficacy has been shown to have an indirect effect on academic achievement in that self-efficacy influences self-regulatory processes, including goal setting, self-monitoring, self-evaluation, and strategy use (Zimmerman, 2000; Zimmerman, Bandura, & Martinez-Pons, 1992). Pintrich and DeGroot (1990) found that after accounting for cognitive engagement variables, including self-regulatory process, the effect of self-efficacy on achievement was non-significant, suggesting that self-efficacy facilitates academic achievement by increasing students' use of cognitive strategies.

Self-efficacy has often been discussed as a benefit of increased digital technologies in classrooms. A frequently cited benefit of the use of computers, laptops, and mobile devices in classrooms is the allowance for individualized instruction and self-paced work (Clarke & Bensory, 2010; Kim & Kamil, 2002; Melhuish & Fallloon, 2010; Rockman, 2007; Warschauer, 1995). Individualized instruction supports self-efficacy in that students are given more opportunities for success on challenging yet obtainable goals (Pajares, 2006). While differentiating instruction is daunting in a traditional heterogeneous classroom, when used appropriately, digital technologies can help make this goal more attainable. Claims are often made that computers, particularly mobile devices, greatly empower students by allowing them to construct their own learning

environments and take control over their learning (Lepper, 1985; Naismith et al., 2004; Reeves, 1998). In addition to providing individualized instruction, e-learning environments may influence self-efficacy by changing the nature of traditional tasks. Specifically, O'Brien (2003) argued that adolescents who disengage from print text will often continue to engage in popular media texts and demonstrated how using technology to incorporate non-print media can transform students' perceptions of competence, which may also improve achievement in print literacy.

Task values. The value component of student motivation refers to the degree to which a task meets the needs of an individual and the likelihood an individual would select the task (Wigfield & Eccles, 1992). Subjective task value is comprised four components: Attainment value, or the importance attached to succeeding or participating in a specific task, interest or intrinsic value, or the enjoyment experienced or anticipated by a task utility value, and cost (Eccles, 2005). The first three components are associated with the positive valence of a task and are most consistently discussed in subjective task value literature, so this review will be limited to the first three components (Eccles & Wigfield, 1995; Wigfield & Eccles, 2000).

The concepts of intrinsic motivation and interest are not unique to expectancy-value theory and have been well studied in motivational literature.   Theories of intrinsic motivation aim to explain behaviors that are performed because they are inherently enjoyable and not because they lead to separable outcomes (Deci & Ryan, 1985). Intrinsic motivation has been conceptualized in terms of both innate, basic needs, and as a subjective experience (Eccles & Wigfield, 2002). According to self-determination theory, humans have basic needs for competence, autonomy, and relatedness (Deci &

Ryan, 1992). Contextual factors influence intrinsic motivation to the degree that they support these basic needs (Ryan & Deci, 2002).

Intrinsic motivation has also been described in terms of the experience of flow, or the subjective feelings of pleasure, happiness, or satisfaction that influences one's volition to attend to stimuli (Csikszentmihalyi, 1988). The experience of flow has been described as involving focused attention on stimuli, a sense of control over actions, a distortion of time, and a sense of the experience as rewarding (Nakamura & Csikszentmihalyi, 2002).

Similarly, interest is an affective state that represents a student's subjective experience and is derived from either individual or situational factors (Ainley, 2006). Individual interest develops slowly over time and refers to enduring individual differences in preferences and predispositions to attend to specific stimuli or events (Hidi, 1990). Engaging in activities that are of individual interest is associated with positive affect, greater attention, persistence, and learning, and serves as a pre-condition for intrinsic motivation (Ainley, Hidi, & Berdorff, 2002; Hidi & Harackiewicz, 2000).

Situational interest is triggered by environmental factors and is related to intrinsic motivation to the degree that it is held or maintained over time (Hidi & Harackiewicz, 2000). The motivating effect of high interest materials is useful in the classroom to the extent that they can help overcome gaps in individual interest or knowledge by contributing to cognitive processing and persistence (Hidi, 1990). Further, situational interest can develop into individual interest over time when stimuli are meaningful, induce curiosity or personal involvement, or are aligned with students' everyday lives (Hidi & Renninger, 2006; Mitchell, 1993). It is therefore conceivable that

adolescents, who spend a significant amount of time consuming technology each day (Rosen, 2010), may find perceive reading tasks as more meaningful and interesting if presented in an electronic formal.

Multiple studies have reported findings in which students report learning with digital technology to be more interesting than traditional instruction (Randel, Morris, Wetzel, & Whitehill, 1992; Rockman et al., 2000). However, it is important to consider the degree to which the "bells and whistles" of computerized effects are simply catching students' attention and whether interest in the subject matter will maintain after computers are removed (Lepper, 1985). It is argued that over time, students will become satiated with even the most interesting stimuli, and thus it is more important to consider the degree to which stimuli holds students' attention (Keller & Suzuki, 2004). However, more recent research indicated that when technology is used in a way that involves engaging students in collaborative problems solving and taking advantage of constructivist features, situated interest is more likely to develop into sustained individual interest for the topic area (Brophy, 2010).

Changing motivational beliefs. The role of motivation becomes increasingly important for older students, as achievement motivation, including reading motivation, has been shown to decrease as students go through school (Eccles & Midgley, 1989;Wigflield, 2004). As students go through school, students become increasingly aware of their abilities relative to others and classrooms place more focus on comparison and extrinsic motivators such as grades (Gurthrie & Wigfield, 2000). Moreover, students begin to perceive the concept of ability as more stable and less controllable (Stipek & Iver, 1989). Further, as children get older, the relationship between task-expectations and

values strengthens, such that older children are more likely to value tasks on which they feel they do well (Wigfield, 1994). This change is believed to be a result of changes in both students' cognitive development and educational environment (Stipek & Iver, 1989).

Strategic interaction with text. Motivation beliefs are necessary, but not sufficient for engagement (Appleton, Christenson, & Furlong, 2008). The distinction between motivation and engagement has been conceptualized as the difference between motivation beliefs and behaviors. Whereas motivation beliefs include self-efficacy and interest, representing the will to engage in learning, engagement requires one to have the skill to regulate and manage his or her behaviors (Cleary & Zimmerman, 2012).

In the engagement literature, the use of strategies is often discussed in the context of self-regulated learning. Self-regulated learning describes learning in which the learner plays an active role in his or her learning process and involves meta-cognitive, motivational, and behavioral components (Zimmerman & Martinez-Pons, 1988). Self-regulated learning has been further categorized the application of cognitive learning strategies to learn, remember, and understand material, and the meta-cognitive and effort management strategies (Pintrich & DeGroot, 1990).

Three types of cognitive learning strategies are frequently discussed in the engagement and self-regulation literature: Rehearsal, elaboration, and organizational (Weinstein & Mayer, 1986; Weinstein & Mayer 1991). Rehearsal strategies are important in the early stages of learning a topic and used for memorization of information (Weinstein & Mayer, 1991). The purpose of rehearsal strategies is to help a student attend to important information and keep information in working memory (Weinstein & Mayer, 1986). Common rehearsal strategies include recitation or repetition of information,

copying materials, writing down keywords, and underlining, highlighting or marking text (Weinstein, Husman, & Dierking 2000; Weinstein & Mayer, 1991). Elaboration strategies are used to make information more meaningful by relating the text to other parts of text or existing knowledge. The goal of elaboration strategies is to integrate information with existing knowledge and transfer new information into long-term memory (Weinstein & Mayer, 1991). Common elaboration strategies include summarizing, paraphrasing, creating analogies, generative note-taking, and generating questions. Organizational strategies involve transforming information into another form in order to create meaning and move into long-term memory (Weinstein & Mayer, 1991). Common organizational strategies include selecting and organizing main ideas from text, outlining, and mapping (Weinstein & Mayer, 1986).

The use of strategies while reading is consistent with a generative model of comprehension (Wittrock, 1989) and has been repeatedly cited as a critical component in improving reading comprehension (Alvermann, 2001; Dole, Duffy, Roehler, & Pearson, 1991; Kamil, Borman, Dole, Kral, Salinger, & Torgesen, 2008; Torgesen, Houston, & Rissmann, 2007; Vaughn et al., 2008). While some cognitive strategies represent thoughts or cognitions, and are therefore difficult to observe or measure, others are manifested through behaviors. One observable way strategies can be used while reading is through annotation. Annotation has been operationally defined as writing brief summaries in text margins, listing ideas or concepts in margins, putting key information on graphs or charts, noting possible test questions and confusing ideas, and selectively underlining key words or phrases (Simpson & Nist, 1990).

The relationship between motivation, engagement, strategy use, and reading comprehension. Conceptualized as the integration of motivational processes and strategy use while reading, reading engagement is correlated with reading comprehension (Guthrie et al., 2008). Guthrie, Wigfield, and You (2012) described a framework of reading engagement that describes how classroom practices and conditions affect reading outcomes. Specifically, the authors proposed classroom practices and conditions have direct effects on reading comprehension, but also indirect effects through the mediating roles of motivations and behavioral reading engagement. This framework is supported by research in which motivational variables of self-efficacy and task value were positively related to use of rehearsal, elaboration, and organizational strategies (Pintrich, 1999). The use of cognitive strategies, have in turn been shown to support reading comprehension (Souvignier & Mokhlesgerami, 2006).

The theoretical argument for the incorporation of motivation and engagement in models of reading comprehension is supported by research on the effectiveness of Concept Oriented Reading Instruction, a reading curriculum that includes strategy instruction and motivational support. Specifically, elementary students receiving strategy instruction plus motivational support have been shown to outperform their peers receiving strategy instruction without motivational support on measures of reading comprehension, reading strategy use, and reading motivation (Guthie et al., 2004).

Summary. The FRAME theory suggests theories of mobile learning must consider the characteristics of the individual, device, and social and cultural context in which they are situated. Thus, in exploration of the effect of mobile technologies on reader comprehension and engagement, it is necessary to consider the extent to which

device characteristics support strategic interaction with text, the degree to which the presentation of text on mobile devices supports or hinders readability, whether or not the reader perceives reading on mobile devices as important, useful, or intrinsically motivating, and the readers self-efficacy in using and reading from mobile devices. Lastly, these factors must be considered the broader societal context, including the role of technology across populations and generations of individuals.

Reading on Mobile Devices: Contextual Factors

Twenty first century students and their use of mobile technology. Changing society is a common argument for the use of mobile technology in education (Gupta & Koo, 2010; Rosen, 2010; Tapscott, 1999). More so than any prior generation, technology is at the core of the lives of the current generation of adolescents. A national study of adolescent media use revealed that nearly 40 percent of 15-18 year-olds own their own laptop computer, with the amount of recreational time adolescents report spending on computers increasing by 30 minutes a day from 2004 to 2009 (Rideout et al., 2010). A separate survey found that the average combined technology consumption for 16-18 year olds totals over 20 hours per day, with an average of 2.5 hours being spent online and 3.5 texting (Rosen, 2010). This population of individuals born after 1977 has been referred to as the "Net Generation" and is comprised of young adults who grew up surrounded by computers and are accustomed to media multi-tasking, quick communication and access of information, and frequent instances of collaboration and innovation (Tapscott, 2009). The US Department of Education Office of Technology (2010) acknowledged that technology is central to students' current life and future careers, and schools must attempt to mirror students' daily lives outside of school. It has further been argued that asking

children to be surrounded by technology in all aspects of their life except school risks

losing a generation of technology savvy students (Rosen, 2010). However, student

expectations of technology as an argument for increased implementation of digital

technology in education has been criticized by some, who argued instead that the

implementation of mobile technology should be based on the degree to which

technologies actually enhance learning (Kinash, 2011; Kinash, Brand, & Mathew, 2012).

Despite the increasing use of technology among younger generations, the extent

to which young adults are requesting tablet devices in their educational environments is

unclear. Kinash, Brand, and Mathew (2012) loaned undergraduate students iPads that

were loaded with *Blackboard Mobile Learn,* an application for accessing class content

and participating in class discussions. At the completion of the study, students completed

a questionnaire regarding their use of the iPads and the degree to which iPads contributed

to their learning and motivation. While 42% of the students agreed with the statement

that iPads motivated them to learn, the majority of students (51%) were neutral in their

responses to the question of whether or not they felt iPads actually improved their

learning in the class (Kinash et al., 2012). Students also reported to be using the iPads

more for searching the web for pleasure and accessing social networks than for class

activities. These results were interpreted to suggest that 21st century students are not

demanding more technology in their education and are neutral in the extent to which they

perceive mobile technology as beneficial to their learning. The Kinash et al. (2012)

results were consistent with The ECAR Study of Undergraduate Students and

Information Technology (Dahlstorm, 2012), suggesting that students wanted to use their

mobile devices to be able access course materials, and the number of college students

who used their mobile devices for academic purposes increased, but students still rated iPads behind laptops, desktops, printers, and thumb drives in regards to their academic value.

Device characteristics and relevance to education. The development of the iPad has been described as introducing a new class of mobile technology (Johnson et al., 2012b). Modern tablets have much of the functionality of laptops with the portability of a smartphone (Melhuish & Falloon, 2010). Murray and Olcese (2011) reviewed the iPad hardware and applications relevant to education to explore the extent to which iPads allow learners to do things they would not otherwise be able to do. The authors concluded that several features related to the hardware of the iPad affords the opportunity for great innovations in education, including the access to thousands of applications, multi-touch display, large rotating screen, Wi-Fi networking, Bluetooth capabilities, and long battery life. Despite the potential of iPad hardware, Murrary and Olscese also argued that software developers are not creating applications that fully take advantage of the iPads capabilities to transform education.

Murray and Olscese's claim of unused potential was supported by a study in which the potential educational capabilities of the iPad were compared to the actual utility in the classrooms of 36 universities that were actively using iPads in several courses (Murphy 2011). Collectively, this research suggests that the iPad has the potential to be used for collaboration, generation of information, productivity, and research, but the most frequently reported use of iPads at universities is consumption of course information, with the majority of universities not reporting to be taking advantage of other features.

Despite the new opportunities afforded by tablets, several of the same features toted as benefits to learning, can also be perceived as barriers. For example, the compact and lightweight design of the modern mobile devices facilitate increased portability and ubiquity, but also result in a smaller screen and keyboard, which have also been cited as limitations (Rossing, Miller, Cecil, & Stamper, 2012). Further, the increased Internet connectivity allows students to have access to an abundance of resources and information and affords increased opportunities for collaboration (Johnson et al., 2012), but also increases the risk of distractibility, which has been cited as a limitation of the device (Maremarelli & Ringle, 2011; Rossing et al., 2012; Weisburg, 2011). Conversely, it has been argued that for 21st century students, using mobile devices for purposes other than learning is not categorically dissimilar from doodling for earlier generations of students, and thus should not be a major concern for teachers (Kinash et al., 2012).

Text characteristics. At the most basic level, reading a digital book on a tablet involves reading electronic text, but digital books and tablets can also incorporate additional features such as multimedia, web-based text, and opportunities for active reading. Moreover, it has been argued that reading electronic documents changes not only the cognitive nature of the task, but physical or ergonomic aspect as well, including positioning of the text, turning pages, annotating (Hillesund, 2010). All of these features must be considered in studying the effect of text modality on reading outcomes.

Electronic text. Electronic text refers to any text that is presented on a computer screen (Dillon, 2004). In the last 3 decades, a great deal of research has been conducted on the effects of reading from a screen verses paper. A review of early literature comparing print and electronic reading found no conclusive differences in

comprehension, but depicted electronic reading as potentially slower and more fatiguing than reading paper text (Dillon, 1992). Moreover, the differences were hypothesized to be due to screen quality and may disappear as quality of screen displays improve (Dillon, 1992). Recent research suggests that the legibility of text of current e-readers, as measured by eye-movement data, is comparable to print text (Siegenthaler, Wurtz, Groner, 2010). However, additional variables, such as text font, size, and resolution, may influence the effect of text modality on reading performance (Dyson, 2004; Ziefle, 1998).

Multimedia. Reading electronic text often involves more than simply reading text presented on a screen. The incorporation of some degree of multimedia has been included as a defining feature of children's e-books (Zucker, Moody, & McKenna, 2009). Multimedia learning refers to learning from both words and pictures (Mayer & Moreno, 2003). The rational for multimedia learning is based on the assumption that humans have separate information processing systems for verbal and visual material, and incorporating both words and pictures takes greater advantage of the mind's capacity for processing information (Mayer, 2002). Further, e-books have been shown to have a greater effect on children's comprehension when they incorporate multimedia (Verhallen, Bus, & Jong, 2006). Specifically, e-books, as defined as incorporating features of traditional print books along with some degree of multimedia enhancements (e.g. options for audio reading), have been shown to have a small to moderate effect on comprehension for kindergarten to 5th grade students (Zucker et al., 2009).

Despite apparent benefits, cognitive overload is a potential concern associated with multimedia learning (Mayer & Moreno, 2003). Mayer's (2002) cognitive theory of multimedia learning incorporates the assumption of active learning, referring to

multimedia learning as a cognitively demanding process in which a learner is required to actively select, organize and integrate relevant stimuli into prior knowledge. However, several strategies have demonstrated effectiveness in reducing cognitive load, including presenting words as narration opposed to text, presenting lessons in learner controlled segments, eliminating extraneous material, and presenting text and visuals simultaneously and in close proximity (Mayer & Moreno, 2003).

>*Web-based text.* A frequently cited benefit of modern e-readers and mobile devices is Internet connectivity (Corbeil & Valdes-Corbiel, 200l, 2007; Low & O'Connell, 2006; Weisburg, 2011). The Internet affords students the opportunity to interact with different formats of texts, creating both challenges and support for reading comprehension (Corio, 2003). Web-based text is frequently imbedded with hypermedia, referring to various forms of media that are organized in a non-linear format (Dias & Sousa, 1997). Processing non-linear text is a different reading task than processing linear text in that it gives the reader complete control over the sequencing of topics (Wenger & Payne, 1996). Moreover, whereas linear text is permanent and unchangeable, non-linear text allows students to explore the learning environment and combine text to suit their needs (Alexander, Kulikowich, & Jetton, 1994).

>Despite these perceived benefits, research on the effect of hyperlinks on student outcomes has been inconsistent and contradictory (Destefano & LeFeure, 2007; Shaprio & Niederhouser, 2004).   A frequently cited concern of hyperlinks is that they place a greater demand on cognitive processing and working memory in that they require the reader to make decisions about whether or not to follow a link and interrupt processing when links are followed, therefore hindering reading comprehension (Destefano, &

LeFeure, 2007). A synthesis of the literature suggested hypertext has the potential to enhance learning, but the effect of hypertext on student learning was dependent on the interaction between the text structure and individual characteristics (Shaprio & Niederhouser, 2004). For example, students with low prior knowledge in the content domain were likely to benefit more from highly structured text while students high in prior knowledge were more likely to do better with a structure that allowed for greater autonomy and exploration. Moreover, the effect of hypermedia on student understanding is influenced by students' self-regulation skills and was increased if training or scaffolding was provided to students on how to regulate their learning (Azevedo & Cromley, 2004; Azevedo et al., 2008). Thus, while electronic text has the potential to contribute to learning, student characteristics, including prior knowledge, self-regulation and web-navigation skills, must also be considered.

Ergonomics. Reading electronic text has also been argued to affect the ergonomics of reading (Schilit, Price, Golovchinsky, Tanaka, & Marshall, 1999). Ergonomics is the study of workplace design or equipment related to efficiency, productivity, and comfort. For example, compared to reading from a book, in which a reader can change the positioning as needed, electronic documents have historically been read on relatively stationary laptops or PCs in which the user must change his or her own position rather than the device for better viewing.   However, improvements in portability associated with modern e-readers largely reduce or eliminate differences in positioning of text.

Paper has also been considered superior for document navigation and flexibility in spatial layout, which allows readers to cross reference the text (O'Harra & Sellen, 1997).

Specifically, paper text is associated with a fixed layout, which has been argued to promote spatial memory and help reader obtain an improved "overall sense" of the text (Schilit et al., 1999, p. 66). Similarly, the physical nature of turning a page of a printed book, compared to scrolling of electronic books, has also been suggested to support spatial orientation of reading (Dillon, 1992).

Lastly, there is evidence to suggest that adults approach reading tasks differently when reading electronic documents compared to paper documents. When reading electronic documents, adults report spending more time browsing and scanning materials, reading selectively, searching for keywords, reading non-linearly, and less time engaged in continuous and in depth reading compared to print documents (Hillesund, 2010; Liu, 2005). The aforementioned differences in how readers approach and respond to electronic and print text provide support for the notion that studies of electronic text should include both process and outcome measures (Dillon, 1992).

Reading on Mobile Devices: Empirical Findings

Given the rapid proliferation of tablets in the last few years, empirical research on their effect on reading outcomes has been limited. More research has been conducted on other mobile platforms for e-books, which is included in the following review. The following review summarizes results of research conducted thus far, discusses implications for reading comprehension and engagement, and provides suggestions for future research.

Comprehension. Comprehension is believed to be dependent of features of the text (Snow, 2002), suggesting a review on the effect of modern e-readers and tablet computers on comprehension must account for the degree to which individual studies

have utilized additional textual features such as multimedia and hyper-text. Although

limited in breadth, available research suggests reading tasks on mobile devices in which

textual features are similar to print text has little or no effect on comprehension. For

example, no differences in comprehension were found regardless of text difficultly when

4th grade students were asked to read six books of varying levels of difficulty on either a

traditional book or a Kindle, a modern e-reader with a presentation similar to print text

(Milone, 2011). A similar study compared 3rd grade students' comprehension when using

either iPads or printed books and found no differences in comprehension between

modality conditions (Grace, 2011). Students in this study had access to annotation and

dictionary tools, but the text did not incorporate additional multimedia features. Although

differences in comprehension were not found, 95% of students reported reading on the

iPad to be easier, and over 50% reported using annotation tools and dictionary tools

(Grace). These results suggested that students as young as 3rd grade can use device and

application features intended to enhance learning, such as annotation and dictionary tools,

but these features might not improve comprehension. Additional research is necessary to

determine if these findings are replicated across populations, particularly older students

who likely have more experience with using strategies while reading.

Lastly, Sheppard (2011) found similar results in his study with 11-13 year-old

boys in which he looked at the effect of iPads on comprehension of narrative text.

Similar to the study by Grace, students had access to annotation features within the

reading application and were able to change front size and text color, but the text did not

incorporate additional multimedia features such as animation or audio. Sheppard found

that differences only occurred among low achieving readers, in that these students

comprehended less when reading from iPads than print text. Thus the role of reading ability should be considered in future research on reading on mobile devices.

Unlike the above studies, in which multimedia features were not included in the electronic text, Kim et al. (2010) looked at the effect of mobile devices loaded with e-books that incorporated animation and audio features on the literacy achievement of 2nd grade students at two elementary schools. After 16 weeks, students who had access to the mobile reading devices performed significantly better on the literacy achievement test than those who used standard enrichment literacy materials. This study is consistent with earlier research on electronic text finding that electronic books have a greater effect on children's comprehension when they incorporate multimedia (Verhallen, Bus, & Jong, 2006).

Reading engagement. Among the theorized benefits of mobile devices in education is increased student engagement (Manuguerra & Petocz, 2011). Engagement and motivation are commonly discussed in the context of increased technology in classrooms, but there is inconsistency in the quality of the definitions and measures of these constructs (Penuel, 2006). For example, several studies relied on student or teachers response to a single question, which required the respondent to interpret the definition (e.g. Bebell, 20005; Mister-Jackson & Songer, 2000; Swan, van't hooft, Kratcoski, & Unger, 2005). In the current literature review and research design, reading engagement will be conceptualized and measured in terms of the expectancy-value theory of motivation and strategic interaction with text (Guthrie et al., 2004; Guthrie et al., 2006).

Motivation. According to an expectancy-value theory of motivation, mobile technology would affect motivation to read to the extent that it affects students' expectancies for success and values of interest, importance and usefulness.

Expectancies. Prior research has supported a relationship between one-to-one computer initiatives and general self-efficacy (Spektor-Levy, Menashe, Doron, & Raviv, 2010), but there have been limited studies that look specifically at the relationship between the use of modern mobile technologies and self-efficacy of reading. A recent study looked at the relationship between 6th grade students' self-efficacy and use of technology in and outside of school and found that using laptops in the classroom, and iPads and smart phones outside of the classroom, was correlated with increased confidence in learning in general, but no effect was found for reading (Castagnaro, 2012). Through focus groups, potential reasons for this effect were identified, including the ability to easily find answers on computers and prior knowledge of technology. Additional research is necessary to further explore the relationship between mobile devices and self-efficacy of reading.

Subjective-task value. Current research on the use of mobile devices for reading has largely focused broadly on students' attitudes, with little research looking specifically at individual motivation variables. Thus, the following review will summarize literature reflecting students' broader perceptions of task value related to reading on mobile devices, rather than perceptions of interest, usefulness, and importance individually.

As of 2010, nearly 50% of adults reported perceiving mobile devices as having the potential to be useful for educational reading (Gupta & Koo, 2010). However, there is evidence to suggest perceptions of reading electronic text are improving with

advancements in mobile technology. Weisburg (2011) looked at undergraduate student attitudes and behaviors related to digital textbooks over a 2-year study with multiple cohorts of students between 2009 and 2011. The time period in which this study took place is significant because it allowed researchers to capture student change in attitudes and behavior related to digital textbooks during time in which tablet computers and advanced e-readers were being introduced and increasing in popularity. Specifically, at the start of the study in 2009, the e-readers available to students were the Amazon Kindle and Sony e-Reader and were largely unfamiliar to students. Students in this cohort rated e-readers as unsuitable for classroom use. By the fall of 2010, when iPads were introduced and available to study participants, students' perceptions of digital textbooks became more favorable, with more students indicting a preference for tablet reading. Portability, convenience, connection to the Internet, and cost were cited as benefits of tablet e-readers. Despite the increased acceptability of digital textbooks over the two-year study, students were more likely to report using digital textbooks as a secondary textbook than a primary textbook, indicating they would still want access to print materials. Disadvantages of e-textbooks cited were increased distractibility and decreased affordance to comprehend content. Although this study is descriptive in nature, and therefore provides limited evidence of digital textbook acceptability, it suggests the degree to which students value reading e-textbooks has changed in recent years and is dependent on the specific platform used, warranting further study on this topic.

Perceived usability has been shown to be a critical factor in e-book use (Shin, 2011). The Reed Institute (Maremarelli & Ringle, 2009, 2011) conducted back-to-back

studies on the use of the Kindle DX and iPad in higher education classrooms using two different samples. In both studies, students were asked to use the electronic reading device for all of their class readings and provide feedback on several aspects of usability. Students in both studies reported the device portability and text legibility as favorable. However, students who used the iPad reported higher ratings of navigation than students who used the Kindle. Further, while students who used the Kindle found note-taking cumbersome and consequently resorted to note-taking on paper, students who used the iPad rated the annotation and note-taking tools more favorably, found the quality and quantity of their notes on the iPad increased as the semester went on, and even reported that, in most cases, highlighting on the iPad was *easier* than on paper. However, students who used iPads also noted concerns of distraction, which was not noted in the Kindle study.

There is evidence to suggest that the increased acceptance of digital text is especially salient among younger generations of individuals. In a study of college student and faculty acceptance of e-books, 17-21 year-olds reported the greatest use of e-books and were the most likely to prefer reading e-books off a computer screen rather than printing the readings (Rowlands, Nikolas, Jamali, & Huntington, 2007). Further, this generation effect may be present when comparing today's elementary and college age students. Culén and Gesparini (2011) conducted simultaneous iPad pilot studies with 4th grade and graduate-level college students. Interestingly, experience at the elementary level was rated as more positive. At the elementary level, 85% of the students rated the iPads as preferred or equivalent platforms for reading compared to paper. Whereas graduate students, who felt pressure of time and grades, were generally uninterested in

taking time to learn about the functionality of the iPads, elementary students were more likely to explore the capabilities of the iPads and found them easy to use. The graduate students also reported note-taking applications difficult to master.

Interpreting these results together supports a theory of mobile learning that accounts for the interaction of student and device characteristics, in that perceived benefits of mobile technologies are dynamic and dependent on advancements in digital technology, user familiarity, and societal values.

Reader interaction with text. One of the reported benefits of reading digital text is that it allows students to take notes and highlight key points, an option that is generally not available to students renting books from their schools (Clarke & Bensory, 2010). Platforms for reading e-books are increasingly incorporating annotation tools to highlight, write notes, magnify, or change font color (Corbeil & Valdes-Corbeil, 2007). Moreover, advanced digital annotation tools have additional features such as the option to make annotations public to classmates and teachers, search and organization of annotations, and a skimming tool that automatically highlights main points based on other users annotations (Kim, Farzan, & Brusilovsky, 2008). Annotation features embedded within e-books and e-book platforms are in demand among several e-book users. Specifically, among adults who use e-books in their academic work, 68% rated the ability to annotate, bookmark and take notes as an important feature of e-books (Li, Poe, Potter, Quigley, & Wilson, 2011).

Increased interactivity of tablets has been credited in increasing student engagement (Virginia Department of Education, 2011). Annotation features allow for readers to take a more active role in reading. While paper text has historically been

perceived as superior to computer-based text in supporting active reading (O'Hara & Sellen, 1997), results of more recent research have found tablet computers to be rated as comparable or superior to paper in regards to active reading, annotating, and note taking (Morris, Brush, & Meyers, 2007). In one case study with two students, Larson (2010) demonstrated students as young as seven were able to learn to spontaneously take notes using the annotation features of the Kindle after three weeks of practice. However, these results are inconsistent with the results found by Maremarelli and Ringle (2009; 2011) in which college students found note-taking on the Kindle cumbersome, but perceived note-taking on the iPad as comparable to note-taking on paper. The perceived usability of note-taking found among iPad users may be a factor of the iPad's touch screen and affordance for interactivity, features that differentiate the iPad and other modern tablets from earlier e-readers and laptop computers (Johnson et al., 2012b). Thus, more research is necessary on the perceived usability of annotation tools on modern tablet computers and mobile reading devices and the corresponding effect on reading comprehension and engagement.

Summary and Implications for Current Research

Modern mobile devices, tablets and advanced e-readers, are arriving to the educational scene at a time when educational policy makers and researchers are calling for more technology in classrooms (International Society for Technology in Education, 2005; U.S. Department of Education, Office of Educational Technology, 2010). It has been argued the improved portability, storage capacity, and battery life of handheld readers and tablet computers have rejuvenated digital books and will replace textbooks in future years (Abbot & Kelly, 2004; Obst, 2010). However, it is important to consider the

degree to which there is theoretical and empirical evidence for tablets to support reading outcomes before they are integrated into educational practices. Guthrie and colleague's reading engagement framework (2012) describing the relationship between classroom practices, motivations, engagement and comprehension provides a comprehensive theoretical model for studying the affordances of iPads related to reading comprehension as well as the mediating roles of motivation and engagement variables.

Theories of reading engagement, as well as theories of generative comprehension, suggest the use of strategies while reading supports retention of information and engagement (Guthrie et al., 2004; Guthrie et al., 2006; Linden & Wittrock, 1981; Wittrock & Alesandrini, 1990; Wittrock, & Marks, 1978). Thus, advanced e-readers and tablets that are increasingly incorporating touch screen functionality and the applications and annotation tools to highlight, write notes, and alter font could arguably affect reading comprehension and engagement to the extent that readers are afforded increased opportunities to actively interact with text.

Research comparing elementary school students' comprehension when reading from either print or static electronic text presented on mobile devices found no difference in comprehension (Grace, 2011; Milone, 2011). While annotation features were available to students in both of these studies, and there is qualitative evidence of students as young as 2nd and 3rd grade spontaneously using highlighting and note-taking features when reading from mobile devices (Grace, 2011; Larson, 2010), the degree to which reading strategies were used, or the relationship between strategy use and comprehension, across modalities has not been empirically evaluated. Further, research on comprehension and use of annotation tools when reading from mobile devices has largely been limited to

elementary age-students, and additional research should explore the degree to which annotation tools are used by secondary students who have arguably had more experience using strategies while reading.

Students' motivation to read is a critical component of reading engagement (Guthrie et al., 2004; Guthrie et al., 2006). According to expectancy-value theory (Eccles et al., 1983), students' motivation to read would be dependent, in part, on their values related to the specific reading task. The study of students' values related to reading on mobile devices is particularly intriguing among adolescents. Coined as the "Net Generation", today's young adults grew up surrounded by computers and technology and are argued to be accustomed to quick communication and access of information in all aspects of their lives (Tapscott, 2009). Thus, it is conceivable that students may value reading on mobile devices more than print text if it is more aligned with their current and future lives. However, recent research has been interpreted to suggest 21st century students are neutral in extent to which they perceive mobile technology as beneficial to their learning, and place less educational value on mobile devices than laptops and desktop computers (Dahlstorm, 2012; Kinash et al., 2012). However, available research on young adults' attitudes towards mobile devices in educational settings suggests perceptions of usability and value are dependent on the specific device used, and may increase with technological advancements (Maremarelli & Ringle, 2009, 2011; Weisburg, 2011).

Recent research on the use of tablets and other mobile devices for educational purposes have largely considered the effect of the use of the device in general, rather than looking at specific aspects of the device, or opportunities afforded by the device, that may

contribute to learning.   This is significant in light of earlier research on electronic text suggesting the importance of contextual factors such as font, hyperlinked text, multimedia, and reader characteristics, including familiarity with and attitudes towards technology (Azevedo & Cromley, 2004; Azevedo et al., 2008; Shaprio & Niederhouser, 2004; Verhallen, Bus, & Jong, 2006). Moreover, the increasing contextual factors associated with advancing technology, including opportunities afforded by the increased mobility, internet connectivity, and access to countless applications, have been argued to change the construct of reading (Destefano, & LeFeure, 2007; Zucker, Moody, & McKenna, 2009). The dynamic nature of reading on emerging technologies presents challenges for studying specific affordances, generalizing findings, and drawing conclusions across the literature.

Sharples, Milred, and Vauoula (2009) discussed the contextual challenges of evaluating the impact of mobile technology on learning and presented a framework of future evaluation. Specifically, mobile technology is not static, and the effect of mobile technology may largely depend on contextual factors. It is further argued that the full effect of mobile technology on student learning cannot be measured until devices are fully implemented in learning environments, as the actual use of mobile devices may be different than intended by the manufacture. Lastly, mobile devices that enable learners to engage in new learning activities may change how learners approach old learning activities. Thus, an evaluation of mobile technology must also study how new tools are used for every day learning tasks. To address these challenges, Sharples and colleagues (2009) proposed a framework in which mobile technology is evaluated at three different levels: micro, in which the use of mobile technology for individual learning activities is

evaluated for usability, effectiveness, and satisfaction, meso in which the effect of mobile technology on the educational experience as a whole is evaluated to address questions about how technology changes the learning experience, and macro, in which the larger, or long term, impact of mobile technology on learning is evaluated.

In accordance with the framework proposed by Sharples and colleagues (2009), the current research is a micro level study in which the affordances of iPads related to adolescents' reading comprehension and engagement are studied. The study will look at the direct effects of text modality on reading comprehension and engagement, as well as the potential mediating roles of task values, self-efficacy, and strategy use, based on Guthrie and colleague's model of reading engagement (Guthrie et al., 2012). In order to control for the additional contextual features that emerge with increased mobility and connectivity, the current study looks specifically at the affordances of device characteristics when reading static text in classroom settings. The current study addresses the following questions:

1. What is the effect of text modality on student comprehension of text?

2. What is the effect of text modality on students' self-efficacy and subjective task value?

3. What is the effect of text modality on the use of cognitive strategies?

4. If the effect of text modality on the use of cognitive strategies is significant, to what extent is this relationship mediated by self-efficacy and subjective task value?

5. If the effect of text modality on comprehension is significant, to what extent is the relationship mediated by the use of cognitive strategies

Chapter 3

Methodology

Participants and Setting

Two hundred and eighty-one ninth grade students from two rural Midwest high schools were asked to participate. Of the students at School 1, approximately 94% (n =73) were Caucasian, 4% (n=3) were Hispanic, and 2.5% (n=2) of the students were of another or non-defined nationality. Of the students at School 2, approximately 85 % (n= 172) were Caucasian, 2 % (n= 4) were Hispanic, and less than 1 % were African American ($n = 2$), Asian ($n = 2$), or American Indian ($n = 1$). The nationality of 10 % of students at School 2 (n =22) was not identified. Further, approximately 12 % (n =22*)* of the 9th grade students at School 2 received special education services, and 38% *(n = 69)* of the students received free or reduced lunch.

Among those students who were invited to participate, several participants were eliminated from the study. Reasons for exclusions include absences and lack of parent or individual consent. The actual number of students who participated from School 1 and School 2 were 44 and 189, respectively. Among those who participated, several students were unable to complete all components of the study. Characteristics of student data by school and condition are provided in Table 1.

As observed in Table 1, missing and incomplete data were unequal across schools and conditions and may have been a result of the differences in work environment and technology that existed between the two participating schools. While students at School 2 participated in the study from their regular classroom desks, students from School 1 were pulled from their regular classrooms to participate in either the library or auditorium. The

printing process at School 1 was difficult and unfamiliar to the students, and the printer

was not set up to allow multiple users to print at once. Students at School 2 did not have

printer access, so they were asked to upload their readings to a Dropbox. Lastly, students

at School 1 required more individualized instruction on how to use some of their iPad

features, which appeared to be more familiar to students at School 2. As a result, there

was a disproportionate amount of attrition and incompletion of measures in the iPad

condition at School 1. Specifically, at School 1, 22 students in the paper condition

returned complete sets of data compared to only 8 in the digital condition. At school 2,

93 students in the digital condition turned in complete sets of data compared to 89 in the

digital group.

Table 1

Characteristics of Student Data by School

| | School 1 | | | | School 2 | | | |
| | Paper | | Digital | | Paper | | Digital | |
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Initial	39	50%	39	50%	102	50%	101	50%
Absent	2	5%	6	5%	5	5%	4	4%
No Parent Consent	2	5%	2	5%	3	3%	0	0%
Opted Out	11	28%	11	28%	1	1%	1	1%
Incomplete Comprehension Data	1	3%	10	26%	0	0%	1	1%
Incomplete Motivation Data	1	3%	11	28%	4	4%	2	2%
Participating Students	24	62%	20	51%	93	91%	96	95%
Complete Data	22	56%	8	21%	89	87%	93	92%

The research occurred within 9th grade social studies classes. Social studies was chosen because it was assumed that all 9th grade students were enrolled in a social studies course. Participants were enrolled in one of 12 sections of social studies taught by 3 teachers. To better accommodate the study, School 1 altered students' schedules on the days of the study such that all 9th grade students had their social studies class during the same hour. As a result, students were not in their regular social studies classrooms. Students at School 2 participated during their regularly scheduled social studies hour and classrooms.

Design

A between-participants experimental design was used. Students were randomly assigned to one of four conditions based on two levels of each independent variable conditions in a 2 x 2 factorial design. The first variable was reading modality (digital or paper), and the second was strategy review (review or no review).

Independent Variables

Text modality. Students were randomly assigned to read either a paper or digital presentation of a section of expository history text. Students in the paper condition read from a photocopied packet that was stapled in the upper left hand corner. Students in the paper condition were also provided with a pen and a highlighter. Students in the digital condition read from their iPads using either iAnnotate (Branchfire, LCC, 2010) or Noterize (presently called PaperPort Notes; Nuance Communications, 2010). iAnnotate and Noterize are applications designed for the iPad to read, annotate, and share PDF files. While both schools were encouraged to use iAnnotate, administrators at School 2 were uninterested in loading a new application on students' iPads when Noterize, an

application with comparable functions, was already in use. Thus, while students at School 1 used iAnnotate to read the designated text, students at School 2 used Noterize.

Students in the two conditions completed the readings and questionnaires in two separate rooms and were unaware of the text modality used by students in the other condition. A researcher surveyed the room to ensure all students were reading from their assigned modality.

Strategy lesson. Within each modality condition, half of the students were randomly assigned to receive a lesson on comprehension strategies. It was assumed that all students had received some degree of exposure to basic comprehension strategies at some point in their educational history. However, it was not assumed that students had been exposed to these skills recently or that they were in the regular practice of applying these strategies independently while reading. The purpose of strategy instruction was to review these strategies and teach students how they can be applied directly to text while reading in order to increase the likelihood of students applying the strategies when given a reading assignment on the following day.

The primary researcher and a female graduate assistant provided small group instruction simultaneously for the print and digital condition. The lesson was developed by the primary researcher to incorporate evidence-based practices in annotation and strategy use and was scripted to ensure standardization across classes. Students were taught to annotate text using five evidence-based strategies: clarification, identifying the main idea, identifying key words and supporting details, question generating, and connecting text to prior knowledge and text (Duke & Pearson, 2002; Mastropieri & Scruggs, 1997; Simpson & Nist, 1990). Students were taught to apply each strategy to

text annotation using three steps: 1) explanation and rational, 2) model, and 3) guided

practice with feedback. All strategies were practiced on passages that were related to the

content that was currently being taught in the students' history class. While the

instruction on effective use of strategies while reading was the same across the digital and

print conditions, the digital condition received additional instruction on using the

annotation tools provided by the iAnnotate or Noterize application. The lessons were

approximately 40 minutes in length and were audio recorded and checked for integrity.

While students in the strategy condition received instruction, students in the no-strategy

control group participated in an independent work time in a separate classroom.

Materials

All students were asked to read two passages, both of which were approximately

1000 words in length. Students in the print conditions read print copies of the readings,

and students in the digital condition read a digital version of the same text that had been

uploaded into the iAnnotate or Noterize application on an iPad 2.

The test passages were selected to correspond with the content currently being

covered in students' history classes. At the time of the study, students at both schools

were learning about the early stages of World War II. The primary researcher worked

with the history teacher at one of the participating schools to identify texts that were

comparable to what students were accustomed to reading. Passage difficulty was

determined using the Lexile scale. The Lexile scale is a developmental reading scale

ranging from 200L to 1700L based on word frequency and word length (Lennon &

Burdick, 2004). Fifty percent of 9th grade students read at a Lexile level between 855L

and 1165L (Metametrics, 2012). The passages used in the current study were at Lexile levels of 930L and 1220.

Measures

Student motivation. In accord with an expectancy-value theory of motivation, student motivation to read expository text was measured with measures of self-efficacy and subjective task value. Researcher developed measures were used because published, norm referenced assessments of motivation tend to measure general indicators of motivation and would likely be insensitive to between group differences in motivation for this specific reading task.

Self-efficacy. A scale of self-efficacy was created based on the guidelines provided by Bandura (2006). The scale requires students to rate their confidence (1 to 10) in their ability to perform 11 sub-skills involved in successful reading of expository text. The sub-skills ranged in difficulty from basic decoding skills to note-taking and strategy use while reading. See Appendix A for complete scale.

While scoring students' responses, a response pattern was noticed in which students rated their confidence in skills related to note-taking lower than all other reading skills. As a result of this observation, an exploratory factor analysis was performed to determine if the self-efficacy scale measured more than one factor. An Alpha Factor extraction method with Promax rotation yielded a two factor solution with eigenvalues of 5.14 and 1.39, explaining 46.8% and 12.66% (cumulative 59.5%) of variance, respectively. Consistent with the observed response pattern, 8 items reflected general reading self-efficacy ($\alpha = .865$), and 2 items reflected self-efficacy of note-taking while reading ($\alpha = .745$). As a result, the two factors were treated as two separate sub-scales of

self-efficacy and analyzed separately using the average item score for each sub-scale. The factor pattern matrix is presented in Table 2.

Table 2

Factor Pattern Matrix

Item	Factor 1	Factor 1
Stay focused while reading	**.569**	-.052
Read the words easily	**.657**	.069
Understand the meaning of the words	**.720**	-.060
Identify the main idea of what I read	**.810**	-.050
Re-tell what I read in my own words	**.798**	-.068
Comprehend what I read	**.908**	-.132
Use strategies to help me remember what I read	**.409**	.115
Use strategies when I read something difficult that I don't understand	**.568**	.282
Take notes while I'm reading	-.007	**.779**
Use my notes to study for a test	0.076	**.757**
Remember what I read for a test	**.601**	.228

Subjective task value. Subjective task value was measured with three subscales from the Self and Task Perception Questionnaire (Eccles & Wigfield, 1995) that were adapted for the domain of reading. In the original version of the subscales, 2 items were used to measure intrinsic interest value (α= .76), 3 items measured attainment value (α= .70), and 2 items measured utility value (α=.62).

In addition to modifying the questions to the context of reading, an item was added to both the Intrinsic Interest Value subscale and the Utility Value subscale to increase variability. The item created for the Intrinsic Interest subscale was, "Compared to other class assignments, how much did you enjoy this reading task?" The item added to the Utility Value subscale was, "If your history teacher gave you a reading task similar to the one you just read, how useful would it be in helping you do well in history class?" The response format for all items was a 10-point Likert scale. Cronbach's Alpha for the current version of the Interest, Attainment Value, and Utility Value subscales were .90, .84, and .81, respectively. Average item scores within each sub-scale were used in analyses. See Appendix B for complete scale.

Strategy use. Strategy use was measured using a direct analysis of students' annotations and notes. Although annotation and note taking is a limited conceptualization of strategy use, it was chosen as an observable and concurrent measure of strategy use. Concurrent measures of strategy use have been found to be superior to prospective or retrospective measures of strategy use in predicting reading comprehension (Cromley & Azvedo, 2006).

Copies of students' readings were obtained from 224 of the total participants. Of the 224 participants, only 12 used a note-taking strategy other than highlighting or underlining. Thus, a dichotomous coding strategy was used in which data were coded for whether or not a student used any type of annotation strategy, and further analyses on the quality and quantity of notes were not performed.

Comprehension. Comprehension of text content was assessed using a researcher-developed measure of text comprehension. The measure is a 20-item multiple choice

measure reflecting the three cognitive targets assessed on the National Assessment of

Educational Progress (NAEP): locate or recall, integrate or interpret, and critique or

evaluate (Institute of Education Sciences, 2010). Consistent with the NAEP,

approximately 20 % of the items reflect the locate or recall target, 55 % reflect the

integrate or interpret target, and 25 % reflect the critique or evaluate target. The 20-item

measure was found to have adequate internal reliability for research purposes, (α =.70;

Salvia, Ysseldyke, & Bolt, 2010).

  Scaling. IRT scaling was used to transform students' raw scores on the

comprehension measure because students' summed scores on the comprehension

measure did not meet the assumptions of normally distributed, continuous data necessary

for parametric statistical analyses (Harwell & Gatti, 2001). XCalibre 4.1 (ASC, 2012)

was used to estimate person ability scores (θ) with 1-parameter, 2-parameter, and 3-

parameter dichotomous IRT models. The 2-parameter model was determined to best fit

the data, resulting in the lowest Akaike information criterion (AIC) and Baysian

information criterion (BIC) values of 4481 and 4606, respectively. The 3-parameter

failed to converge on multiple items, suggesting a poor fit of the data. The difference

likelihood ratio statistic (ΔG^2) was calculated to compare the relative fit of the 1-

paratmeter and 2-paramer model (de Ayala, 2009, pg. 140). The resulting ΔG^2 was 116,

which when evaluated on a chi-square distribution (n =240, df = 52) was significant at p

< .001, indicating that there was a significant difference between the 1- and 2- parameter

model. Thus, the person ability scores from the 2-parameter model were used in analyses

involving students' comprehension of text.

Transformations. Theta scores were transformed into T-scores with a mean of 50 and standard deviation of 10 to improve interpretation. This transformation took place by first transforming theta scores into z-scores, multiplying the z-scores by the desired standard deviation of 10, and adding the desired mean of 50. The following equation was used:

$$T = \frac{X - \mu}{\sigma} * 10 + 50$$

Reading Achievement. Students' fall scores on the reading portion of the Measures of Academic Progress (MAP; Northwest Evaluation Association) were used as a covariate in all parametric analyses. The MAP is a computerized adaptive achievement test designed to measure student growth in the areas of mathematics and reading. A review of the psychometric properties of the MAP found evidence of concurrent validity and internal and alternate form reliability coefficients that meet or exceed .89 (Brown & Coughlin, 2007).

Procedures

Consent forms were sent home to parents 1 week prior to the start of the study. The study procedures were similar to regular classroom activities, so a passive consent procedure was used in which parents were asked to return the consent form if they did not want their child to participate. Students with parent consent were randomly assigned to a digital or paper condition and a strategy review or no strategy review condition using an Excel random number generator. The remaining study procedures were conducted over two consecutive days.

Day 1. Students were briefed on the study and asked to provide assent of participation. Students in the strategy condition received a lesson in which

comprehension strategies were reviewed and annotation was taught as previously described. Specifically, five strategies were reviewed: clarification, identifying the main idea, identifying key words and supporting details, question generating, and connecting text to prior knowledge and text. Lessons were scripted and taught by either the primary researcher or a female research assistant. Each strategy was reviewed using the same format: define strategy and explain purpose, model, allow opportunity to practice on example paragraphs, and provide feedback.   Students were taught to apply these skills to either paper or digital text depending on the text modality condition they were assigned. Students who were in the no strategy condition remained in the classroom for independent work time.

Day 2. Students were separated into different rooms by text modality. Students in the paper condition were given a folder that contained the passages to be read, a packet of comprehension questions, and the motivation scales. Students were also given a highlighter and a pen. The primary researcher or research assistant gave the following directions, "Please read the two readings carefully as if you are studying for a test because you will be asked to answer some questions about them when you are finished." After 20 minutes, students were asked to put the readings back in their folders and complete the comprehension questions and the motivation scale. Students in the digital condition received similar instructions but were first instructed to upload the reading into iAnnotate or Noterize. After reading, students in the digital condition were instructed to either print the reading or upload it to a Dropbox account depending on the school's set up. Specifically, students at School 1 had access to a printer, and therefore printed their

readings. Students at School 2 did not have access to a printer so they uploaded their readings to a Dropbox.

Analyses

A description of the analyses used to address each research question is presented below. Prior to conducting primary analyses, data were evaluated on the degree to which necessary assumptions were met.

What is the effect of text modality on student comprehension of text? A 2x2 analysis of covariance (ANCOVA) was performed to analyze main effects and interactions of text modality and strategy review on comprehension of text (θ). The effect of strategy review was included in the analyses to account for differences in student familiarity with annotation strategies across the two modalities. Students' scores on the reading portion of the fall MAP test were used as a covariate to control for prior differences in reading achievement.

What is the effect of text modality on student motivation? In align with an expectancy-value theory of motivation, student motivation to read expository text was measured with measures of self-efficacy and subjective task value. Separate 2 x 2 multivariate analyses of covariance (MANCOVA) were run on the Self-Efficacy and Subjective Task Value subscales. Due to the established relationship between motivation and reading achievement (Baker & Wigfield, 1999, Wigfield & Guthrie, 1997), reading MAP scores were used as a covariate.

What is the effect of text modality on the use of cognitive strategies? A three-way Chi-Square test of independence was performed to test the relationship between the

use of cognitive strategies and text modality, for students who received a strategy review lesson and those who did not**.**

If the effect of text modality on strategy use is significant, to what effect is this relationship mediated by self-efficacy and/or subjective task value? Baron and Kenny (1986) argued the following requirements for a mediating relationship: a) a significant relationship between the mediating variable (self-efficacy or subjective task value) and independent variable (modality), b) a significant relationship between mediator (self-efficacy or subjective task value) and dependent variable (strategy use), and c) a significant relationship between the independent variable (modality) and dependent variable (strategy use). Point biserial correlations were calculated to determine the significance of the preceding relationships (see Table 3) and whether or not additional mediating analyses were necessary.

Table 3

Correlation Matrix of Variables

	1	2	3	4	5	6	7	8
1. Modality	1							
2. Comprehension	-.024	1						
3. Interest	.068	.341*	1					
4. Attainment Value	.007	.320*	.798*	1				
5. Utility Value	.001	.225*	.613*	.719*	1			
6. Self-Efficacy: Reading	.088	.471*	.612*	.568*	.525*	1		
7. Self-Efficacy: Note-taking	.026	.220*	.207*	.225*	.309*	.490*	1	
8. Strategy Use	.349*	.156*	.188*	.198*	.214*	.171*	.227*	1

* $p < .05$.

If the effect of text modality on comprehension is significant, to what extent is the relationship mediated by the use of cognitive strategies? Point biserial correlations were calculated to determine if the relationships between modality, comprehension, and strategy use were significant and met requirements of a mediating relationship (Baron & Kenny, 1986). **Treatment Fidelity and Interrater Reliability**

The primary researcher checked treatment fidelity for 50% ($n = 7$) of the strategy review lessons. Treatment fidelity was determined by listening to audio recordings of the lessons and using an implementation checklist that included primary lesson components (see Appendix D). The number of correctly implemented components was divided by

the total number of lesson components, resulting in 100% of items being implemented correctly.

Interrater reliability of comprehension scores was determined by having two graduate research assistants score 25% ($n = 60$) of the comprehension measures. Items that were consistently scored as correct or incorrect by both raters were counted as an agreement and those that were inconsistently scored were counted as disagreements. The total number of agreements was divided by the number of agreements plus disagreements and multiplied by 100. Total interrater reliability was 95% with a Kappa statistic of .945.

Chapter 4

Results

Characteristics of Data

As previously described, there was a disproportionate amount of missing and incomplete data at School 1. The effect of disproportionate attrition at School 1 on task performance was assessed by determining whether or not there were significant differences in reading achievement, as measured by scores on the reading portion of the MAP test, between School 1 students who finished the comprehension test and School 1 students who did not finish, and determining whether or not there was a significant difference in performance on the comprehension task between students at School 1 and School 2. A one-way ANOVA revealed no significant difference in reading achievement, as measured by scores on the reading portion of the MAP test, between School 1 students who finished the comprehension test and those who did not, $F(1, 48) = .001$ $p = .97$. These results suggest that there was not a significant difference in reading ability, between students at School 1 who finished all experimental tasks and those who did not. An analysis of covariance (ANCOVA) revealed that the difference in performance on the comprehension task between the two schools, after controlling for reading MAP scores, was significant, $F (1, 191) = 6.219$, $p =.01$, indicating that students at School 2 performed better than students at School 1 on the comprehension measure. In order to address missing data at School 1, all research questions were answered by separately analyzing two sets of data: data from School 2 only and the combined data from School 1 and School 2. Due to the small sample size and non-random missing data, separate analyses were not run on data from School 1 only.

The disproportionate amount of attrition in the digital condition could also have an effect on the results of the factorial analyses of variance. Unbalanced factorial designs can result in ambiguity in regards to calculation of marginal means and partitioning of sum of squares (Tabachnick & Fidell, 2007). In the current study, which utilizes factorial ANCOVA and MANCOVA, the problem of unbalanced designs was lessoned by using the default Type III method of sums of squares calculation in SPSS to run factorial analyses of variances because the Type III method uses a harmonic mean instead of a weighted mean (Shaw & Mitchell-Olds, 1993).

Descriptive Statistics

Data from the two schools were treated as both individual and combined data sets. The descriptive statistics for all measures in each data set are presented in Tables 4, 5, and 6.

School 1. The descriptive data from School 1 are presented in Table 4. Only 45% to 66% of the sample completed all measures administered to School 1 as a result of technology complications and time limitations. The distributions of the two self-efficacy scales and Attainment and Utility Value subscales of the Subjective Task Value Questionnaire were slightly negatively skewed. However, with the exception of MAP scores, the skew and kurtosis values for all measures were between -1 and 1, and therefore were assumed to not deviate significantly from a normal distribution (Leech, Barrett, & Morgan, 2005). The distribution of MAP scores was slightly platykurtic, with a kurtosis value of 1.86, but was not a significant concern for use in ANCOVAs, which have been shown to be robust to minor violations of normality (Olejnik & Algina, 1984)

School 2. The descriptive data from School 2 are presented in Table 5. The

response rate for measures administered to School 2 was between 94% and 99%, but MAP scores were only available for 77 % of the sample. With the exception of the Interest sub-scale of the Subjective Task Value Questionnaire, the distribution of data from all measures had a slight negative skew. However, skew and kurtosis values for all measures were between -1 and 1. Kurtosis values were all within a normal range.

Combined data set. The descriptive statistics from the combined data set are presented in Table 6. The distributions of data from all measures were slightly skewed, but all values of skew were between -1 and 1 and thus assumed to not deviate significantly from the normal distribution. The kurtosis values for the distribution of all measures was within a normal range with the exception MAP scores. The distribution of MAP scores was slightly platykurtic, with a kurtosis value of 1.24, but deemed appropriate for use in robust analyses such as ANCOVAs (Olejnik & Algina, 1984).

Table 4

Descriptive Statistics for School 1Data

	N	% of sample	Mean (SD)	Skew (SE)	Kurtosis (SE)
Self-Efficacy- Reading	34	45.9	7.4 (2.0)	-.65 (.18)	-.19 (.36)
Self-Efficacy-Note-taking	35	47.3	6.2 (2.9)	-.44 (.18)	-.63 (.36)
Interest	37	50.0	5.6 (2.6)	-.32 (.18)	-.62 (.36)
Attainment Value	35	47.3	5.8 (2.4)	-.51 (.18)	-.19 (.36)
Utility Value	35	47.3	6.2 (2.5)	-.53 (.18)	-.22 (.36)
Comprehension	49	66.2	48.0 (10.2)	.69 (.34)	1.0 (.67)
MAP Score	71	95.9	222.7 (14.3)	-.71 (2.9)	1.9 (.56)

Table 5

Descriptive Statistics for School 2 Data

	N	% of sample	Mean (SD)	Skew (SE)	Kurtosis
Self-Efficacy- Reading	176	94.6	7.3 (1.6)	-.65 (.15)	-.19 (.36)
Self-Efficacy-Note-taking	182	97.8	6.2 (2.5)	-.44 (.18)	-.63 (.36)
Interest	180	96.8	6.1 (2.1)	-.32 (.18)	-.22 (.36)
Attainment Value	180	96.8	6.5 (1.8)	-.51 (.18)	-.19 (.36)
Utility Value	178	95.7	6.8 (1.9)	-.53 (.18)	-.62 (.36)
Comprehension	185	99.4	50.5 (9.9)	.56 (.18)	.71 (.36)
MAP Score	144	77.4	224.2 (12.5)	-.53 (.20)	.75 (.40)

Table 6

Descriptive Statistics for Combined Data Set

	N	% of Sample	Mean (SD)	Skew (SE)	Kurtosis
Self-Efficacy- Reading	213	80.7	7.3 (1.7)	-.72 (.17)	.19 (.33)
Self-Efficacy-Note-taking	221	83.7	6.2 (2.6)	-.45 (.16)	-.71 (.33)
Interest	220	83.5	6.0 (2.2)	-.35 (.16)	-.62 (.33)
Attainment Value	218	82.5	6.4 (1.9)	-.54 (.17)	-.094 (.33)
Utility Value	216	81.8	6.7 (1.98)	-.58 (.17)	-.21 (.33)
Comprehension	238	90.1	50.0 (10.0)	.57 (.16)	.64 (.31)
MAP Score	218	82.5	223.7 (13.1)	-.59 (.17)	1.2 (.33)

Primary Analyses

Research question # 1: What is the effect of text modality on student comprehension of text? The first research question sought to address the effect of text modality on comprehension of text. The effect of strategy review was also included in the analyses to account for differences in student familiarity with annotation strategies across the two modalities. Main effects and interactions of modality and strategy review on comprehension of text were analyzed with a 2 x 2 factorial ANCOVA, using MAP scores as a covariate. Separate analyses were conducted for School 2 data and the combined data set of School 1 and 2.

Prior to conducting an ANCOVA, Levine's test for homogeneity of variance was conducted on comprehension data to test the assumption of homogeneity of variance. The results of Levine's test were not significant for either the School 2 data $F(3, 139) = 2.03$, $p > .05$, or the combined data set $F(3, 190) = 2.03$, $p > .05$, indicating the assumption for homogeneity of variance was reasonably met. A visual inspection of regression lines suggests a linear relationship between the covariate and dependent variable with similar slopes across modality and strategy review conditions, indicating the assumptions of linearity and homogeneity of regression were also met.

Combined data set. The descriptive statistics for the comprehension data for School 1 and 2, including cell sizes, covariate means, actual comprehension means, and estimated marginal means are presented in Table 7. The main effect of modality on comprehension was not statistically significant using the combined data set $F(1, 189) = 2.48$, $p > .05$, $\eta^2 = .013$. These results suggest that after controlling for prior reading achievement, there was no statistical difference in comprehension between students who read on an iPad and those who read on paper. The main effect of strategy review on comprehension was also not statistically significant $F(1, 189) = .01$, $p > .05$, $\eta^2 < .001$. These results suggest that after controlling for prior reading achievement, there was no statistical difference in comprehension between students who received a strategy review lesson and those who did not. There was no interaction effect $F(1, 189) = .73$, $p > .05$, $\eta^2 = .004$.

School 2 only. The descriptive statistics for the comprehension data for School 2, including cell sizes, covariate means, actual comprehension means, and estimated marginal means are presented in Table 8. The main effect of modality on comprehension

was not statistically significant F (1, 141) = 1.57, $p > .05$, partial $\eta^2 = .011$. The main effect of strategy review on comprehension was also not statistically significant F (1, 141) = .212, $p > .05$, $\eta^2 = .002$. These results suggest that after controlling for prior reading achievement, there was no statistical difference in comprehension between students who received a strategy review lesson and those who did not. There was no interaction effect F (1, 141) = .118, $p > .05$, $\eta^2 = .001$.

Table 7

Mean Measures of Academic Progress (MAP), Comprehension, and Adjusted Mean Comprehension (AMC) scores by Condition at School 1 and School 2

	Digital		Paper	
	Strategy Review	No Strategy Review	Strategy Review	No Strategy Review
	$N = 43$	$N = 50$	$N = 54$	$N = 47$
Mean MAP Score (SD)	222.4 (11.4)	222.6 (15.0)	227.1 (11.4)	222.9 (14.3)
Mean Comprehension Score (SD)	49.5 (9.9)	49.4 (10.6)	49.0 (9.8)	48.3 (8.8)
AMC Score (SE)	50.3 (1.1)	49.5 (1.0)	47.8 (1.0)	48.8 (1.1)

Table 8

Mean Measures of Academic Progress (MAP), Comprehension, and Adjusted Mean Comprehension (AMC) scores by Condition at School 2

	Digital		Paper	
	Strategy Review $N = 35$	No Strategy Review $N = 38$	Strategy Review $N = 39$	No Strategy Review $N = 34$
Mean MAP Score (SD)	223.0 (12.4)	224.6 (11.4)	226.5 (11.2)	222.3 (15.1)
Mean Comprehension Score (SD)	49.5 (9.7)	50.6 (10.4)	49.4 (9.3)	48.3 (9.4)
AMC Score (SE)	50.1 (1.2)	50. 4 (1.2)	48.2 (1.2)	49.3 (1.2)

Research question # 2: What is the effect of modality on student motivation?

In align with an expectancy-value theory of motivation, student motivation to read expository text was measured with measures of self-efficacy and subjective task value. The effect of modality on self-efficacy and subjective task value was analyzed using separate 2 x 2 MANCOVAs with subscales from each measure as dependent variables and MAP scores as a covariate. As with research question 1, the effect of strategy review was also included in the analyses to account for differences in student familiarity with annotation strategies across the two modalities.

A visual inspection of scatter plots was used to check the assumption homogeneity of regression for all MANCOVAs. The slopes of the regression lines between the covariate, MAP scores, and all dependent variables appeared to be slightly discrepant across strategy and modality conditions. When the combined data set was used, the discrepancies across independent variables (i.e. modality and strategy lesson) in regression line slopes appeared relatively minor (see Figure 1 for example of a minor discrepancy), with the exception of the regression line between MAP and utility value, in which the independent variable, strategy lesson, appeared to have a greater effect on the slope (see Figure 2*).* When only data from School 2 was used, the slopes of the regression lines between MAP and all subjective task value variables also appeared to differ more across strategy conditions (see Figure 3 for example of larger discrepancy*).* To test whether or not the assumption of homogeneity of regression was significantly violated, the interaction between MAP and both independent variables were included in all MANCOVAs.
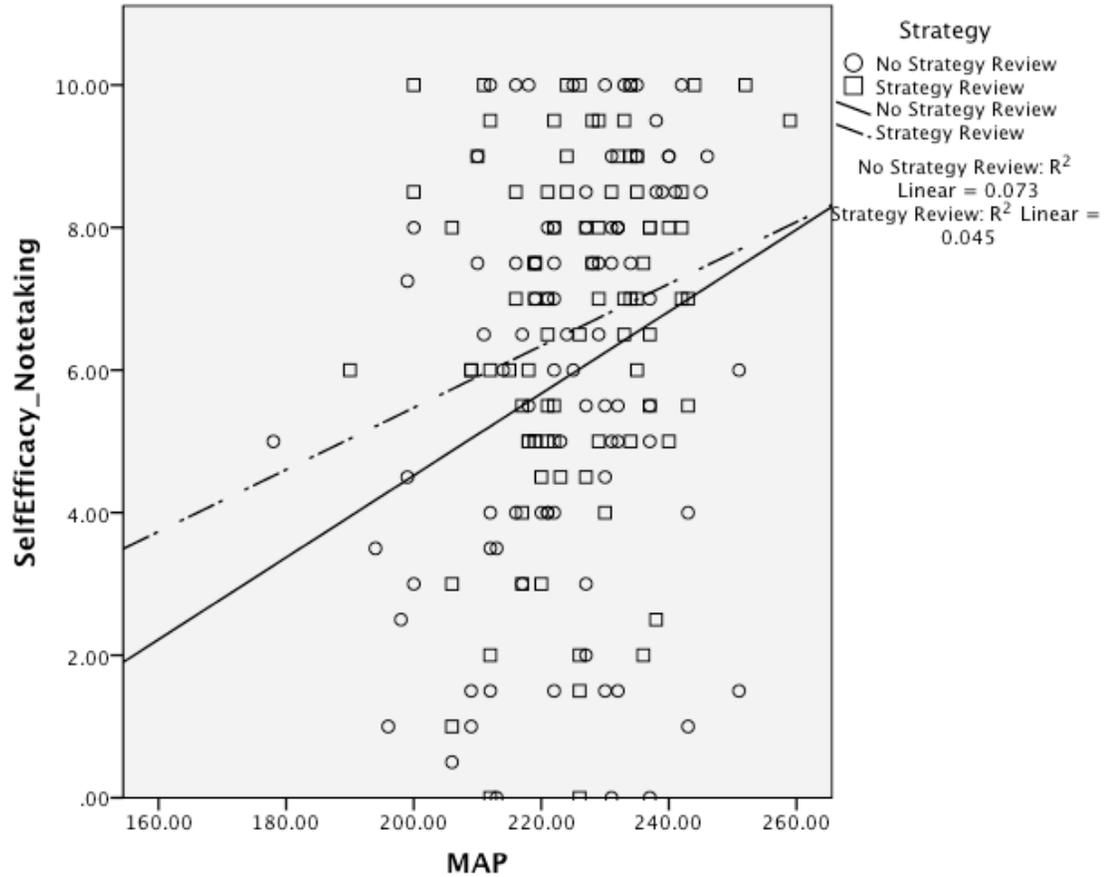
Figure 1. The relationship between MAP scores and ratings of Self-Efficacy of Note-taking among students who received a strategy review lesson and those who did not in the combined data set.
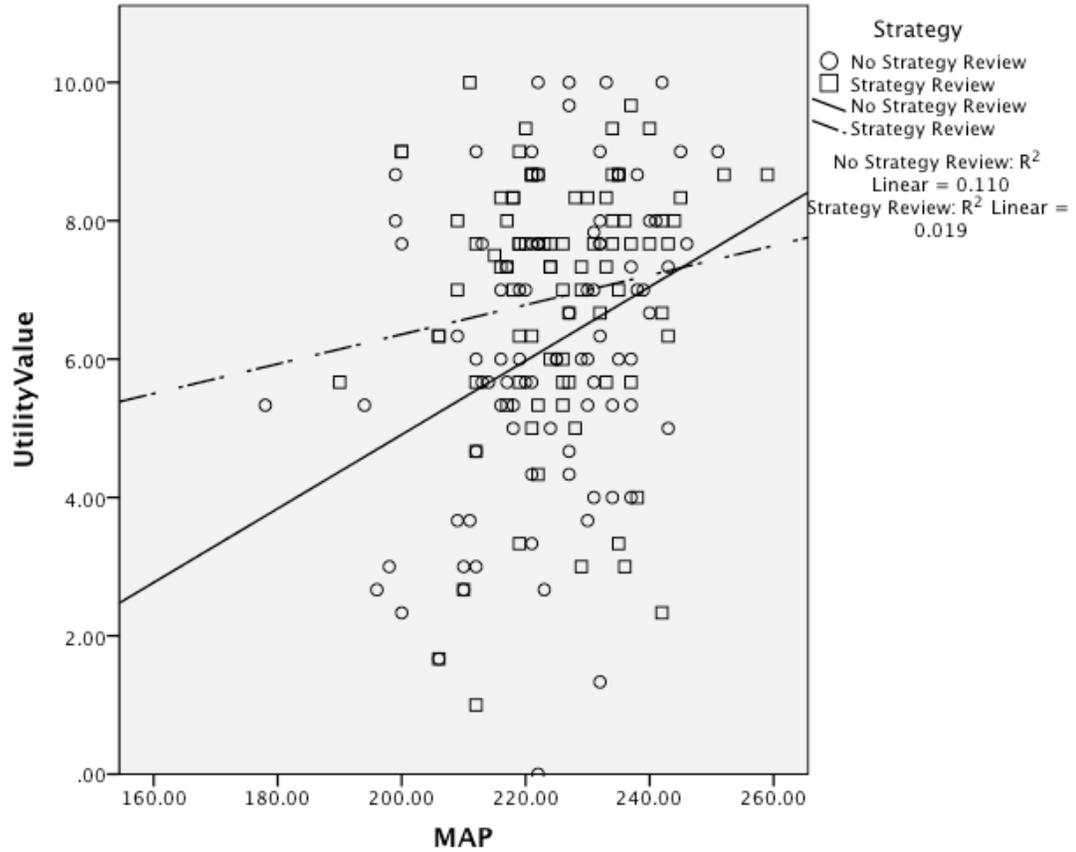
Figure 2. The relationship between MAP scores and ratings of Utility Value among students who received a strategy review lesson and those who did not in the combined data set.
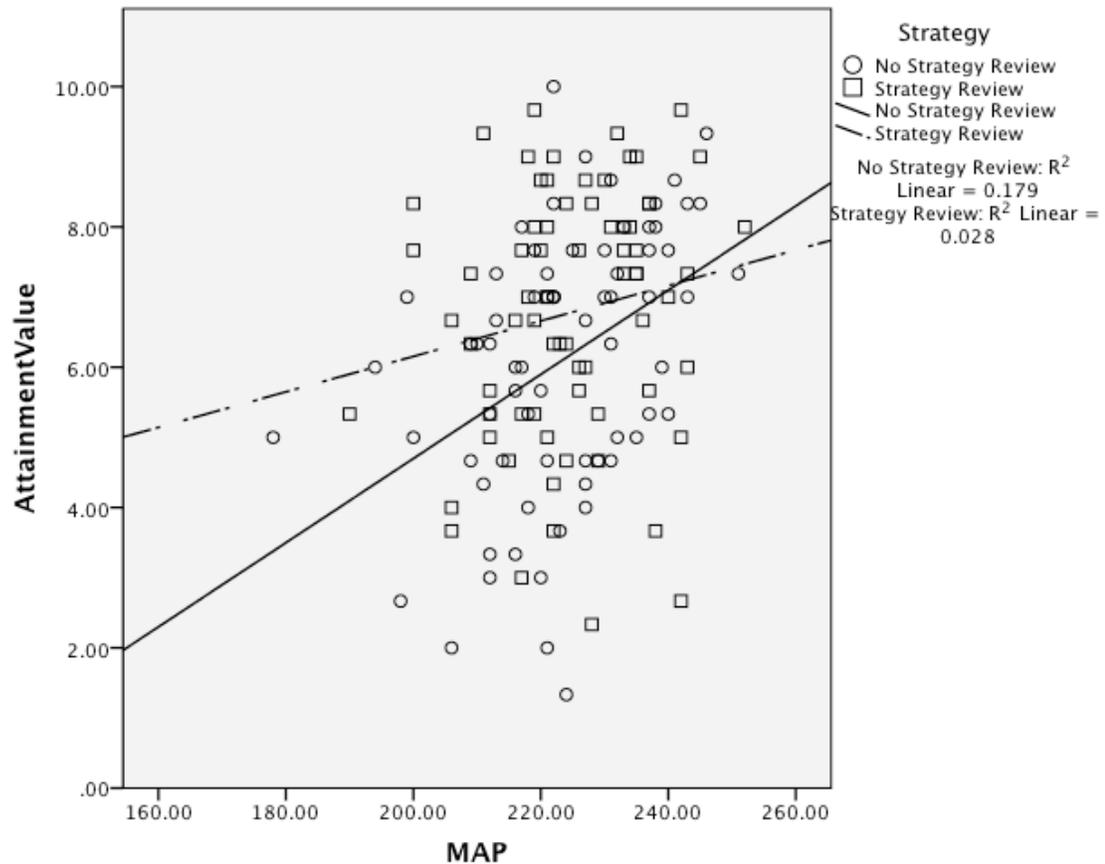
Figure 3. The relationship between MAP scores and ratings of Attainment Value among students who received a strategy review lesson and those who did not at School 2.

Self-efficacy. Separate analyses were run for School 2 data and the combined data set of School 1 and 2.

Combined data set. The descriptive statistics for the self-efficacy data for the combined data set including cell sizes, covariate means, actual comprehension means, and estimated marginal means are presented in Table 9. Prior to running analyses, Levine's test for homogeneity of variance was conducted on the self-efficacy data to test the assumption of homogeneity of variance. The results of Levine's test were not significant for either the Self-Efficacy of Reading $F(3, 174) = 1.56$, $p > .05$, or Self-

Efficacy of Note-taking F (3, 174)= 1.56, p > .05. A visual inspection of regression lines provided evidence of a linear relationship between the covariate, MAP scores, and both dependent variables, Self-Efficacy of Reading, and Self-Efficacy of Note-Taking, suggesting the assumption of linearity had been met. Observed differences in the slopes across modality and strategy conditions were minimal, and when these interactions were tested in a multivariate analysis on subjective task value, neither MAP x modality F (3, 168) = .86, p > .05, nor MAP x strategy review F (3, 168) =1.55, p >.05, were significant. Thus, it was assumed that the assumption of homogeneity of regression for MANCOVA was not significantly violated.

The omnibus MANCOVA revealed no significant main effects of modality F (2, 172) =.34, p >.05, $\eta^2 = $ .004, or strategy use F (2, 172) =1.28, p >.05, η^2 = .015 on self-efficacy. The interaction was also non-significant F (2, 172) = .08, p >.05, η^2 = .001. These results indicate that students in the combined data set reported comparable levels of self-efficacy for reading and note-taking, regardless of whether they were reading from an iPad or paper and whether or not they had a review lesson on strategy.

Table 9

Mean Measures of Academic Progress (MAP), Mean Self-Efficacy subscale Ratings, and Adjusted Mean Self-Efficacy subscale by Condition at School 1 and 2

	Modality	Strategy Condition	N	Mean MAP (SD)	Mean Rating 1-10 (SD)	Adjusted Mean Rating (SE)
Self-Efficacy of Reading	Digital	Strategy Review	36	222.9 (12.2)	7.1 (2.0)	7.3 (.26)
		No Strategy Review	44	223.9 (13.5)	7.1 (1.9)	7.1 (.23)
	Paper	Strategy Review	52	226.9 (11.5)	7.5 (1.5)	7.3 (.22)
		No Strategy Review	46	224.0 (13.8)	7.2 (2.0)	7.24 (.34)
Self-Efficacy of Note-Taking	Digital	Strategy Review	36	222.9 (12.2)	6.7 (2.4)	6.8 (.44)
		No Strategy Review	44	223.9 (13.5)	5.9 (2.9)	6.0 (.40)
	Paper	Strategy Review	52	226.9 (11.5)	6.5 (2.6)	6.38 (.36)
		No Strategy Review	46	224.0 (13.8)	5.9 (3.0)	5.90 (.39)

School 2 only. The descriptive statistics for the self-efficacy data for School 2 including cell sizes, covariate means, actual comprehension means, and estimated marginal means are presented in Table 10. Levine's Test of Equality of Error variance was conducted on the self-efficacy data to test the assumption of homogeneity of variance. The results of Levine's Test were not significant for either the Self-Efficacy of Reading $F (3, 139)= .095, p > .05$, or Self-Efficacy of Note-taking $F (3, 139) = 2.09, p > .05$. A visual evaluation of regression lines provided evidence of s a linear relationship between the covariate, MAP scores, and both dependent variables, Self-Efficacy of Reading and Self-Efficacy of Note-Taking, suggesting the assumption of linearity had been met. Observed differences in the slopes across modality and strategy conditions were minimal, and when these interactions were tested in a multivariate analysis on self-efficacy, neither MAP x modality $F (2, 138) = .424, p > .05$, nor MAP x strategy review $F (2,138) = 2.42, p > .05$, were significant. Thus, it was assumed that the assumption of homogeneity of regression was not significantly violated.

The omnibus MANCOVA revealed no significant main effects of modality $F (2,137) =.39, p > .05, \eta^2 = .006$, strategy use $F (2,137) =2.483, p > .05, \eta^2 = .035$, or self-efficacy. The interaction was also non-significant $F (2,137) = .01, p > .05, \eta^2 = .001$. These results indicate that students from School 2 reported comparable levels of self-efficacy for reading and note-taking, regardless of whether they were reading from an iPad or paper and whether or not they had a review lesson on strategy use.

76

Table 10

Mean Measures of Academic Progress (MAP), Self-Efficacy Subscale ratings and Mean Subscale ratings by Condition at School 2

	Modality	Strategy Condition	N	Mean MAP (SD)	Mean Rating 1-10 (SD)	Adjusted Mean Rating (SE)
Self-Efficacy of Reading	Digital	Strategy Review	35	223.03 (12.37)	7.31 (1.69)	7.38 (.25)
		No Strategy Review	37	224.57 (11.66)	7.11 (1.78)	7.08 (.25)
	Paper	Strategy Review	37	226.11 (11.12)	7.56 (1.58)	7.42 (.25)
		No Strategy Review	34	222.29 (15.19)	6.98 (1.83)	7.10 (.26)
Self-Efficacy of Note-Taking	Digital	Strategy Review	35	223.03 (12.37)	6.86 (2.08)	6.90 (.44)
		No Strategy Review	37	224.57 (11.66)	5.84 (2.87)	5.82 (.42)
	Paper	Strategy Review	37	226.11 (11.12)	6.50 (2.43)	6.40 (.43)

No Strategy Review	34	222.29 (15.19)	5.57 (2.91)	5.66 (.44)

Subjective task value. Separate analyses were conducted for the subjective task-value data for School 2 and the combined data set of School 1 and 2.

Combined data set. Levine's test for homogeneity of variance was conducted on the subjective task value data for School 1 and School 2 combined. The results were not significant for Interest Value F (3, 170) = .62, p >.05, Attainment Value F (3, 170) =.18, p > .05, or Utility Value F (3,170) = .82, p > .05, suggesting that the assumption of homogeneity of variance was not violated. The assumption of linearity between the covariate and dependent variable was evaluated with a visual inspection of scatter plots. The relationships between scores on each subjective task value subscale and MAP scores appeared to be linear. Homogeneity of the regression lines were further assessed by testing MAP x modality and MAP x Strategy review interactions in a multivariate analysis on subjective task-value. Neither MAP x modality F (3, 168) = .86, p > .05, nor MAP x strategy review F (3,168) = 1.55, p >.05, were significant. Thus, it was assumed that the assumption of homogeneity of regression was not significantly violated.

The omnibus MANCOVA revealed no significant effects of modality F (3,167) =.49, p >.05, or strategy use F (3,167) =.21, p >.05, on subjective task value, indicating that students' ratings of interest, utility, and attainment value were statistically equal across conditions. Covariate scores mean subscale ratings, and adjusted mean ratings are presented in Table 11.

Table 11

Mean Measures of Academic Progress (MAP), Subjective Task Value Subscale ratings, and Mean Subscale ratings by Condition at School 1 and 2

	Modality	Strategy Condition	N	Mean MAP (SD)	Mean Rating 1-10 (SD)	Adjusted Mean Rating (SE)
Interest	Digital	Strategy Review	34	222.3 (12.5)	6.0 (2.1)	6.1 (.38)
		No Strategy Review	42	223.2 (13.3)	5.6 (2.4)	5.7 (.34)
	Paper	Strategy Review	53	227.2 (11.7)	6.2 (2.1)	6.1 (.30)
		No Strategy Review	45	223.6 (13.9)	5.8 (2.4)	5.9 (.33)
Attainment Value	Digital	Strategy Review	34	222.3 (12.5)	6.6 (2.0)	6.7 (.33)
		No Strategy Review	42	223.2 (13.3)	6.1 (2.1)	6.1 (.30)
	Paper	Strategy Review	53	227.2 (11.7)	6.6 (2.0)	6.4 (.27)
		No Strategy Review	45	223.6 (13.9)	6.1 (1.9)	6.2 (.29)
Utility Value	Digital	Strategy Review	34	222.3 (12.5)	6.9 (2.2)	7.0 (.34)
		No Strategy Review	42	223.2 (13.3)	6.5 (2.0)	6.5 (.31)
	Paper	Strategy	53	227.2 (11.7)	6.9 (1.7)	6.8 (.25)

Paper	Strategy Review	53	227.2 (11.7)	6.9 (1.7)	6.8 (.25)
	No Strategy	45	223.6 (13.9)	6.0 (2.3)	6.0 (.30)

School 2 only. Levine's Test of Equality of Error Variances was conducted on the School 2 data from the three subjective task value subscales to check the assumption of homogeneity of variance. The results of Levine's Test were not significant for Interest $F(3,137) = .38$, $p > .05$, Attainment Value $F(3, 137) = .92$, $p > .05$, or Utility Value $F(3,137) = p > .05$. The assumptions of linearity were confirmed with a visual inspection of scatter plots of covariate, MAP scores, and dependent variables, Utility Value, Interest, and Attainment Value. Homogeneity of the regression lines was further assessed by testing MAP x modality and MAP x strategy review interactions in a multivariate analysis on subjective task-value. As with the combined data set, when these interactions were tested in a multivariate analysis on subjective task value, neither MAP x modality $F(3, 135) = .70$, $p > .05$, nor MAP x strategy review $F(3,135) = 1.70$, $p > .05$, were significant. Thus, it was assumed that the assumption of homogeneity of regression was not significantly violated.

The omnibus MANCOVA revealed no significant main effects of modality $F(3, 134) = .673$, $p > .05$, $\eta^2 = .015$, strategy use $F(3,134) = 1.86$, $p > .05$, $\eta^2 = .04$, on subjective task value. The interaction was also non-significant $F(3,134) = .60$, $p > .05$, $\eta^2 = .013$. These results indicate that students from School 2 reported comparable levels of task interest, attainment, and utility value regardless of whether they were reading from an iPad or paper and whether or not they had a review lesson on strategy use. Covariate scores, mean subscale ratings, and adjusted mean ratings are presented in Table 12.

Table 12

Mean Measures of Academic Progress (MAP), Subjective Task Value Subscale ratings, and Mean Subscale ratings by Condition at School 2

	Modality	Strategy Condition	N	Mean MAP (SD)	Mean Rating 1-10 (SD)	Adjusted Mean Rating (SE)
Interest	Digital	Strategy Review	33	222.64 (12.50)	6.15 (1.97)	6.21 (.36)
		No Strategy Review	38	224.45 (11.53)	5.39 (2.30)	5.37 (.34)
	Paper	Strategy Review	38	226.47 (11.39)	6.60 (2.10)	6.49 (.34)
		No Strategy Review	32	221.81 (15.54)	5.82 (2.18)	5.91 (.37)
Attainment Value	Digital	Strategy Review	33	222.64 (12.50)	6.77 (1.79)	6.83 (.31)
		No Strategy Review	38	224.45 (11.53)	5.93 (2.08)	5.91 (.29)
	Paper	Strategy Review	38	226.47 (11.39)	6.59 (1.78)	6.68 (.29)
		No Strategy Review	32	221.81 (15.54)	6.34 (1.68)	6.44 (.32)
Utility Value	Digital	Strategy Review	33	222.64 (12.50)	7.09 (1.96)	7.14 (.32)
		No Strategy Review	38	224.45 (11.53)	6.25 (2.00)	6.23 (.30)
	Paper	Strategy	38	226.47 (11.39)	6.91 (1.59)	6.82 (.30)

Review

No Strategy   32   221.81 (15.54)   6.37 (1.96)   6.45 (.33)

Review

Research question # 3: What is the effect of text modality on the use of cognitive strategies? Research question # 3 was addressed with a three-way chi-square test of independence to determine if the use of visible cognitive strategies (annotation) was independent of modality among students who had a lesson in strategy use and those who did not. Separate analyses were conducted for the combined data set and data from School 2 only.

Combined data set. Technology limitations (i.e. poor internet connection and printer malfunctioning) resulted in missing copies of students' readings in the iPad condition. This limitation did not exist for students in the paper condition. Thus, analyses included data from 121 students from the paper condition and 103 students in the iPad condition.

A significance difference in frequency of strategy use was found between modality conditions among students who received the strategy lesson, $\chi2 = 4.55$, *df =1, p = .033*, and among students who did not receive the strategy lesson, $\chi2 = 30.83$, *df =1, p <. 001*. These results indicate that students in the paper condition were more likely to use visible cognitive strategies while reading, regardless of whether or not they received a lesson in strategy use. Among students who received a strategy lesson, 44% of students in the digital condition used an annotation strategy, compared to 64.4% of students in the paper condition. Among students who did not receive a strategy lesson, only 3.8% of students in the digital condition used an annotation strategy while reading, compared to

51.6% of students in the paper condition. The numbers of students who did and did not use annotation strategies by modality are presented in Table 13.

Table 13

Annotation X Modality X Strategy Lesson Contingency Table for Combined Data Set

		Annotation used		Annotation not used		Total
		n	%	*n*	%	*n*
Strategy Lesson	Digital	22	44	28	56	50
	Paper	38	64.4	21	35.6	59
	Total	60	55	49	45	109
No Strategy Lesson	Digital	2	3.8	50	96.2	52
	Paper	32	51.6	30	48.4	62
	Total	34	29.8	80	70.2	114
Total	Digital	24	23.5%	78	76.5%	102
	Paper	51	42.1%	70	57.9%	121
	Total	94	42.2%	129	57.8	223

School 2 only. The chi-square analyses included data from 86 students from the digital condition and 93 students from the paper condition. Among students who received a strategy review lesson, the difference in frequency of visible strategy use was found between modality conditions was not significant, $\chi2 = 3.31, df = 1, p > .05$, indicating that students in the paper and digital conditions were equally likely to use visible cognitive

strategies while reading. Specifically, 44.2 % of students in the digital condition used an

annotation strategy, compared to 63.6 % of students in the paper condition. Among

students who did not receive a strategy lesson, the difference in frequency of visible

strategy use between modality conditions was significant, $\chi 2$ =22.20, df =1, p < .001.

Specifically, 4.7 % of students in the digital condition used an annotation strategy,

compared to 49% of students in the paper condition. The numbers of students who did

and did not use annotation strategies by modality are presented in Table 14.

Table 14

Annotation X Modality X Strategy Lesson Contingency Table for School 2 Data

		Annotation used		Annotation not used		Total
		n	%	*n*	%	*n*
Strategy Lesson	Digital	19	44.2	24	55.8	43
	Paper	28	63.6	16	36.4	44
	Total	47	54	40	45	87
No Strategy Lesson	Digital	2	4.7	41	95.3	43
	Paper	24	49	25	51	49
	Total	34	29.8	80	70.2	92
Total	Digital	21	24.4	65	75.6	86
	Paper	52	55.9	41	44.1	93
	Total	73	40.8	106	59.2	179

Research Question # 4: If the effect of text modality on strategy use is

significant, to what effect is this relationship mediated by self-efficacy and/or subjective task value? The role of self-efficacy and subjective task value as mediating variables in the relationship between modality and strategy use was evaluated by first testing the following prerequisites for a mediating relationship proposed by Baron and Kenny (1986), (a) a significant relationship between the mediating variable (self-efficacy or subjective task value) and independent variable (modality), (b) a significant relationship between mediator (self-efficacy or subjective task value) and dependent variable (strategy use), and (c) a significant relationship between the independent variable (modality) and dependent variable (strategy use). Point biserial correlations were calculated to determine the significance of the preceding relationships (see Table 2) and whether or not additional mediating analyses were necessary.

The resulting correlations indicate that only two of the three requirements were met. The relationships between strategy use and all self-efficacy and subjective task value variables were significant, and the relationship between strategy use and modality was significant. However, the first requirement, of a significant relationship between modality and self-efficacy or subjective task value variables, was not met. Thus, further mediation analyses were not conducted.

Research Question #5: If the effect of text modality on comprehension is significant, to what extent is the relationship mediated by the use of cognitive strategies. Point biserial correlations were calculated to determine the significance of the relationships between the independent, dependent, and potential mediating variables. Although the relationship between modality and strategy use was significant, $r = .35$, $p < .001$, the relationship between modality and comprehension was not significant, $r = -.02$, p

> .05. It was therefore deemed unnecessary to conduct further mediation analyses. Moreover, previous analyses revealed a non-significant effect of modality on comprehension, nullifying the need for further exploration of mediating variables.

Chapter 5

Discussion

The overarching purpose of the current study was to contribute to the understanding of the affordances of tablets related to adolescents' reading comprehension and engagement. Guided by Guthrie et al.'s reading engagement framework (2012), this study looked at the direct effects of text modality on comprehension and engagement variables as well as the relationships between variables to examine the theoretical pathways between strategy use, comprehension, and motivation related to the use of modern tablet devices in education. Results indicated that text modality did affect the degree to which students physically interacted with text, but there was no effect on student comprehension or task motivation. Interpretations of results and implications for research and practice are discussed below.

The first research question addressed the direct effect of text modality on student comprehension of text as well as the effect of a strategy review lesson intended to prime students to use strategies. After controlling for prior reading achievement, there were no significant differences in comprehension among students who were reading on iPads and those who were reading from paper, regardless of whether or not students received a review lesson in comprehension strategies. These findings are consistent with previous studies with elementary students in which no differences in comprehension were found among students reading on mobile devices and paper (Grace, 2011; Milone, 2012). They

are also consistent with earlier research on electronic text, which has found minimal effects on comprehension (Dillon, 1992; Dillon, 2004).

Although differences in comprehension were not found, students who read on the iPad annotated text significantly less than students who read on paper. These results were inconsistent with recent research in which adults reported annotating text on tablet devices to be comparable or easier than paper (Maremarelli & Ringle, 2011; Morris, Brush, & Meyers, 2007). These inconsistencies may be a result of differences in the constructs being measured. Whereas previous studies measured adult perceptions of usability, the current study measured actual use of annotation strategies. Moreover, results from the current study indicate the difference in annotation use between modality conditions was reduced among students who received a strategy review lesson. These results are consistent with those found by Maremarelli and Ringle (2011) in which the quality and quantity of student note-taking on iPads improved with increased use over the course of the semester. Studies of longer duration are therefore necessary to determine if differences in strategy dissipate with further practice.

The observed differences in annotation, but not comprehension, across modality conditions underscore the importance of considering both process and outcome variables (Dillon, 1992). Given a theory of generative comprehension, differences in comprehension would be expected if students in the iPad condition were interacting with the text less than students in the paper condition. The current results may be explained by the use of inefficient strategy use. Specifically, students in the current study relied mostly on underlining and highlighting strategies rather than more elaborative strategies. Differences in comprehension among students who used annotation strategies and those

87

who did not may not be expected if the strategies used were not effective. However, the results of the current study are also consistent with previous literature in which the process and outcome variables of reading electronic text have not always been congruent. For example, despite limited evidence of comprehension differences, adults have reported to spend less time engaged in in-depth reading when reading electronic text and noted concerns of limited affordance for spatial memory, navigation, and annotation (Hillesund, 2010; Liu, 2005; O'Hara & Sellen, 1997; Schilit et al., 1999).

In conjunction with strategy use, reading engagement is theorized to be dependent on motivation, which was conceptualized in this study by self-efficacy and task values (Eccles et al., 1983). The current study found no difference in self-efficacy among students who read on an iPad or paper. The adolescents who participated in this study were equally confident in their ability to read text presented on iPads and paper, which could possibly be explained by arguments of 21st century learners increased use and familiarity with digital media (Rideout, Foehr, & Roberts, 2010; Tapscott, 2009). Specifically, it is conceivable that today's adolescents are so accustomed to using digital technology that they do not perceive differences in their ability to read and comprehend text, regardless of modality. However, students who read on iPads did not report increased self-efficacy over students who read on paper. However, the features of digital technology that have been argued to support self-efficacy, including individualized instruction, opportunities to control and change the nature of academic tasks (Naismith et al. 2004; O'Brien, 2003; Pajares, 2006), may not have been utilized in the current study.

The saliency of digital technology in the lives of today's adolescents has prompted questions of the degree to which young adults' perceptions of task values are

affected when tasks are presented on mobile devices. In the current study, students were asked to complete a reading task on either an iPad or paper and then rate the degree they found the task useful, interesting, or important. The results revealed no difference in perceptions of utility, interest, or attainment value among students who read on the iPad or on paper. Thus, despite their increase use of digital media outside of school, the students in this study who read on iPads did not rate the reading task as more interesting, useful, or important than those who read on paper. Given the amount of time adolescents choose to engage in digital technologies outside of school, it is interesting that students in the current study did not rate the reading task on iPads as more interesting, as interest is related to intrinsic motivation, subjective feelings of pleasure and happiness (Csikszentmihalyi, 1988). However, these findings are congruent with research suggesting students were more interested in using iPads for personal or social purposes than academic purposes (Kinash et al., 2012). Moreover, the finding of equivalent ratings of utility value among students in the iPad and paper conditions is consistent with the findings of two recent studies that suggest young adults want to able to be able to access class material on their mobile devices, but are neutral in the extent to which they perceive mobile devices as being useful or beneficial to their learning (Dahlstorm, 2012; Kinash et al., 2012). An alternative interpretation of these findings is that the way in which iPads were used in the current study did not significantly change the task of reading enough to alter perceptions of interest, utility, or attainment value.

The current study examined both direct and indirect effects of text modality by considering the role of mediating factors. Two mediation analyses were included in the design of this study. The first considered the mediating role of motivation in the

relationship between text modality and strategy use was investigated, as previous

literature has established a relationship between the use of cognitive strategies and the

motivational variables of self-efficacy and task values (Pintrich, 1999). Although

differences in strategy use were found across modality conditions, differences in

motivation variables were not found. It was therefore assumed that the relationship

between modality and strategy use was not mediated by motivation and further mediating

analyses were not conducted. The second mediation analysis included in the design of

this study sought to identify whether or not use of strategies mediated the relationship

between modality and comprehension. However, because differences in comprehension

were not found, the mediating role of strategy use was not further investigated.

Implications for Practice

The results of this study have implications for the use of mobile devices in

education. Tablet computers have been proclaimed to revolutionize digital books in

future years (Abbot & Kelly, 2004; Obst, 2010). However, too often, educators confuse

technology with innovation and quickly infuse the latest gadgets into their classroom

without considering how they will be used to enhance learning (Shepherd, 2008). This

research contributes to a body of empirical research that is necessary in determining the

degree to which mobile technologies support or hinder learning.

Although the current study does not provide evidence of iPads facilitating reading

comprehension, it does provide evidence to suggest that reading on iPads does not hinder

comprehension among high school students. A concern related to iPads in education was

increased distractibility (Maremarelli & Ringle, 2011; Rossing, Miller, Cecil, & Stamper,

2012; Weisburg, 2011). In the current study, students in the iPad condition had access to

other applications while reading, and some students were observed to use the Internet or drawing applications during the reading task. However, comprehension scores were not significantly lower for students who used iPads and had access to these applications than students who read from paper and did not have access to these applications. A possible explanation for this finding relates to the argument that using mobile devices for purposes other than learning is not categorically dissimilar from doodling for 21st century students (Kinash et al., 2012). This argument could be empirically explored with future research comparing actual on-task behaviors in classrooms with and without mobile devices.

Although the results of this study suggest students comprehend equally well regardless of reading from an iPad or paper, they also provide evidence to suggest students may not interact with text presented on mobile devices to the same degree they would on paper text. However, this difference decreased substantially when students received a lesson in which specific strategies were reviewed and annotation features on iPads were taught. Interpreting these results in the context of prior research, in which the quality and quantity of annotations on mobile devices was found to increase with practice (Maremarelli & Ringle, 2011), suggests students may require continued instruction and opportunities to practice note-taking when reading from iPads, and schools should not assume these skills will automatically transfer if learned on paper text.

The results of this study also contribute to an emerging body of research exploring the degree to which 21st century learners value increased technology embedded into instruction. The US Department of Education, Office of Technology (2010) argues that technology is central to students' current life and future careers, and schools must attempt to mirror students' daily lives outside of school. However, it is necessary to first

understand which technologies are perceived to be beneficial to learning and how they

can be used in meaningful ways. The results of this study suggest using iPads for a

stationary reading task was not perceived as being more interesting, important, or useful

than reading on paper, suggesting there is nothing inherent about reading on the iPad that

increases student motivation. These results are consistent with prior research finding

college students perceive mobile devices to be beneficial to academic success, but are not

perceived to be as valuable as other educational technologies such as laptops, desktops,

printers, and thumb drives (Dahlstorm, 2012). A possible explanation is that the novelty

of the software and devices has not afforded educators researchers the opportunity to

explore the full capabilities of mobile devices and the specific ways in which they can be

used to support motivation.

Educators must consider how iPads can be used to facilitate sustained interest and

motivation. The interpretations of this study's results are limited to the specific context in

which iPads were used in this study and had been being used at the participating schools.

It is possible that using iPads for the current reading task did not increase student interest

in the task because students' interest in using iPads was situational. Specifically, the high

interest stimuli of iPads may have initially caught students' attention and interest, but

were not used in a meaningful way that facilitated a deeper interest or intrinsic

motivation. At the time of this study, students had been using the iPads in their

classrooms for three months, and the novelty of the "bells and whistles" of reading on an

iPad may have worn off. It is argued that over time, students will become satiated with

even the most interesting stimuli, and thus it is more important to consider the degree to

which stimuli holds students' attention (Keller & Suzuki, 2004). Learning tasks in which

students are afforded opportunities to take advantage of collaborative and constructivist features of new technologies may have a larger effect on sustained interest and motivation.

Implications for Theory

As mobile devices continue to be incorporated to educational environments, empirical research must be conducted and synthesized in order to guide theories of mobile learning to inform educators how mobile devices can be used to support learning. In the last decade, multiple theoretical frameworks have been suggested to guide the implementation of mobile technology in learning environments, and a common theme across proposed theories is the emphasis on contextual factors. The importance of contextual factors in mobile learning environments was evident in both the current literature and interpretations of results of this study. Specific contextual factors that may affect perceived and actual value of mobile devices in education include device characteristics, familiarity with the device, and specific way in which devices are being incorporated into classrooms. In the current study, more students in the iPad condition opted out or failed to complete the study components at School 1 than School 2, which also corresponds with observed differences in overall familiarity with the device between the two schools. The role of contextual factors in mobile learning theory discourages research that studies the global effect of mobile devices, and warrants further research on how mobile devices can be effectively used in educational environments and the interaction effects of contextual factors.

The results of the current study also question the integration of traditional learning theories and mobile learning theories. This study was guided by well-established theories

of comprehension and engagement that were applied to a reading task on mobile devices. Interestingly, the data obtained in this study are not entirely congruent with a generative theory of comprehension. Specifically, whereas a generative theory of comprehension would support comprehension of text to be related to strategy use, the results of the current study indicate the use of iPads affected strategy use, but not comprehension. Although this discrepancy could be explained by study limitations, which are discussed in the following section, another possible explanation relates to the application of traditional theories of learning to mobile learning environments. Sharples, Tayler and Vavoula (2007) argue that a current theory of mobile learning must be distinct from current theories of classroom learning, suggesting caution when assuming traditional learning theories will apply to mobile learning environments. The appropriateness of traditional theories is further complicated by the notion of emerging technologies continuously changing the construct of reading (Destefano, & LeFeure, 2007). Although the purpose of this study was not to confirm or disprove theories of mobile learning, the results provoke thoughtful considerations for future research related to theories reading applied to modern digital technologies and mobile learning environments.

Limitations

The results of the current study should be interpreted within the context of study limitations. A notable limitation of the current study design, as well as the design of several other studies investigating the effect of mobile learning devices, is the failure to provide participants the opportunity to take advantage of the mobile and ubiquitous learning features of the device. In order to increase feasibility, the timeframe of the study design was limited to two 40-50 minute class periods. Students in both the iPad and

paper condition completed the reading task while sitting at their desks during a designated class period. Thus, the affordance of the iPad to facilitate "anytime, anywhere" learning was not permitted in the study design. This limitation is not unique to the current study, and may be a more systematic concern. In a review of iPad software related to education, Murray and Olcese (2011) described the current educational software as limited in the extent that it takes advantage of the full capabilities of the iPad. Conclusions regarding the degree to which iPads and other mobile devices facilitate reading engagement must be interpreted with caution until studied within a context in which these opportunities are afforded.

A second limitation exists in the limited conceptualizations of strategy use and comprehension. While limited, annotation was chosen as an observable and concurrent measure of strategy use, which have been found to be superior to prospective or retrospective measures of strategy use in predicting reading comprehension (Cromley & Azvedo, 2006). However, this conceptualization of strategy use does not take into account less observable reading strategies such as pre-reading, prediction, visualization, or thought processes that were not annotated. Future research may consider incorporating both observable and retrospective student report measures to account for less observable methods of strategy use. Similarly, measurement of comprehension was limited to responses to multiple-choice questions. Incorporating additional measures of comprehension, such as open-ended questions, cloze tasks, or verbal or written re-tell tasks, may provide a more complete picture of students' comprehension when reading on each modality.

An additional limitation exists in that the degree to which students had been previously exposed to strategy instruction was not formally assessed. This study incorporated a strategy lesson that was intended to be a review to prime students to use strategies on the second day of the study. Given the short duration of the lesson (i.e. 40 minutes), the lesson was not intended to teach new skills. However, in personal communication with staff of the larger participating school, it was revealed that students had not received formal instruction in note-taking strategies, which may explain why the strategy review did not affect student comprehension. Similarly, this study also did not account for the degree to which digital textbooks and readings had been previously incorporated into instruction, which may have also had an effect on results.

A final limitation may exist in the measurement of motivation variables. I excluded items in which students were explicitly asked to compare their attitudes towards reading on iPads and paper to avoid bias. Instead, students were given instructions to answer the items in regards to their attitudes towards the task they just completed, with the assumption students answers would reflect their perceptions of completing the task on the assigned modality. However, it is also possible that students' responses reflected more general attitudes towards reading, rather than the specific task completed. This is a potential limitation of the study and should be considered in future research.

Conclusion

The purpose of this study was to examine the direct and indirect effects of tablets on reading comprehension and engagement and contribute to a broader body of literature on how tablets can be integrated into educational settings to support learning. In the current study, students who read on the iPad engaged physically with the text less than

students who read on paper, but students' comprehension and perceptions of task value, utility, or importance were not affected by reading on an iPad. Interpreting these results in the context of previous research and theory related to mobile learning results in three primary conclusions.

The first conclusion is students' comprehension does not appear to be affected when reading static text on tablets. This result is consistent with a larger body of research suggesting reading tasks on mobile devices in which textual features are similar to print text has little or no effect on comprehension. However, this study does not account for other textual factors that are often incorporated into electronic books such as hyper-text and multi-media, which should be studied specifically in future research.

Second, despite apparent ubiquitous use of media and mobile devices among today's adolescents, simply completing tasks on mobile devices may not alter perceptions of tasks or increase task motivation. However, educators and future researchers should consider the how iPads can be used in more meaningful ways that may have a greater affect on task motivation. Similarly, regardless of technology use outside of school, educators should not assume all academic skills will transfer when asked to apply them to mobile devices. This was evident in the current study when students used significantly less annotation strategies when reading on iPads than paper. This difference was reduced among students who received a 40-minute lesson to review strategies and learn how to use specific features of the device and note-taking application to apply strategies, underscoring the need for explicit instruction on using the device and applications for different purposes.

The current results, when interpreted in the context of and previous research and theory, reiterate the importance of contextual factors. The current study examined the affordances of iPads related to reading comprehension and engagement while used in a static learning environment. Thus, the results should not be interpreted to suggest iPads and mobile learning devices do not have a significant impact on learning outcomes. Alternatively, it is plausible that research has not yet captured the full capabilities of iPads and other mobile devices.   Research of longer duration (e.g. a school year) is necessary in which students are provided the opportunity to take advantage the mobile and connectivity features of the iPad.

The contextual factors that may have the greatest impact on tablet research are time and technological advancements. The current study was conducted within a year and a half of the iPad being introduced and included schools that were among the first in the country to distribute iPads to all students. Since the time this study was conducted, three new versions of the iPad have been released, more schools have incorporated mobile devices into their classrooms, new tablet devices, software and applications have been developed, and more research and support is available for educators, all of which result in an arguable increase in student and teacher familiarity with tablets. The advancing features and applications of tablets and other mobile devices create new opportunities for learning that warrant additional research. However, the same features that excite educators and are believed to transform learning, including instant connectivity and mobility, create challenges for rigorous scientific research. To better understand how dynamic mobile technology can support educational outcomes, the study of mobile technology may require the integration of micro research, or the effectiveness and

usability of specific affordances related to the use of mobile technology in education, and macro research, reflecting the larger impact of mobile devices on learning experiences as a whole (Sharples et al., 2009). In doing so, programs of research can systematically evaluate affordances of specific features of mobile devices as well as their broader impact on education.

References

Abbott, W., & Kelly, K. M. (2004). Sooner or later! Have e-books turned the page? *Proceedings of the 12th VALA Biennial Conference.* Retrieved from http://www.vala.org.au/vala2004/2004pdfs/46AbbKel.PDF

Ainley, M. (2006). Connecting with learning: Motivation, affect, and cognition in interest processes. *Educational Psychology Review, 4,* 391-405.

Alexander, P., Kulikowich, J., & Jetton, T. (1994). The role of subject-matter knowledge and interest in the processing of linear and non-linear texts. *Review of Educational Research,* 64, 201-252.

Alverman, D. (2001). Effective literacy instruction for adolescents. *Journal of Literacy Research,* 34, 189-208.

Appleton, J.J., Christenson, S.L., & Furlong, M.J. (2008). Student engagement with school: critical conceptual and methodological issues of the construct. *Psychology in the Schools, 45, 369-386.*

Appleton, J., Christenson, S.L., Kim, D., & Reschly, A. (2006). Measuring cognitive and psychological engagement: Validation of the Student Engagement Instrument. *Journal of School Psychology, 44,* 427-445.

Azevedo, R. & Cromley, J. (2004). Does training on self-regulated learning facilitate students' learning with hypermedia? *Journal of Educational Psychology,* 93, 523-535.

Azevedo, R., Moos, D., Greene, D., Winters F. & Cromley, J. (2008). Why is externally

    facilitated regulated learning more effective than self-regulated learning with

    hypermedia? *Educational Technology Research and Development, 56,* 45-72.

Baker, L., & Wigfield, A. (1999). Dimensions of children's motivation for reading and

    their relations to reading activity and reading achievement. *Reading Research*

    Quarterly, 34, 452-477.

Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist,*

    44, 1175-1184.

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T.C.

    Urdan (Eds.), *Self-efficacy beliefs of adolescents* (307-337). Charlotte, NC:

    Information Age Publishing Inc.

Baron, R.M., & Kenny, D.A. (1986). The moderator-mediator variable distinction in

    social psychological research: Conceptual, strategic, and statistical considerations.

    Journal of Personality and Social Psychology, 51, 1173-1182.

Bebell, D., (2005). *Technology promoting student excellence: An investigation of the*

    first year of 1:1 computing in New Hampshire middle schools. Boston, MA:

    Technology and

    Assessment Study Collaborative. Retrieved from

    https://center.uoregon.edu/ISTE/uploads/NECC2005/KEY_6592566/Bebell_Bebe

    llNECC2005_RP.pdf

Branchfire, LCC (2010). *iAnnotate* [iPAd application]. Chicago, IL.

Brand, J., Kinash, S., Mathew, T., & Kordyban, R. (2011). iWant does not equal iWill:

Correlates of mobile learning with iPads, e-textbooks, BlackBoard Mobile Learn and a blended learning experience. Proceedings of the *Ascilite Conference*, Hobart Tasmania, Australia. Retrieved from http://www.leishman-associates.com.au/ascilite2011/downloads/papers/Brand-full.pdf

Brophy, J. (2010). *Motivating students to learn* (3rd Edition). New York, NY: Routledge.

Brown, R. S., & E. Coughlin. (2007). *The predictive validity of selected benchmark assessments used in the Mid-Atlantic Region* (Issues & Answers Report, REL 2007–No. 017). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Mid-Atlantic. Retrieved from http://ies.ed.gov/ncee/edlabs

Cardullo, V., Zygouris-Coe, V., Wilson, N. S., Craanen, P. M., Stafford, T. R. (2012). How students comprehend using e-readers and traditional text: suggestions from the classroom. *American Reading Forum Annual Yearbook* [Online], Vol. 32.

Castagnaro, A. (2012). Evaluating sixth graders' self-efficacy in response to the use of educational technology. (Doctoral Dissertation). Retrieved from CGU Theses and Dissertations. (69).

Clarke, L. & Bensory, K. (2010). Connecting the old to the new: What technology crazed adolescents tell us about teaching content area literacy. *Journal of Media Literacy Education,* 2 (1), 47-56.

Cleary, T., & Zimmerman, B. (2012). A cyclical self-regulatory account of student engagement: Theoretical foundations and applications. In S. L. Christenson, A. L.

Reschly, & C. Wylie's (Eds.), *The handbook of research on student engagement* (pp. 237-258). New York: Springer Science.

Corbeil, J.R., & Valdes-Corbeil, M.E. (2007). Are you ready for mobile learning? *Educause, 30,* Retrieved from http://www.learning-centric.net/mobile.cc/relatedinfo.pdf

Corio, J. (2003). Reading comprehension and the Internet: Expanding our understanding of reading comprehension to encompass new literacies. *Reading Teacher, 56,* 458-464.

Cromley, J. G., & Azevedo, R. (2006). Self-report of reading comprehension strategies: What are we measuring? *Metacognition and Learning*, *1*(3), 229-247.

Csikszentmihayi, M. (1988). The flow experience and its significance for human psychology. In M. Csikszentmihayi & I. Csiksentimihayi (Eds.), *Optimal experience: Psychological studies of flow in consciousness* (pp.15-35). Cambridge, United Kingdom: Cambridge University Press.

Culén, A., & Gesparini, A. (2011). iPad: A new classroom technology? A report from two pilot studies. *Proceedings of the INFuture Conference*, 199-208.

Dahlstrom, E. (2012). ECAR Study of Undergraduate Students and Information Technology, 2012. Louisville, CO: EDUCAUSE Center for Applied Research.

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

Deci, E.L., & Ryan, R.M. (1992). The initiation and regulation of intrinsically motivated learning and achievement. A.K. Boggiano, & T.S. Pittman (Eds.), *Achievement*

and motivation: A social-developmental perspective (pp.9-36). New York, NY:

Cambridge University Press.

Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and

education: The self-determination perspective. *The Educational Psychologist*, *26*,

325-34.

Dias, P. & Sousa, A. (1997). Understanding navigation and disorientation in hypermedia

learning environments. *Journal of Educational Multimedia and Hypermedia, 6,*

173-185.

Dole, J. A., Duffy, G. G., Roehler, L. R., & Pearson, P. D. (1991). Moving from the old

to the new: Research on reading comprehension instruction. *Review of*

Educational Research, *61*(2), 239-264.

Destefano, D., & LeFeure (2007). Cognitive load in hypertext reading: A review.

Computers in Human Behavior, 23, 1616-1641.

Dillon, A. (1992). Reading from paper verses screens: A critical review of empirical

literature. *Ergonomics,* 35, 1297-1326.

Dillon, A. (2004). *Designing usable electronic text*. Boca Raton, FL: CRC Pressl LLC.

Doctorow, M., Wittrock, M. C., & Marks, C. (1978). Generative processes in reading

comprehension. *Journal of Educational Psychology*, *70*(2), 109-118.

Duke, N., & Pearson, D. (2002). Effective practices for developing reading

comprehension, in A. Farstrup & J. Samuels (Eds.), *What Research has to Say*

About Reading 3rd ed., pp. 205-244)*.* Newark, DE: International Reading

Association.

Dyson, M. (2004). How physical text layout affects reading from screen. *Behavior and Information Technology,* 23, 377-393.

Eccles, J. (2005). Subjective task value and the Eccles et al. model of achievement related choice. In A. Elliot, & C. Dweck (Eds.), *Handbook of Competence and Motivation* (pp. 105-121). New York: The Guilford Press.

Eccles, J., S., Adler, T.F., Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J.T. Spence (Ed.), *Achievement and Achievement motivation* (pp. 75-146). San Francisco, CA: W.H. Freeman.

Eccles, J., & Midgley, C. (1989). Stage-environment fit: Developmentally appropriate classrooms for young adolescents. In C. Ames & C. Ames (Eds.), *Research on motivation in education (pp. 139-186)*. New York: Academic Press.

Eccles, J., & Wigfield, A. (2002). Motivational beliefs, values, goals. *Annual Review of Psychology.* 53,109-132.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin*, 3, 215-225.

Finkel, S., & Aspey, S. (2011). New Survey: Students who own tablets more likely to favor digital textbooks. *Pearson Foundation.* Retrieved from http://www.pearsonfoundation.org/pr/new-survey-students-who-own-tablets-more-likely-to-favor-digital-textbooks.html

Georgiev, T, Georgieva, E., & Smirkarov, A. (2004). M-learning- a new stage of e-learning. Proceedings from the *International Conference on Computer System and*

Technologies, Roussse, Bulgaria. Retrieved April, 2, 2011 from

http://ecet.ecs.ru.acad.bg/cst04/Docs/sIV/428.pdf

Grace, K.E. (2011). *Comparing the iPad to paper: Increasing comprehension in the digital age.* (Doctoral dissertation). Bowling Green State University, Bowling Green, OH.

Gregory, C. (2008). "But I want a real book": An investigation of undergraduates' usage and attitudes towards electronic books. *Reference and User Service Quarterly, 47,* 266-273.

Gupta, B., & Koo, Y. (2010). Applications of mobile learning in higher education: An empirical study. *International Journal of Information and Communication Technology Education (IJICTE)*, *6*(3), 75-87.

Guthrie, J., & Wigfield, A. (2000). Engagement and motivation in reading. In M.L. Kamil, P.B. Mosenthal, P.D Pearson & R. Barr (Eds.). *Handbook of Reading Research (*Vol.3, pp. 404-422). New York: Erlbaum.

Guthrie, J., Wigfield, A., Barbosa, P., Perencevich, K., Taboada, A., Davis, M., Scafiddi, N., & Tonks, S. (2004). Increasing reading comprehension and engagement through concept-oriented reading instruction. *Journal of Educational Psychology,* 96, 403-423.

Guthre, J., Wigfield, A., Humenick, N., Perencevich, K., Taboada, A., & Barbosa, P. (2006). Influences of stimulating tasks on reading motivation and comprehension. *Journal of Educational Research, 99,* 232-245.

Guthrie, J. T., Wigfield, A., & You, W. (2012). Instructional contexts for engagement and achievement in reading. In S.L. Christenson, Amy L. Reschly, & C. Wylie

(Eds.), *Handbook of research on student engagement* (pp. 601-634). New York: Springer US.

Harwell, M.R., & Gatti, G.G. (2001). Rescaling ordinal data to interval data in educational research. *Review of Educational Research,* 71, 105-131.

Hidi, S. (1990). Interest and its contribution as a mental resource for leaning. *Review of Educational Research, 60,* 549-571.

Hidi, S., & Harackiewicz, J. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research, 70,* 151-179.

Hido, S., & Renninger, K.A. (2006). The four phase model of interest development. *Educational Psychologist, 41,* 111-127.

Hillesund, T. (2010). Digital reading spaces: How expert readers handle e-books, the web, and electronic paper. *First Monday, 15*(4). Retrieved from http://firstmonday.org/article/view/2762/2504

International Society for Technology in Education (2007). *The ISTE NETS and performance indicators for students (NETS•S).* Retrieved from http://www.iste.org/standards/nets-for-students.aspx.

Januszewski, A., & Molenda, M. (2008). *Educational Technology: A definition with commentary.* New York: Lawrence Erlbaum Associates.

Johnson, L., Adams, S., & Cummins, M. (2012). *The NMC Horizon Report: 2012 Higher Education Edition*. Austin, Texas: The New Media Consortium.

Johnson, L., Adams, S., & Cummins, M. (2012). *The NMC Horizon Report: 2012: K-12 Edition*.

Kamil, M. L., Borman, G. D., Dole, J., Kral, C. C., Salinger, T., and Torgesen, J. (2008). *Improving adolescent literacy: Effective classroom and intervention practices: A*

Practice Guide (NCEE #2008-4027*)*. Washington, DC: National Center for Education Evaluation.

Keller, J., & Suzuki, K. (2004). Learner motivation and e-learning design: A multinationality validated process. *Learning, Media, & Technology, 3,* 229-239.

Kim, J., Farzan, R., Brusilovsky, P. (2008). Social navigation and annotation for electronic books. Proceeding of the 2008 ACM workshop on research advances in large digital book repositories. New York, NY: ACM.

Kim, P., Hagashi, T., Carillo, L., Gonzalez, I., Makany, T., Lee, B., & Gàrate, A. (2010). Socioeconomic strata, mobile technology, and education: A comparative analysis. *Educational Technology Research and Development,* 59, 465-486.

Kim, H., & Kamil, M. (2002). Successful uses of computer technology for reading instruction. In M. Kamil, J. Manning, and H. Wolberg (Eds.), *Successful Reading Instruction* (pp.11-22)*.* Greenwich, Connecticut: Information Age Publishing

Kinash, S., Brand, J., Mathew, T. & Kordyban, R. (2011). Uncoupling mobility and learning: when one does not guarantee the other. In R. Kwan, P. Tsang, F.L. Wang, K.C. Li (Eds.), *Enhancing learning through technology. Education unplugged: Mobile technologies and Web 2 (*pp. 342-350). Berlin: Springer.

Kinash, S., Brand, J., & Mathew, T. (2012). Challenging mobile learning discourse through research: Student perceptions of Blackboard Mobile Learn and iPads. *Australasian Journal of Educational Technology*, *28*, 639-655.

Koole, M. L. (2009). A model for framing mobile learning. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training* (pp. 25-47). Edmonton, Alberta: AU Press.

Landoni, M. (2008). The active reading task: E-books and their readers. Proceeding of the 2008 ACM workshop on research advances in large digital book repositories. New York, NY: ACM.

Larson, L. C. (2010). Digital readers: The next chapter in e-book reading and response. *The Reading Teacher*, *64*(1), 15-22.

Leech, N., Barrett, K., & Morgan, G. (2005). *SPSS for intermediate statistics: Use and interpretation-2nd edition*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Lennon, C., & Burdick, H. (2004). *The Lexile Framework as an approach for reading measurement and success.* Durham, NC: MetaMetrics. Inc.

Lepper, M. (1985). Microcomputers in Education: Motivation and Societal Issues. *American Psychologist, 40*, 1-18.

Leu, D. J. (2000). Literacy and technology: Deictic consequences for literacy education in an information age. In M.L. Kamil, P.Mosenthal, P.D. Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. *3*, pp. 743-770). Mahway, NJ: Erlbaum/

Li, C., Poe, F., Potter, M., Quigley, B., & Wilson, J. (2011). *UC Libraries academic e-book usage survey.* University of California: Springer e-Book Pilot Project Reader Assessment Subcommittee.

Linden, M., & Wittrock, M. C. (1981). The teaching of reading comprehension according to the model of generative learning. *Reading Research Quarterly*, 44-57.

Lipsman, A., & Aquino, C. (2013). *2013 Mobile future in focus*. comScore. Retrieved

from

http://www.comscore.com/Insights/Presentations_and_Whitepapers/2013/2013_
[Mobile_Future_in_Focus](http://www.comscore.com/Insights/Presentations_and_Whitepapers/2013/2013_Mobile_Future_in_Focus)

Liu, Z. (2005). Reading behavior in the digital environment: Changes in reading behavior

over the past 10 years. *Journal of Documentation,* 61, 700-712.

Low, L., & O'Connell, M. (2006). Learner-centric design of digital mobile learning.

Proceedings of the OLD Conference Learning on the Move. Brisbane, Australia.

Maehr, M., & Meyer, H. (1997). Understanding motivation and schooling: Where we've

been, where we are, and were we need to go. *Educational Psychology Review, 9,*

371-409.

Manuguerra, M., & Petocz, P. (2011). Promoting student engagement by integrating new

technology into tertiary education: The role of the iPad. *Asian Social Science*,

7(11), 61-65.

Marmarelli, T., & Ringle, M. (2009). *The Reed College Kindle study*. Portland, OR: The

Reed Institute.

Marmarelli, T., & Ringle, M. (2011). *The Reed College iPad study*. Portland, Oregon:

The Reed Institute.

Marshal, C. (2010). *Reading and Writing the Electronic Book.* Chapel Hill, North

Carolina: Morgan and Claypool Publishers.

Martin, A. (2007). Examining a multidimensional model of student motivation and

engagement using a construct validation approach. *British Journal of Educational*

Psychology, 77, 413-440.

Mastropieri, M., & Scruggs, T. (1997). Best practices in promoting reading

    comprehension in students with reading disabilities 1976-1996. *Remedial and*

    Special Education,18, 198-212.

Mayer, R. (2002). Multimedia learning. *Psychology of Learning and Motivation.* 41, 85-

    139.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia

    learning. *Educational psychologist*, *38*(1), 43-52.

Melhuish, K., & Falloon, G. (2010). Looking to the future: M-learning with the iPad.

    Computers in New Zealand Schools: Learning, Leading, Technology, 22(3), 1-6.

MetaMetrics, (2012). *Lexile-to-grade correspondence.* Retrieved from

    http://www.lexile.com/about-lexile/grade-equivalent/grade-equivalent-chart/

Milman, N. B., Carlson-Bancroft, A., & Boogart, A. V. (2012). iPads in a PreK-4th

    Independent School–Year 1–Enhancing Engagement, Collaboration, and

    Differentiation across Content Areas. Paper presented at ISTE conference. San

    Diego, CA.

Milone, M. (2011). *Student comprehension of books in Kindle and traditional format*.

    Madison, WI: Renaissance Learning.

Mitchell, M. (1993). Situational interest: Its multifaceted structure in the secondary

    school mathematics classroom, *Journal of Educational Psychology, 85,* 424-436.

Mistler-Jackson, N. & Songer, M.B. (2000). Student motivation and Internet technology:

    Are students empowered to learn science? *Journal of Research in Science*

    Teaching, 5, 459-479.

Morris, M.R., Brush, A.B., & Meyers, B. (2007). Reading revisited: Evolving the

    usability of digital display surfaces for active reading tasks. In *Proceedings of*

    IEEE TABLETOP 2007, 79-86.

Multon, B., Brown, S., & Lent, R. (1991). Relation of self-efficacy beliefs to academic

    outcomes: A meta-analytical investigation. *Journal of Counseling Psychology, 38,*

    30-38.

Murphy, G. (2011). Post PC Devices: A summary of early iPad technology adoption in

    tertiary environments. *e-Journal of Business Education and Scholarship of*

    Teaching, 5(1) 18-32.

Murphy, K.P., & Alexander, A.A. (2000). A motivated exploration of motivation

    terminology. *Contemporary Educational Psychology, 25,* 3-53.

Murray, O. T., & Olcese, N. R. (2011). Teaching and Learning with iPads, Ready or Not?

    TechTrends, *55*(6), 42-48.

Naismith, L., Lonsdale, P., Vavoula, G., & Sharples, M. (2004). *Literature review in*

    mobile technologies and learning. Bristol, UK: Future Lab.

Nakamura, J. & Csikszentmihalyi, M. (2002). The concept of flow. In C.R. Snyder & S.J.

    Lopez (Eds.), *Handbook of Positive Psychology (*pp. 89 -105)*. Oxford, NY:

    Oxford University Press.

Nuance Communications. (2012). *PaperPort Notes* [iPad application].

O'Brien, D. (2003, March). Juxtaposing traditional and intermedial literacies to redefine

    the competence of struggling adolescents. *Reading Online, 6*(7). Retrieved from

    http://www.readingonline.org/newliteracies/lit_index.asp?HREF=obrien2/

O'Brien, D., & Voss, S. (2011). Reading multimodally: What is afforded? *Journal of Adolescent & Adult Literacy*, *55*(1), 75-78.

Obst O. (2010). Emerging challenges- iPad and textbooks. *Journal of the European Association for Health Information and Libraries, 6(3),* 39-40.

O'Hara, K., & Sellen, A. (1997, March). A comparison of reading paper and on-line documents. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 335-342). ACM.

Olejnik, S.F., & Algina, J. (1984). Parametric ANCOVA and the rank transform ANCOVA when the data are conditionally non-normal and heteroscedastic. *Journal of Educational and Behavioral Statistics,* 9, 129-149.

Pajares, F. (2006). Self-efficacy during childhood and adolescence: Implications for teachers and parents. In T. Urdan, & F. Pajares (Eds.), *Self-efficacy beliefs of adolescents (*pp. 339-367). Greenwich, CT: Information Age Publishing.

Park, Y. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *The International Review of Research in Open and Distance Learning,* 12(2), 78-102.

Partnership for 21st Century Skills (2011). *Framework for 21st Century Learning*. Retrieved from: http://www.p21.org/storage/documents/1.__p21_framework_2-pager.pdf

Pearson Foundation. (2011). Survey on students and tablets. Retrieved from http://www.pearsonfoundation.org/downloads/PF_Tablet_Survey_Summary.pdf

Penuel, W.R. (2005). *Research: What is says about 1 to 1 learning*. Cupertino, CA: Apple Computer.

Pintrich, P. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research, 31,* 459-470.

Pintrich, P.R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95,* 667-686.

Pintrich, P.R., & DeGroot, E.V. (1990). Motivation and self-regulating learning component of classroom academic performance. *Journal of Educational Psychology, 82,* 33-40.

Randel, J., Morris, A., Wetzel, D., & Whitehill, B. (1992). The effectiveness of games for educational purposes: A review of recent research. *Simulations and Gaming, 23,* 261-276.

Rainie, L., & Duggan, M. (2012). *E-book reading jumps; Print book reading declines.* Washington, DC: Pew Research Center.

Ravenscroft, A. (2001). Designing e-learning interactions in the 21st century: Revisiting and rethinking the role of theory. *European Journal of Education*, *36*(2), 133-156.

Reeves, T.C. (1998). *The impact of media and technology in schools.* Georgia: The Bertelsmann Foundation.

Rideout, V., Foehr, U., & Roberts, D. (2010). *Generation of M^2 Media in the lives of 8-18 year olds: A Kaiser Family Study*. Retrieved on February 28 from kff.org

Rockman et al. (1997). *Report of a laptop program pilot: A project for Anytime Anywhere Learning by Microsoft Corporation Notebooks for Schools by Toshiba America Information Systems*. San Francisco, CA: Rockman et al.

Rockman et al. (1998). *Powerful tools for schooling: Second year study of the laptop program – A project for Anytime Anywhere Learning by Microsoft Corporation Notebooks for Schools by Toshiba America Information Systems*. San Francisco, CA: Rockman et al.

Rockman et al. (2000). *A more complex picture: Laptop use and impact in the context of changing home and school access – the third in a series of research studies on Microsoft's Anytime Anywhere Learning program*. San Francisco, CA: Rockman et al.

Rockman, S. (2007). It's my laptop. *Threshold, 1,* 24-28 obtained January 25, 2011 from: www.ciconline.org.

Rosen, L. (2010). Welcome to the iGeneration! *Education Digest: Essential Readings Condensed for Quick Review*, *75*(8), 8-12.

Rossing, J., Miller, W., Cecil, A., & Stamper, S. (2012). iLearning: The future of higher education? Student perceptions on learning with mobile tablets. *Journal of the Scholarship of Teaching and Learning,*12(2), 1-26.

Rowland, I., Nikolas, D., Jamali, H. & Huntington, P. (2007). What do faculty and students really think about e-books? *Aslib Proceedings, 59(6),* 489-511.

Salvia, J., Ysseldyke, J., & Bolt, S. (2010). *Assessment: In special and inclusive education (11th edition)*. Belmont, CA: Wadsworth Publishing Company.

Schilit, B., Price, M.N., Golovchinsky, G., Tanaka, K., & Marshall, C. (1999). The reading appliance revolution. *Computer,* 32(1), 65-73.

Selwyn, N. (2010). Looking beyond learning: Notes toward the critical study of educational technology. *Journal of Computer Assisted Learning,* 26, 65-73.

Shapiro, A., & Niederhauser, D. (2004). Learning from hypertext: Research issues and

findings. In D. H. Jonassen (Ed.), *Handbook of research on educational

communications and technology (*pp. 6-5-620). Mahwah, NJ: Lawrence Erlbaum

Associates.

Shaw, R., & Mitchell-Olds, T. (1993). ANOVA for unbalanced data: An overview.

Ecology, 74,1638-1645.

Sharples, M., Milrad, M., & Vavoula, G. (2009). Mobile learning: Small devices, big

issues. In N. Balacheff, S. Ludvigsen, T. de Jong, & S. Banes (Eds.), *Technology

Enhanced Learning: Principles and Products* (pp. 233-249). Heidelberg,

Germany: Springer.

Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age.

In R. Andrews C. & Haythornthwaite (Eds.), *The Sage Handbook of Elearning

Research* (pp. 221-247). London: Sage.

Shepperd, J.A., Grace, J.L., & Koch, E.J. (2008). Evaluating the electronic textbook: Is it

time to dispense with the paper text? *Teaching of Psychology, 35,* 2-5.

Sheppard, D. (2011). Reading with iPads- The difference makes a difference. *Education

Today,*3, 12-15.

Shin, D. (2011). Understanding e-book users: Uses and gratification expectancy model.

New Media & Society, 13, 260-278.

Siegenthaler, E., Wurtz, P., & Groner, R. (2010). Improving the usability of e-book

readers. *Journal of Usability,* 6(1), 25-38.

Simpson, M. L., & Nist, S. L. (1990). Textbook annotation: An effective and efficient

study strategy for college students. *Journal of Reading*, 122-129.

Skinner, E. A., Kindermann, T. A., Connell, J. P., & Wellborn, J. G. (2009). Engagement and disaffection as organizational constructs in the dynamics of motivational development. In K. Wentzel, & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 223-245). New York: Routledge.

Snow, C. (2002). *Reading for understanding: Toward a research and development program in reading comprehension.* RAND: Santa Monica, CA.

Souvignier, E., & Mokhlesgerami, J. (2006). Using self-regulation as a framework for implementing strategy instruction to foster reading comprehension. *Learning and instruction*, *16*(1), 57-71.

Spektor-Levy, O., Menashe, K., Doron, E., & Raviv, D. (2010). Learning with personal laptops in school: Benefits & gains, obstacles & constraints: Following a longitudinal study. *Proceedings of the Chais conference on instructional technologies research 2010: Learning in the technological era.* Raanana: The Open University of Israel.

Stipek, D., & Iver, D. M. (1989). Developmental change in children's assessment of intellectual competence. *Child Development*, 521-538.

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*, 99-112.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics (5th ed.).* Boston, MA: Pearson Education Inc.

Tapscott, D. (1999). Educating the net generation. *Educational Leadership,* 56(5) 6-11.

Tapscott, D. (2009). *Grown up digital.* New York: McGraw-Hill.

Torgesen, J., Houston, D., & Rissman, L. (2007). *Improving literacy in middle and high schools: A guide for principles.* Portsmouth, NH: RMC Research Corporation, Center on Instruction.

U.S. Department of Education, Office of Educational Technology. *Transforming American Education: Learning Powered by Technology.* Washington, D.C., 2010.

Uden, L. (2007). Activity theory for mobile learning. *International Journal of Mobile Learning and Organization*,1, 81-102.

Vaughn, S. Fletcher, S., Francis, D., Denton, C., Wanzek, J., Wexler, J., Cirino, P., Barth, A., & Romain M. (2008). Response to intervention with older students with reading difficulties. *Learning and Individual Differences,* 18, 338-345.

Verhallen, M. J. A. J., Bus, A. G., & de Jong, M. T. (2006). The promise of multimedia stories for kindergarten children at risk. *Journal of Educational Psychology*, *98*(2), 410- 419.

Virginia Department of Education. (2011). Beyond Textbooks: Year one report. Richmond, VA: Author. Retrieved from http://www.lwbva.org/Year_One_Beyond_Textbooks_Report.pdf.

Warschauer, M. (1995). *Computer-mediated collaborative learning: Theory and practice.* (Research Note #17). Honolulu, HI: University of Hawaii, Second Language Teaching and Curriculum Center.

Weinstein, C. E., Husman, J., & Dierking, D. R. (2000). Self-regulation interventions with a focus on learning strategies. In M. Boekaerts, P. Pintrich, & M. Seidner (Eds.), *Self-regulation: Theory, research, and applications* (pp. 727–747). Orlando, FL: Academic Press.

Weinstein, C. & Mayer, R. (1986). The teaching of learning strategies. In M. Wittrock

(Ed.) *Handbook of Research on Teaching* (3rd ed.). New York: Macmillan.

Weinstein, C. E., & Meyer, D. K. (1991). Cognitive learning strategies and college

teaching. *New Directions for Teaching and Learning*, 1991(45), 15-26.

Weisburg, M. (2011). Student attitudes and behaviors towards digital textbooks.

Publishing Research Quarterly, 27, 188-196.

Wenger, M., & Payne, D. (1996). Comprehension and retention of nonlinear text:

Considerations of working memory and material-appropriate processing. *The

American Journal of Psychology, 109,* 93-130.

Wigfield, A. (1994). Expectancy-value theory of achievement *motivation*: A

developmental perspective. *Educational Psychology Review,* 6(1), 49-78.

Wigfield, A. (2004). Motivation for reading during the early adolescent and adolescent

years. In D. Strickland, & D. Alvermann (Eds.), *Bridging the literacy

achievement gap, grades 4-12* (pp. 56-69). New York: Teacher's College,

Columbia University.

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A

theoretical analysis. *Developmental Review*, *12*, 265-310.

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement

motivation. *Contemporary Educational Psychology*, *25*(1), 68-81.

Wigfield, A., & Guthrie, J. (1997). Relations of children's motivation for reading to the

amount and breadth of their reading. *Journal of Educational Psychology, 89,* 420-

432.

Wigfield, A., Guthrie, J., Perencevich, K., Taboada, A., Klauda, S.L, McRrae, A., & Barbosa, P. (2008). The role of reading engagement in mediating effects of reading comprehension instruction on reading outcomes. *Psychology in the Schools,* 45, 432- 445.

Wigfield, A., Tonks, S, Klauda, S. (2009). Expectancy value theory. In K.R. Wentzel, & A. Wigfield (Eds.), *Handbook of motivation at school (*pp. 55-75)*.* New York, NY: Routledge.

Wittrock, M. C. (1989). Generative processes of comprehension. *Educational Psychologist*, *24*(4), 345-376.

Wittrock, M. C., & Alesandrini, K. (1990). Generation of summaries and analogies and analytic and holistic abilities. *American Educational Research Journal*, *27*(3), 489-502.

Ziefle, M. (1998). Effects of display resolution on visual performance. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 40, 554-568.

Zimmerman, B. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology,* 25, 82-91.

Zimmerman, B., Bandura, A., & Martinez-Pons (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal,* 29, 666-676.

Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology*, *80*, 284-290.

Zucker, T. A., Moody, A. K., & McKenna, M. C. (2009). The effects of electronic books on pre-kindergarten-to-grade 5 students' literacy and language outcomes: A research synthesis. *Journal of Educational Computing Research*, *40*(1), 47-87.

Appendix A

Self-Efficacy Scale

ID _____

Gender _____

Instructions:
Think about the text you just read. If given another text **like the one you just read**, rate your confidence in your ability to complete the following tasks.

Rate your degree of confidence by recording a number between 0-10 using the following scale

0	1	2	3	4	5	6	7	8	9	10
Cannot do					Moderately					Highly certain
at all					Can do					can do

Confidence
0-10

	Confidence 0-10
Stay focused while reading	
Read the words easily	
Understand the meaning of the words	
Identify the main idea of what I read	
Re-tell what I read in my own words	
Comprehend what I read	
Use strategies to help me remember what I read	
Use strategies when I read something difficult that I don't understand	
Take notes while I'm reading	
Use my notes to study for a test	
Remember what I read for a test	

Appendix B

Subjective Task Value Scale

Instructions
Please answer the following questions in regard to your attitude towards reading history texts **similar to the ones you just completed**.

Interest-Enjoyment

In general, how interesting would you rate reading history texts like the ones you just read?

1   2   3   4   5   6   7   8   9   10
Very Boring   Very Interesting

How much did you like reading the history texts that you just read?

1   2   3   4   5   6   7   8   9   10
Strongly Dislike   Strongly Liked

Compared to other class assignments, how much did you enjoy this reading task?

1   2   3   4   5   6   7   8   9   10
Did not enjoy at all   Very much enjoyed

Attainment Value

To what extent is reading history texts like the ones you just read worth your time?

1   2   3   4   5   6   7   8   9   10
Not at all worthwhile   Very worthwhile

How important is it to you that you read this type of text for history class?

1   2   3   4   5   6   7   8   9   10
Not important   Very Important

Compared to other assignments in history class, how important is this type of reading task?

1   2   3   4   5   6   7   8   9   10
Not important   Very Important

Utility Value

If your history teacher gave you a reading task similar to the one you just read, how useful would it be in helping you do well in history class?

1	2	3	4	5	6	7	8	9	10

Not at all useful   Very Useful

To what degree will this type of reading task be useful after you graduate high school?

1	2	3	4	5	6	7	8	9	10

Not at all useful   Very Useful

To what degree will similar reading activities be useful in your life outside of school?

1	2	3	4	5	6	7	8	9	10

Not at all useful   Very Useful

Appendix C

Comprehension Measure

Please answer the following questions about the readings you just read.

1. Which of the following statements best describes the attitude toward Japanese Americans in the 1940s:
    a. Prejudice towards Japanese Americans began after the attack on Pearl Harbor
    b. Prejudice toward Japanese Americans worsened following the attack on Pearl Harbor
    c. Japanese Americans were not associated with the attack on Pearl Harbor
    d. Prejudice towards Japanese Americans was primarily directed toward those living on the West Coast or Hawaii

2. The imprisonment of Japanese Americans was driven by:
    a. An analysis of military conditions
    b. Evidence of treason committed by the Japanese Americans
    c. Fears of Japanese Americans serving as spies in the U.S.
    d.   All of the above

3. The attack on Pearl Harbor occurred 70 years ago. Based on what you have read, how might treatment toward Japanese Americans be different if the attack occurred today?
    a. There would be no mistreatment today because of the Civil Liberties Act of 1988
    b. We live in a different era and there is no longer prejudice based on race, religion, or culture
    c. Suspicion of Muslim Americans following 9/11 suggests there would be mistrust of Japanese Americans
    d. Japanese Americans would likely be treated similarly to Muslim Americans following 9/11 and would therefore be detained

4. The author uses the term irony to describe the situation in which
    a. Japan attacked a country where Japanese Americans live
    b. Japanese Americans were being incarcerated by the U.S. Government on threats of treason while their sons fought for the United States
    c. The living conditions in detainment camps were not fit to live in
    d. Most of the imprisoned Japanese Americans were deceased by the time the Civil Liberties Act was passed

5. Franklin D. Roosevelt signed Executive Order 9066 that resulted in:
    a. An apology to Japanese Americans
    b. Treason committed by the Japanese Americans
    c. Exclusion and imprisonment of Japanese Americans
    d. The banning of incarceration based on race

6. In what year was Executive Order 9066 signed into law?
   a. 1988
   b. 1936
   c. 1944
   d. 1942

7. Which word best describes the condition of the detainment centers in the 1940s?
   a. Awful
   b. Modest
   c. Comfortable
   d. Illegal

8. Which of the following statements is true about the Japanese Americans when they were released from prison?
   a. Most Japanese Americans were able to regain their homes and businesses
   b. Prejudice toward Japanese Americans had decreased
   c. Despite how Japanese Americans were treated, they maintained their faith in the U.S. Government
   d. Many Japanese Americans continued to be treated unfairly and lived in poverty

9. Which president enacted the Civil Liberties Act?
   a. John F Kennedy
   b. Franklin D. Roosevelt
   c. George H.W. Bush
   d. Ronald Reagan

10. How did the courts respond when challenged about the legality of the Japanese internment camps?
    a. The wartime courts supported the hysteria
    b. The Supreme Court ruled that he denial of civil liberties based on race and national origin were legal
    c. The Supreme Court ruled that a loyal citizen could not be detained
    d. All of the above

11. The passing of the Civil Liberties Act in 1988 resulted in:
    a. The justification of forcing of Japanese Americans into confinement during WWII
    b. An apology to all Japanese Americans who were confined
    c. A law stating that the exclusion and incarceration based on race and national origin were illegal
    d. None of the above

12. The article recites a quote from a Muslim missionary saying that the September 11th attacks hijacked the faith of Islam. What does the missionary mean by this?
    a. Islam is becoming increasingly popular among Americans
    b. The Islam religion is frequently associated with terrorism
    c. Muslims were the primary targets of the September 11th attacks
    d. Several Islamic Masques have been vandalized since September, 11, 2001

13. How has the September 11th attacks affected the lives of Muslim Americans?
    a. Increased surveillance at airports
    b. Increased suspicion and mistrust among fellow Americans
    c. Branding of their religion and culture
    d. All of the above

14. According to the readings, what important fact about the September 11th attacks has "gotten lost"?
    a. The majority of Muslims did not condone the attacks
    b. The attack happened 10 years ago
    c. Muslims were once welcome in the United States
    d. Only 20% of Muslims worldwide live in the Middle East

15. According to the readings, which of the following words best describes Americans' attitudes towards Islam before September 11th?
    a. Hostile
    b. Impartial or neutral
    c. Suspicious
    d. Intolerant

16. What similarities are there between Japanese Americans during WWII and Muslim-Americans after 9/11/01?
    a. Both groups have been incarcerated following attacks on the United States
    b. Both groups have been mistreated because of their identification with a specific race, religion, or culture
    c. Both groups have been exiled for committing treason against the United States
    d. Both groups faced increase surveillance at airports

17. From what perspective is the article on American Muslims written?
    a. Family members of 9/11 victims
    b. Muslims associated with the 9/11 attacks
    c. Americans who believe Muslims should be exiled
    d. Primarily American Muslims

18. How is the situation different for Muslim Americans today than Japanese Americans in the 1940s?
    a. Muslim Americans are not being associated with the attacks of 9/11
    b. Suspicion of Muslim Americans is primarily being driven by the general public, not the government
    c. Japanese Americans were actually guilty of treason during WWII whereas there has not been documentation of treason among Muslim Americans
    d. Muslim Americans are still patriotic

19. How has the recent Muslim American experience demonstrated a shift in public opinion and tolerance of other cultures?
    a. Increased suspicion of Muslim Americans suggests tolerance for other cultures has decreased in the last decade
    b. There is still suspicion of other cultures but there is more open debate and less wide spread hysteria than in the past
    c. The similarities between the Muslim American experiences and those of the Japanese Americans suggest public opinion and tolerance has not changed
    d. The Civil Liberties act of 1988 ended intolerance of other cultures

20. According to the readings, what can Muslims do to improve the outside view of their culture?
    a. Encourage non-Muslims to learn more about the Islamic faith
    b. Increase political involvement
    c. Comply with increased surveillance
    d. Demonstrate patriotism by increased acts of community service

Appendix D

Treatment Fidelity Checklist

Treatment Integrity Checklist

Introduce self and purpose of presentation	
Ask students about their own experience with reading	
Introduce and define strategies	
Introduce and define annotation	
Explain why annotation is important	
Digital Only: Explain annotation tools in annotation application	
Explain process of reading a paragraph before annotating	
Introduce strategy 1: Clarification	
Provide a purpose for clarification	
Model clarification	
Give students opportunity to practice clarification and ask for examples	
Introduce strategy 2: Finding the main idea	
Provide a purpose for finding the main idea	
Model finding the main idea	
Give students opportunity to practice finding the main idea	
Introduce strategy 3: highlighting/ underlining	
Provide purpose for highlighting/underlining	
Model highlighting/	

underlining	
Provide opportunity for students to practice highlighting/underlining	
Introduce strategy 4: making connections	
Provide purpose for making connections	
Model making connections	
Provide opportunity for students to practice making connections	
Introduce strategy 5: Questioning	
Provide a purpose for questioning	
Give examples of question stems	
Model Questioning	
Provide opportunity for students to model questioning strategy	
Encourage students to practice reading next time they are given a reading assignment	