The Affordances of Multimodal Texts and Their Impact on the Reading Process

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Dedication

This study is dedicated to Tzitel, Jacob, Ceceilia, and Lydia whose dedication and

support have been unconditional.

Abstract

This mixed methodology study examines how students interact (and transact) with texts across modalities as evidenced by comprehension performance. In addition, it examines their perceptions of the texts and reading processes across each modality. The first phase of this study included a controlled experiment of 90 high school students. Using a passage from their Earth Science textbook, students were asked to read the text off the screen, use the assigned affordance (print only, print and audio, or print and video), and complete both comprehension and self-efficacy items. Analysis of this data showed that there were no statistically significant differences across the three treatments for either the comprehension or self-efficacy measures. The second phase of the study included a guided interview with 27 students. Employing the interpretive analysis of Grounded Theory, these interviews showed that students who successfully navigated these modalities were able to both perceive the affordances and strategically utilize them. This study holds implications for the notion of what an affordance is, how teachers use online digital textbooks, and how publishing companies design and format digital versions of their texts.

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Chapter 1

Introduction

According to Ancient Greek Mythology, Midas made the mistake of overreaching. Instead of simply asking for riches and fortune, he asked that everything he touched be turned to gold, thus making him the richest man in the world. The gods honored his request quite exactly and in the process, they sentenced him to death, since nothing could pass his lips without solidifying itself into the precious metal. He was starving amidst the greatest stockpile of gold in the world.

The story of Midas is perhaps an apt metaphor for the current struggles of literacy. Students today are surrounded by more text than perhaps any other previous generation. They spend more time reading, viewing, producing, sharing, and interacting with text than they do anything else, save for sleeping (Kaiser, 2010).

For years the popular notion was that print rich environments were critical to developing good readers (Duke, 2001; Entwisle, Alexander, & Olson, 1997; Neuman, 1999; Neuman & Celano 2001). Yet the promises of the print rich environment have not necessarily lived up to what researchers had expected.

As a researcher, I am intrigued by the ubiquity of text today. Students from every class and ethnicity are surrounded by more text today than at any point in the history of the world. The Kaiser Family Foundation (2010) found that 7th–12th graders reported spending about an hour and a half a day (1:35) engaged in sending and receiving texts in addition to an hour and a half a day on the computer where they spend most of their time social networking, instant messaging, and emailing. If one considers these activities as

"reading", it is indisputable that they encounter more text today than their parents did. At the same time, reading scores today are stagnant. The National Assessment for Educational Progress found that while 75% of eighth graders are above "basic," (meaning they have partial mastery of the skills necessary to be successful in school), only 32% are considered "proficient" (meaning students show competency over the academic skills for their grade level) (National Center for Education Statistics, 2009). How can it be that students are now reading more than ever and yet have little to show for it in terms of standardized reading scores? Like Midas, our students find themselves surrounded by digital gold but not entirely capable of converting that exposure to a usable currency. It is the Digital Midas Phenomenon, the disconnect between the wealth of text students have access to and their performance on reading measures.

Of course, the digital Midas metaphor is an oversimplification. To begin with, it assumes that all text is the same. That the words, organizational structure, sentence patterns, and grammatical rules communicated in a text message or posted to a Facebook page would be the same ones used in a high school chemistry text. The metaphor does not recognize that the structure and context of informal literacies differ from those of the officially school sanctioned literacies. It also does not distinguish between the way these texts are read or the background knowledge required or the way they might situate a student within a given context.

Still researchers seem to be a little perplexed as to why these new digital affordances (e.g. Web 2.0 applications, video, audio, annotation to name a few) have not

lived up to their potential. This study hopes to advance our understanding of what is happening when readers sit down to read a digital text.

The world of literacy is in the midst of dramatic change (Coiro, 2003; Cope & Kalantzis, 2009; Leu et al., 2008). With the technological and concurring societal changes that have taken place, the nature of text, writing, reading and even learning have been challenged. Our traditional notions of how to engage in these processes do not seem to fit the changing environments in which people are asked to do them. Leu et al. (2008) highlight this dynamic in explaining that even the primacy of print text has been challenged: "The Internet is now the defining technology for reading in a digital, socially networked, multimodal, hyperlinked, and multitasking world of information and communication" (322).

Despite these changes, however, and the considerable amount of discussion about the potential benefits of these new technologies, schools have been relatively slow to adapt (Alvermann, 2008). A distinct divide remains between the practices and discourses of students in their digital lives and the practices and discourses of students in their academic lives. As both a researcher and high school reading specialist, I am uniquely aware of, and interested in, the intersections of these dual lives of students.

As a high school reading specialist and reading coach, I am interested in looking at how teachers and schools can bridge this gap between the informal literacies of students and the formal literacies of schools. Online digital textbooks could be the bridge between these two literacies. Though digital versions of the textbook have been available for quite some time (Lewin, 2009; Surdin, 2009), these online versions are largely digital

copies of the hard print versions (Burroughs, 1010; Foderaro, 2010), which means that they do not make the most of these digital spaces—namely the multimodal affordances.

Considering these interests, I wanted to study how students interact (and transact) with texts across modalities as evidenced by comprehension performance, in order to see if I could find something about this "disconnect" that happens between the literacies. In addition, I wanted to examine student perceptions of the texts and reading processes across each modality. Yet before we take a closer look at the problem being addressed and the purpose of the study, it is important to offer the three theoretical perspectives—New Literacies Studies (NLS), Multimodality, and Affordance Theory-- that have shaped this question.

The New Literacies Studies (NLS) are a loosely bounded collection of studies centered around a set of questions about how we read, produce, and interact with a wide variety of texts today and how the production and use of those texts both reflect and shape broader social, political and economic issues. Leu et al. (2004) suggest that a hard definition for new literacies will always be elusive since they are constantly changing with the new affordances of emerging technologies. However, they do offer a running list—of sorts—that outlines some of the processes of reading as defined by this field.

> The new literacies of the Internet and other ICTs include the skills, strategies, and
> dispositions necessary to successfully use and adapt to the rapidly changing
> information and communication technologies and contexts that continuously
> emerge in our world and influence all areas of our personal and professional lives.
> These new literacies allow us to use the Internet and other ICTs to identify

important questions, locate information, analyze the usefulness of that

information, synthesize information to answer those questions, and then

communicate the answers to others. (1570)

Coiro, Knobel, Lankshear, and Leu (2008) put this in more concrete terms by itemizing

the common assumptions of new literacies. First, the new literacies will require a new set

of skills, strategies and dispositions. Second, new literacies are necessary to survival in

today's global economy. Third, they are dynamic due to the changes in technology and

the perceived affordances that they provide. Fourth, new literacies are multifaceted and

offer many different perspectives and viewpoints.

The field of new literacies guided this research not only in the constructs it has

employed, but in the methodologies that it has adopted. Unlike many other research

traditions, the new literacies draws upon a broad range of epistemological assumptions

and methodologies, many of which had been previously considered to be incompatible.

As will be explored later, the field has criss-crossed the lines of epistemologies and

paradigms, bringing about a rich and new perspective of reading and literacy today.

Coiro et al. (2008) state that the new literacies is bringing together "research taking place

around the world in widely diverse disciplines, with even more diverse theoretical

frameworks and still more diverse epistemological approaches" (2). These

conceptualizations of text and of research have led me to ask questions about how

schools might take better advantage of online digital texts in content area reading.

My research interests have also been influenced by the examination of

multimodal texts. The term *multimodal* has been used quite readily in recent years. Stein

(2008) defined multimodal as the use of "different modes of communication, like speech, writing, image, gesture, and sound to represent or make meaning in the world" (p. 871). These modes of communication, within digital spaces, generally translate to the use of print text, audio recordings, still visual images, use of colors and shapes, and video recordings, to name a few. As a reading specialist and coach of a secondary school, I often work with content area teachers in the selection, assigning, and assessment of their assigned readings. Multimodal theory informs my research question with its focus on how various modes of reading academic texts—like audio and video-- might influence comprehension, self-efficacy, and the reading process.

Affordance theory, which was developed within the field of ecological psychology, has also guided my research question. Though the term affordance has come to mean many different things, its origins can be traced back to Gibson (1979), where he first coined the word to mean what an environment has to offer an organism. The noun, *affordance* first makes an appearance in Chapter 8.

> The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complimentarity of the animal and the environment. (Gibson, 1979, p. 127)

In the years since that writing, the study of affordance theory has mushroomed. ERIC indicates that in the last 10 years, 288 peer-reviewed journals have been dedicated

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to the topic. Google Scholar provided a similar number (298) where "affordance" appeared in the title of the journal article. In 2003, *Ecological Psychology*, published a special issue dedicated to the idea. It was entitled, "How shall affordances be refined?"

Affordance theory has provoked a considerable amount of discussion and debate. Questions have been raised about the very definition and properties of an affordance. Does the essence of an affordance exist within the object, tool or environment? Or does the affordance only become an affordance when it is perceived, recognized, and or utilized by an agent? What happens when the intended purpose of an affordance is co-opted for a different, unintended purpose? Is an affordance something that is voluntarily chosen by an agent, or can it be something required of an agent or subject? Questions like these have become central to discussions within the field and they offer insight into how we choose to design our spaces—especially our digital spaces—and how we recognize the evolving uses of these digital tools.

Ecological psychology informs this study with its emphasis on how environments and objects afford students specific opportunities. In other words, what modes available in the digital format change or improve student readings of texts? An examination of how students interact with their texts across various modes will enable educators to find more effective ways to help students access complex ideas and concepts.

Statement of Problem

The Midas analogy highlights the assumptions we make regarding the potential of digital texts. Many assume that the digital versions of these texts are better, or that the

affordances of the digital texts will make some of the academic texts more accessible. Or perhaps that by offering students the audio, less fluent readers will be able to more easily grasp the ideas of a passage and that by offering supplemental videos students with less background knowledge on a given topic will be able to better understand the content. Do digital affordances make content area texts more accessible? Or does adding features to a text make it all the more complicated for readers to navigate and process? Do added features improve student understanding, or might they become a distraction?

This study seeks to test some of these assumptions and questions. The design of this study seeks to answer this question employing numerous measurements and data sources. In this mixed methodology study I sought to quantitatively and qualitatively document the influence of multimodal texts on comprehension, self-efficacy and the reading process. Findings of this study can build upon previous work in online comprehension (Corio & Dobler, 2007; Leu et al., 2004; Leu et al, 2008), multimodal texts (Low & Sweller, 2005; Mayer & Johnson, 2008; Mayer & Moreno, 1998; Sweller, 1989), and self-efficacy (Guthrie et al., 2004; Schunk & Miller, 2002). Implications for this study could help schools determine how these online digital texts can be used, and the role that technology can play in reading academic texts. It will also offer insight into how students perceive these digital texts and how they might impact their sense of self-efficacy.

Purpose of the Study

This study examines how students interact (and transact) with texts across modalities as evidenced by comprehension performance. In addition, it examines their

perceptions of the texts and reading processes across each modality.   Doing so will offer

some insight into the affordances of online textbooks and how they might or might not

serve an important role in bridging the gap between the informal discourses and practices

of students in their digital lives and those of their academic lives. In the study, I hoped to

answer three questions regarding online textbook reading: Question 1 addresses

comprehension; Question 2, the meaning making process, and Question 3 taps into self-

efficacy.

1)   What impact do different modes (print, audio, and video) of text have on

        comprehension?

2)   How do students make meaning of the text as they access the text digitally?

        What is the process for reading the text? How do the students make use of

        the various affordances?

3)   What effects do the various modalities have on a student's perception of their

        ability to read the text digitally? Is there a measurable difference between a

        student's self-reported feelings of self-efficacy across the modalities? What

        do students say about using online textbooks and how do they feel about

        having them available?

        As explained earlier, this study employed a mixed-methodology approach that

consisted of both quantitative and qualitative features (see Figure 1).
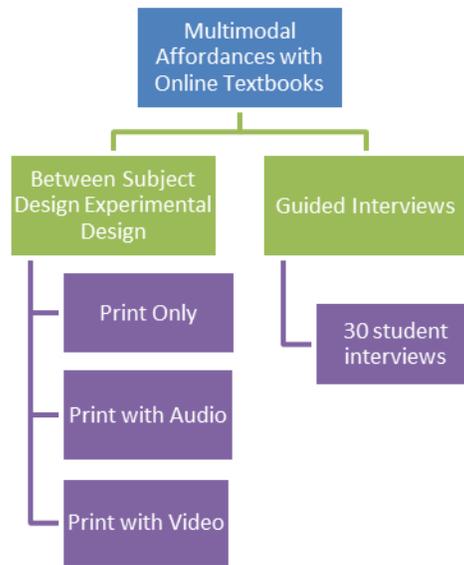
Figure 1.1. Diagram of the mixed methodology design used for this study.

The quantitative element was a between-subject design experiment that examined the difference in comprehension across three modalities: print-only, print with audio, and print with video. Ninety- ninth grade students from a suburban high school were assigned to one of the conditions. The text was taken from a section of their Earth Science textbook (Earth Science, 2002) on population and was modified to fit the three conditions. An 18-item comprehension test was developed based on targets created by the National Assessment of Educational Progress test. In addition to this comprehension measure, students were surveyed in regards to their perceived confidence on the given task.

The qualitative element of the study included pulling 30 students from the original pool to participate in a guided interview. During this interview students were asked to review the text, discuss their process for reading the text, and share their thoughts on

digital texts and online textbooks. Screen capturing software (Camtasia) was used to record and review these interviews.

Definitions

A number of important constructs to reading were used throughout the development of this study, and before moving onto a deeper discussion of them in Chapter 2, I will define those terms.

Text. The word "text" comes from the Latin word *textus,* meaning "something woven" (Hodges & Kress, 1988, p. 6). According to Robert Bringhurst (2002) the word can be traced back to ancient times, when a good storyteller could spin a story like a good piece of thread. The collective whole of that narrative or story was conceptualized as a finely woven cloth. Thus the word "text" became associated with those finely crafted stories. This fits well with the Hodge & Kress (1988) notion that texts should be considered as a comprehensive whole, not as a disconnected, isolated, collection of words and signs. They argue against the rather narrow approach of disciplines like psychology, linguistics, and philosophy and call for "a systematic, comprehensive and coherent study of communications phenomena as a whole, not just instances of it" (1). Within the design of this study, this definition plays the important part of defining text as something more than just the printed words on the page. Some may argue that the definition of text, and by default the definition of reading, should not be expanded to include forms of text beyond the printed word. The argument seems to be that having access to the audio version of text during a comprehension assessment, for example, destroys the validity of the reading comprehension assessment. However, this notion of text, and of reading, is

quite narrow and does not account for the demands of today's workplace, where people will need to be comfortable reading and producing a wide variety of texts. Therefore, this study was designed with the understanding that texts include not only the printed word, but also the visual and audio formats.

Comprehension. Comprehension, as it appears within this study, is based upon the definition used by the National Assessment for Educational Progress (2009) and originally written by the RAND Reading Study Group. "*Reading comprehension* [is] the process of simultaneously extracting and constructing meaning through interaction and involvement with written language. It consists of three elements: the reader, the text, and the activity or purpose for reading" (NAEP, 2009, p. 11). In this sense, comprehension is a complex and dynamic process that includes the interaction of reader, text, and purpose. While the first phase of this study focused more on the product of comprehension—the ability to pick out and understand the salient features of a text, the second phase of the study sought to examine the process of reading, which will hereto be referred to as "meaning making." While the traditional reading assessments, like the one used in the first part of this study, offer researchers an indication of what the reader has understood in the text, they simply can not provide a complete indication of what (or how) the reader encountered that text. Consequently, reading researchers have had to expand their methods of data collection to examine the broader conceptualization of reading and comprehension. In this case, a guided interview was utilized to further explore the experience.

Self -Efficacy. Self-efficacy, as defined by Bandura and Locke (2003), is the "core belief that one has the power to produce the desired effects" (87). In simpler terms, self-efficacy refers to a student's expectation for completing a task or achieving a goal. Guthrie et. al. (2004) explain that there are two central tenets of self-efficacy. First, the belief that one is capable, and second the willingness to act upon that belief. In this particular study, the question is whether access to certain affordances of technology might increase a student's feelings of competence in completing a given task.

The coming chapters, I will examine the literature review, methodology, results, and discussion for this study of multimodal texts.

Chapter 2

Literature Review

To better understand how this research question was developed, it is important to examine the wide body of research that has already been completed on the related fields. This study examines how students comprehend and making meaning of multimodal texts, and as well as how they feel about their understanding and performance as a result. In other words, would students do better on reading measures if they were offered a version of the text with more digital affordances? How would access to multimodal texts influence a student's reading process, their perceptions of that text and their ability to successfully use that text? These research questions have been predominantly informed by work done within the fields of new literacies, multimodality, and affordance theory. However, the questions have also been informed by work done within the fields of self-efficacy and content area reading. This chapter will be devoted to exploring some of the important findings within these lines of research.

New Literacies

For years, researchers and educators have argued that computers and digital texts will change education. However, as of yet, the promises of those technologies have not been realized in terms of traditional reading scores. This raises a number of questions. Can digital technologies improve literacy education? Is reading the same experience on the page as it is on the screen? Are reading measures designed for print adequate for the experience of reading on the screen? The aim of this next section is to review some of

the important studies that have sought to answer these questions within the field of new literacies.

In the first chapter, the field of new literacies was broadly defined as a loosely bounded collection of studies centered around a set of questions about how we read, produce, and interact with a wide variety of texts today and how the production and use of those texts both reflect and shape broader social, political and economic issues.   In the first part of this chapter, we will take a closer look at two lines of study within the field of new literacies: online comprehension and assessment.

Online Comprehension. To start with, it is important to examine the very notion of "comprehension." Perhaps the most widely accepted definition – of recent years at least—is that of the Rand Reading Study (2002) which noted that comprehension is "the process of simultaneously extracting and constructing meaning through interactions and involvement with written language" (xiii). While this definition suited the nature of reading as it existed on the page, Coiro (2003) challenged this conceptualization arguing "that the internet forces us to expand our understanding of each of the elements by considering new aspects of comprehension that are clearly related to traditional comprehension areas. . . but also require fundamentally new thought processes" (2). She raises four questions. First, is reading online different from reading print-based text? Second, what new thought processes are involved in online reading comprehension? Third, are these new processes extensions of old ones or simply brand new processes? Fourth, what are the implications of these new processes on the instruction and assessment of students and professional development of teachers?

Coiro and Dobler (2007) began to explore these questions in a study involving 11 skilled sixth grade readers. In this qualitative study, researchers watched students complete two tasks (one involving a directed reading activity and one involving an open ended search). From their findings, they concluded that online reading requires similar but more complex variations of print-text comprehension in the processes of prior knowledge, inferential reading strategies, and self-regulated reading. They concluded that print-text reading processes were necessary, but not sufficient for making meaning online.

Leu, Kinzer, Coiro, and Cammack (2004) suggest that there are other processes that should be included in our list for online comprehension. They specifically mention the processes of identifying important questions, locating information, analyzing the usefulness of that information, synthesizing information to answer those questions, and communicating the answers to others (1570). Leu et al. (2008) also point out that the two types of reading comprehension (print and online) are different. While both types of reading require an understanding of purpose, task, and context, the online reading process also requires a self-directed text construction "that occurs as readers navigate their own paths through an infinite informational space to construct their own versions of the online texts they will read." (Leu et al. 2008, p. 323).

Given that the processes of reading online are slightly different from reading off the page, one might wonder if the old tools used to measure this construct would still be valid within this new medium. A number of studies have taken up the question of how to measure understanding of multimodal texts.

Online Assessments. The issue of assessments within the U.S. has become quite important with the passage of No Child Left Behind and the accountability movement that has followed. Considering that funding is now tied to school performance on state mandated tests, schools lean heavily on curriculum and practices that can show growth on those test scores. It should be noted again that the promise of technology has been great, but it has little to show for that potential in regards to standardized tests (Wyatt-Smith & Elkin, 2008). To get at this phenomenon of increased digital exposure and stagnant reading scores, a number of potential questions can be asked. Do the old measures of comprehension lack construct validity when used on this different process of online reading? Do the texts themselves fundamentally change when they are transferred to a new medium? What new tools are being developed to get at this new construct of comprehension for online texts?

A good deal of work has questioned whether the print-based assessments should be used to measure digital comprehension. Wyatt-Smith and Elkin (2008) suggest that the current assessments are designed to measure old literacies in an era of new literacies. "Despite their claims to be about comprehension and ICT use, several writers appeared to be located on traditional ground, offering a print dependent construct of reading tied predominantly to school tasks" (907).

This particular notion was mentioned in the findings of Leu et al. (2005) in their Final report to the North Central Regional Educational Laboratory / Learning Point Associates. In this study of 89 seventh graders, researchers assigned students to one of four treatment groups. Multiple measures were taken—both traditional print text based

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and new online reading comprehension based—and though both sets of measurements

had been validated they did not correlate. The online reading comprehension measures

showed growth, while the Degrees of Reading Progress (a print based, standardized test)

did not. They try to explain their finding.

> It is most unusual to find a measure of reading comprehension that has
>
> strong psychometric properties and construct validity but does not
>
> correlate with performance on another measure that also has these
>
> properties. This result may be due to the fact that online reading
>
> comprehension skills are substantially different from traditional text
>
> reading skills and that ORCA-Blog and the DRP measure
>
> complimentary, but orthogonal skill sets. (Leu et al, 2004, p. 24)

Coiro (2007) found, however, that reading online over time could increase

reading scores, but with a rather important distinction. In her study of 109 seventh

graders across multiple offline and online measures, she found a strong correlation

between the scores. Noting that this differs from the previous finding of Leu et al.

(2005), Coiro suggests that perhaps the correlation between online and offline reading is

dependent on whether the measures are employing similar formats and structures.

> In short, as the structure of information in online reading environments moves, for
>
> example, from simple paragraphs on a page to complex lists of search engine
>
> results, and from multi-leveled information websites to highly populated blog
>
> interactions, it may be that each new text structure increases the likelihood that

sets of online reading strategies (i.e., new literacies) might be applied in ways that appear less and less similar to offline reading strategies. (Coiro, 2007, p. 237)

This raises a series of other questions related to reading growth and online activity. If reading scores can be improved by exposing students to texts online in essentially the same format that would appear on the page, would it really be worth the switch? If the affordances of the digital space (e.g. making the text more visual, embedding hyperlinks, reducing the text density, offering audio and video samples), are not used when switching from print to digital text, then is there much benefit to making the switch?

Within the examination of multimodal and online assessments researchers have also questioned the legitimacy of assessing students in traditional print modes considering their consumption of digital media outside the school day. Many have acknowledged this gap between the online literacies and those that are dominant in our schools. Bennett (2002) argues that it is untenable to assess students in a different medium from the one in which they typically learn and the medium in which they will ultimately have to work. Numerous other researchers have called for a closer alignment of the assessments and the everyday practices of its students (Leu et al., 2005; Stein, 2008; Wyatt-Smith & Elkin, 2008).

Along these lines, a number of different types of assessments are being tested. In the above mentioned study, Leu, Coiro, et al. (2005) validated two new measures that emphasize the constructs of online comprehension: ORCA-IM and ORCA-Blog. The one utilizes a fifteen item test through the medium of instant messaging while the other

one utilizes open-ended items requiring students to write a blog. Beyond the ORCAs, Leu et al. (2008) offer FASEKIT ("The Formative Assessment of Students' Emerging Knowledge of Internet Strategies") which asks students to list the most important strategies they employ on the internet. They are also asked to explain why each strategy is important, and when they might use it as part of their online reading experience. Leu et al. (2008) also pointed to the unpublished work of Henry (2007) where the researcher developed a 14 item Digital Divide Measurement Scale for Students (DDMS-S). A second one for teachers was also developed. Work outside of academia has also tackled the issue of multimodal or digital assessments. A number of states (Bennett, 2002) have started to test students on digital literacies and companies have recently unveiled information and communications technology tests, like ICritical, which was developed by ETS. This commercial product, designed for students and adults in 10th grade or higher, focuses on computer-related skills and the critical thinking necessary to search, evaluate, and use information to complete tasks. Another commercial product, ExamView, has been used to align the curriculum of a charter school in Denver with ACT standards (Zucker & Hug, 2007). Students were tested every 13 weeks using this software and then teachers met for data days where they would change or adjust their teaching to perceived needs indicated by the scores. It should be noted, however, that like many of the state assessments that are moving towards online formats, these tests appear to be close replications of the paper and pencil versions currently being used, and thus do not make the most of the multimodal affordances of these digital tools.

In the study that follows, these nagging questions of both comprehension and assessment had to be answered to design the research plan. In the end, it was decided that the study would be designed with hints of both the old constructs and the new. For example, I wanted to know if taking an authentic reading text from the science curriculum and transferring it to the digital sphere would somehow affect the comprehension and self-efficacy of students. By and large, the formatting, presentation, structure, and text density remained unchanged from their original forms in the print version. Because the study's purpose is to examine the impact of these digital textbooks (which is dependent on a rather conventional construct of academic discourse), the widely accepted construct of comprehension offered by the RAND Study (2002) was used to measure performance. In the end, the study hopes to marry to the two ideas, digital texts with multimodal affordances to traditional academic discourses that still seem to dominate the classroom.

Multimodality

Reading has perhaps always been multimodal. Jewitt (2008) writes, "Print-based reading and writing are and always have been multimodal. They require the interpretation and design of visual marks, space, colour, font or style, and, increasingly image, and other modes of representation and communication" (315). Still, this notion of text is rather new, and researchers have only just recently started to explore what that means. To gain a better perspective on what is meant by this multifaceted term, the next section of this chapter will look at how the study of multimodal texts is situated within the field of literacy. I will begin by looking at how the fields of social semiotics and cognitive

science have contributed to the understanding of what it means to be multimodal, and then I will offer a look at how the new literacies have examined questions of multimodal texts.

Social Semiotics. Social semiotics define multimodality as "a field of study concerned with how human beings use different modes of communication, like speech, writing, image, gesture, and sound to represent or make meaning in the world" (Stein, 2008, p. 871). Social semiotics provides a unique lens to multimodal studies because it approaches the meaning making process as a social interaction between the sign, the person interpreting the sign, and the person communicating through the sign. Wyatt-Smith & Elkins (2008) offer a good explanation of this dynamic.

> From this position, the act of multimodal reading and comprehending takes account not only of the demands of vocabulary, generic structure, and linguistic/graphic features, but also extends to the transaction that occurs between the text and the reader. Meaning making then, or comprehending can be said to occur centrally in the transaction; the primary understanding being that meaning is not singular and that the text, of itself, does not guarantee how meaning will be made. (928)

Wyatt-Smith and Elkins highlight that the communication event involves a transactional process of meaning making and that there is a multiplicity of meaning that can be construed from that event. Though Wyatt-Smith and Elkins do not acknowledge it, their ideas closely parallel Rosenblatt's (1978 / 1994) notion of reading as a transactional process. They simply extend this idea to include the multimodal reading of texts.

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Social semiotics also argues that the mode itself can influence the messages being sent. For example, breaking up a relationship by means of a Tweet sends an entirely different message than doing so face-to-face. Stein (2008) explains that this is the type of question social semiotics brings to multimodal studies. "How are learners and learning affected, changed, and shaped by the differences in mode, the material differences entailed, and the different senses called upon or engaged in the use of a mode?" (876). Some researchers, like Kress et al. (2001), were interested in how meaning is transformed across modes— a concept they termed as "transduction".

The very construct of multimodality is central to social semiotics. In fact, Hodges & Kress (1988) argue that social semiotics grew, in part, as a reaction against the compulsion to narrowly define the processes of communication, which they saw as a fault of psychology, philosophy, and linguistics at the time. They offered a different perspective. "Semiotics offers the promise of a systematic, comprehensive and coherent study of communications phenomena as a whole, not just instances of it" (Hodges & Kress, 1988, p. 1). By contrast, the cognitive sciences, as will be mentioned later, offered a much different perspective, viewing multimodal reading as the result of discrete processes, not some holistic, unitary phenomena. Whereas a social semiotician would be hesitant to take the reading process apart and operationalize various aspects of the cognitive experience, a cognitive scientist is not. The coming section takes a closer look at how cognitive science tries to deconstruct the meaning making process to ascertain exactly what happens when one tries to read multimodal texts.

Cognitive Science. The field of cognitive science encompasses a large range of studies, across the fields of psychology, linguistics, artificial intelligence, and neuroscience (Thagard, 2008). For the most part, its origins come from experimental psychology, where scientists were interested in how the mind functions to perform various tasks. In their studies, according to Moreno (2007), these researchers have established lines of studies in working memory, cognitive load, cognitive processing, motivational factors, metacognition, and prior knowledge. A number of studies within the field have helped to guide thinking on how multimodal texts might influence cognition. This brief review of studies skims the surface of the field, offering a sampling of questions that examine how the brain processes multimodal texts.

First, it is important to note that researchers in the field of cognition use a different definition of "multimodal" from that offered by the field of social semiotics. Moreno and Mayer (2007) explain that cognitive scientists use the term interchangeably with "multimedia" to mean the mode in which information is communicated: verbal (print text, spoken word) or non-verbal (illustrations, static images, animation). In contrast, the field of social semiotics suggests that the term is much broader than this, encompassing other elements (like color, space, and gesture). Additionally, social semioticians conceptualize language and symbols within situated social contexts, thereby recognizing the possibility of multiple understandings of a given text. Researchers in the cognitive sciences conceptualize comprehension as a more measurable, perhaps concrete, construct. Consequently, many of the following studies employ comprehension measures that seek to draw conclusions from performance on these measures.

Important multimodal studies in this field have tried to examine the idea of cognitive load or cognitive capacity. Sweller (1988) found that mental processes are slowed when the mind tries to activate more than one process at a time. He pointed to a body of research that showed in particular how the processes of problem solving and schema acquisition when employed simultaneously seemed to interfere with each other. Sweller (1989) examined the split attention required of certain math problems. In one study of 42 "year 10 students," he developed an experiment with a math problem that involved reading both the diagram and the equation. "Attention must be split between the two sources of information, and cognitive activity must be directed to ways of mapping the information contained in the equations onto the diagram. The need to integrate two discrete sources of information does not occur when using algebra worked examples. One can hypothesize that the more sources of information that need to be integrated, the greater the cognitive load" (464).

Another popular line of study within this field has involved split attention theory. Mayer and Moreno (1998) ran an experiment of 75 college students where their performance on comprehension tests showed that splitting their attention between a visual and audio stimuli was better than when they were trying to split it between video and print text. Other studies, like that of Ayers and Sweller (2005), have found similar results, giving credence to the idea of dual code theory, which argues that two discrete channels of information processing exist in our audio and visual capacities (Paivio, 1976).

A number of studies from the cognitive sciences have branched from this line of research, examining what the optimal balance of modes might be for retaining and using information. These studies have been conducted on a variety of modes like audio, visual, hypertexts, and interactive environments. Low and Sweller (2005) and Mayer (2005) found that when administered in a particular way, offering texts in multiple modes (audio and visual for example) can expand working memory capacity more than if that same text were offered in only one mode. Mayer and Johnson (2008) studied the effects of "redundant" audio and visual information on retention and transfer, discovering that there was a positive affect on comprehension when redundant text served to guide the learner's attention without overwhelming the cognitive process.

Some findings, however, suggest that offering more modes does not always improve performance. Kalyuga, Chandler, and Sweller (2004) argue that cognitive processes work best when multiple modes of texts are offered non-concurrently, or in one mode only, to avoid cognitive overloading and to maximize memory functions. Looking at the more recent addition of hypertext as a mode, Macedo-Rouet, Rouet, Epstein, and Fayard (2003) using 45 college aged volunteers show that features like hypertext decrease comprehension and increase cognitive load and that including graphics can make reading more difficult without improving student understanding.

Studies examining interactive multimodal environments also try to discern what the optimal balance of interactivity might be for cognitive processing. In one such study, Mayer and Chandler (2001) studied the effects of limited interaction on retention and transfer of information when 59 university students were given the power to control the

pace of narration in an instructional activity. Mayer and Chandler hypothesized that in this case, "learners must devote so much processing capacity simply to receiving the incoming words and pictures that they have no capacity left to mentally organize the incoming material or mentally integrate it with other knowledge" (391-392). Thus offering subjects the chance to control the pace of the narration offers them the chance to have greater control over monitoring their own cognitive loads. Wolgang Schnotz and Thorsten Rasch (2005) with their collection of 50 university students found that the effects of multimodal interactive features were dependent on cognitive ability. They explain, "The negative effects of animation . . . were found primarily when students had low learning prerequisites rather than high learning prerequisites" (57). In other words, students with low ability were less able to cognitively juggle the dynamic and interactive visual images than their high ability peers. Kayluga (2007) offers a good summary of these studies. "In general, the design of interactive learning environments should support the acquisition and use of learners' organized knowledge structures by reducing unnecessary irrelevant forms of WM [working memory] load that may prevent the allocation of sufficient cognitive resources to learning processes, and by enhancing forms of processing load that are essential for learning" (390).

This line of study from the standpoint of literacy is important in so far as it gives us an idea of what might be occurring within the mind as it processes information. Though it might be dangerous to believe that these findings are conclusive—especially considering that most of the studies are completed on small samples within a lab, using college-aged subjects—they help the field of literacy to conceptualize reading as a series

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of discrete processes that bring about comprehension, and that this comprehension can be aided (or even hindered) by variables and combinations of modalities. Unlike social semiotics, this cognitive approach does not recognize the contexts of these reading events. It ignores any variables beyond those that can be directly observed and controlled.

New Literacies. Standing somewhere between the highly specialized and technical focus of cognitive science and the broad contextual lens of social semiotics is the field of new literacies. Because new literacies draws from such a broad representation of theories and perspectives, it is hard to pin point what researchers in the field generally mean by "multimodal". For the most part, the new literacies draws its influence from the field of social semiotics. However, for the sake of this discussion we will return to the definition of multimodality that was provided by Stein (2008) "a field of study concerned with how human beings use different modes of communication, like speech, writing, image, gesture, and sound to represent or make meaning in the world" (871). New literacies has explored the concept of multimodal texts from many different angles.

Though it is not necessarily germane to my particular area of study (which will focus on online multimodal reading), it should be noted that the new literacies also challenges the very definition of "reading". Wyatt-Smith & Elkin (2008) point out that the new literacies blurs the lines between the processing of text in the form of reading and the production of text in the form of writing. They claim that these two processes in interactive, multimodal spaces, become virtually inseparable. This has a direct impact on

school practices, which to date, tend to compartmentalize these processes so that instruction is done on one (reading) and then on the other (writing).

Another related area of research questions the very definition of "reader." McEneaney (2006) argues that recent technologies have allowed texts to "read the reader." Drawing from the works of Rosenblatt (1978 / 1994), McEneaney argued for a new model of the reading process that acknowledges the dynamic transaction of the reader and the text. Rosenblatt referred to the reading experience as a living experience that changes according to the reader and the context. McEneaney acknowledges this, but mentions that the potential for digital texts to respond to the reader makes this transaction even more dynamic than in the printed word. He refers to this idea as an "agent-based theory" since he discusses how the text becomes an agent of action within this dynamic. To illustrate his point, McEneaney offers the example of Amazon.com, where the website records searches, documents purchases and returns, and acknowledges consumer activity. Consequently, the website offers recommendations that appear on the opening page every time the costumer visits the site, it sends out emails tailored to a costumer's specific buying patterns and interests and it can offer deals that might uniquely target costumer's behaviors and patterns. The text (in this case, the website) is quite literally reading the reader. Considering this new affordance of the technology, McEneaney suggests that perhaps it is time to design a more applicable model of the reading process, one where the text quite literally changes as the reader reads it.

Beyond troubling the definition of text and reader, a number of recent studies highlight the diversity of questions being asked within the field of multimodal studies.

Mills (2010) highlights a broad range of recent studies that have addressed what multimodal reading looks like. She refers to studies in Japanese style comics (manga), digital movie composing, graffiti, online fanficiton, cellphone advertising, illustrated stories, and rap lyrics. A recent conceptual piece written by Serafini (2011) reaffirms the call of the New London Group to move beyond prevailing monomodal readings, which schools seem to favor. He offers three alternative perspectives to comprehending texts: art theory and criticism, visual design and grammar, and media literacy.

Another recent study (Alvermann & Wilson, 2011), looked at how multimodal texts could be used within a middle school science unit. They point out that science disciplines may be "particularly dependent on a variety of visual displays or objects, where in addition to pictures, diagrams and charts, scholars may be asked to "read" the physical world itself. They discuss how comprehension strategies, like reading with purpose, making inferences and connections, distinguishing important from unimportant details, could be applied to the "reading of a landscape." They also argue that this same type of "multimodal" reading could be done in other disciplines—reading numeric manipulatives in math, reading monuments and architecture in social studies, art or humanities, reading football fields in physical education.

While these recent studies offer a general notion of multimodality, this study examines the concept in a more limited sense. It examines how people use various modes to process, understand or consume text within the traditional context of academic reading. And it questions what the affordances of those modes might be. To get a better

understanding of what is meant by "affordances", I will now examine the theory behind the term and how it applies to this study.

Affordance Theory

When Gibson (1979) defined the term affordance, he set off a firestorm regarding what exactly affordances are and how they function. At the heart of the discussion, which still continues today, is a debate over the very nature of an affordance. Is an affordance inherently part of object or environment, or is it merely something that an animal (the term used by ecological psychologists) perceives within the environment? Or perhaps an affordance involves an interaction between the two? Stoffregen (2003) explains that the study of affordances is "central to the ecological approach to perception and action" (115). He, along with others within the field, argue that learning about affordances enables us to both understand human action within a given context but additionally to more effectively design environments or systems.

Some within the field, like Gibson (1979), suggested that the affordance is not perceived, but an inherent quality of an environment. This was supported by Warren (1984) who used an experiment with stair climbing to prove his point. Participants were studied climbing stairs with varying degrees of rise. They were observed to see how high the rise of a stair would get before the participant would chose not to climb it, at least in a bipedal manner. Warren concluded that the upper limit of a stair's rise could not exceed 88% of the person's leg before it was no longer convenient to "step up". Since the participant generally is not consciously aware of how these decisions to step or crawl are made, Warren suggests that the affordance must be innate to the obect.

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Stoffregen (2003) argued that perception, along with purpose, are more critical to the notion of affordance than the inherent properties of the object itself. He writes, "For living things, the conjunction of particular properties of the animal with particular properties of the environment does not lead to the involuntary actualization of action afforded. Affordances are what one *can* do, not what one *must* do" (119).

Michaels (2003) counters with the idea that affordances are not a matter of what "animals" or people notice about their environment. She explains, "Despite the interpretations of some cognitive psychologists, affordances do not arise as a consequence of mental operations. They are action-referential properties of the environment that may or may not be perceived" (137).

To complicate things even further is a debate about whether an "event" could be defined as an affordance or not. Conceptually, some argue that the debate has been rather limited to notions of affordance that only entail an actor / animal and an object. Some, like Chemero (2000) believe that affordances (including those that are created by an event in time) can be perceived.

Within the field, scientists continue to re-define and expand our understanding of affordances. Experiments continue to explore these notions of what an object affords, using a wide variety of everyday tasks like hammering and scooping (Randerath et al., 2011), playing with beads (Cook et al, 2011), and grasping items (Lopresti-Goodman et al, 2011). In that last study, Lopresti-Goodman et al. (2011) offered a nuanced idea of

what an affordance is and how it is the dynamic result of an interplay between both agent and environment.

> The present GT [Grasping-transition) modeling, methodology, and focus on affordances are in concert, therefore, with the thesis that perceiving, acting, and knowing emerge from the interplay of body, brain, and environmental surroundings (e.g., Calvo & Gomila, 2008; Clancey, 1997; Clark, 1997, 1999) and are approachable through the tools of dynamical-systems theory. (1961)

Thus, they bring together a wide variety of ideas regarding affordances and how they are influenced not only by what the brain and body seem to perceive, but by the environmental surroundings and the changing dynamics of that space.

The field of literacy (like many others) has recently adopted the term to generally indicate the various benefits of a new technology or tool. Thus, there are studies about the "affordances" of instant messaging (Murphy & ManZanares, 2008), or wikis and blogs (Carrington, 2009; Robertson, 2011), or white boards (Maher, 2011). Van Leeuwen (2005) offers perhaps a more thoughtful discussion when he explained that all texts have potential uses that fulfill a given purpose or need. Wilson (2008) extends this thought with an example of a map, and how that particular text affords people the opportunity to see the information in a spatially defined format created in proportion to a scale. She compares this to offering the same information in the spoken word, which would not afford the listener the same visual cues that would make their task a little easier.

These studies in ecological psychology informed my questions about what content area reading online would afford. What does reading academic texts online allow, or not allow a reader to do? How do readers perceive those affordances? Do their perceptions of those affordances somehow influence the way readers use them? And finally, do these affordances have any type of influence on how the readers perceive a task, making it seem more easy or difficult? The remainder of this chapter will explore two other fields that are germane to the study at hand.

Self-Efficacy

Beyond just the impact that this digital switch may have on comprehension, this study wanted to get at any potential impact that the switch may have on a student's perceptions of their success. Self-efficacy, as defined by Bandura and Locke (2003), is the "core belief that one has the power to produce the desired effects" (87). In simpler terms, self-efficacy refers to a student's expectation for completing a task or achieving a goal. Guthrie et al. (2004) explain that there are two central tenets of self-efficacy. First, the belief that one is capable, and second the willingness to act upon that belief. Within this domain, researchers are trying to answer the question, "Do beliefs of personal efficacy contribute to human functioning?" (Bandura & Locke, 2003). For researchers who assume that efficacy is integral to motivation, the question then becomes, how do schools / teachers foster students' reading efficacy? Researchers look to identify the sources of information students use to form their efficacy beliefs.

As Parajes (1996) points out, studies in self-efficacy have been completed across many different disciplines. He lists studies completed in clinical phobias, social skills,

assertiveness, smoking behavior, pain control, athletic performance, attention, and, of course, academic performance and reading. In fact, a simple search of ERIC for the keywords "self-efficacy" and "reading" produced 74 peer reviewed journal articles in the last ten years. Researchers are firmly convinced that there is a link between belief and performance. So to help those who struggle the most, schools must turn their attention to increasing the reading self-efficacy of their students. This examination of self-efficacy will focus on some general findings within this field, specific behaviors that it might influence it, and variables that might constrain or promote it.

In general, self-efficacy has proven to have a positive effect on student performance in schools. However, there is a great deal of nuance to that finding, and examining the body of research that led to that conclusion offers a more detailed description. Interestingly, student perceptions of their abilities change over time. Stipek and MacIver (1989) found that young children generally overestimate their abilities. However, these notions of ability become more complex as the child gets older as he or she meets with both success and failure (Wigfield & Eccles, 2001). Schunk and Miller (2002) point out that developmentally, adolescence brings about two important changes to a student's sense of self efficacy. First, they become more accurate with their predictions, and second they become more specific. In this sense, students—according to Schunk & Miller—are less likely to generalize ability across various disciplines, and more likely to make predictions about their success or failure based on past experience within that particular activity or domain (35). Gottfried, Fleming, and Gottfried (2001)

add that perceptions of self-efficacy tend to stabilize overtime and become more permanently embedded in the student's beliefs about who they are.

A closer look at this construct shows that there are a number of behaviors that are correlated to self-efficacy and a number of potential factors that contribute to its development. Some researchers argue that self-efficacy beliefs influence a broad range of behaviors like choice of activities, effort, persistence, and even achievement (Schunk, 2003; Bempechat, 2008). These findings suggest that students determine whether to take up, or even continue with a given activity based on beliefs they have regarding their ability to complete the task. Given that premise, educators then ask the question, how can self-efficacy be promoted? And what are the factors that contribute to a strong sense of self-efficacy? Studies have tried to isolate these factors, like that of Guthrie et. al. (2004) where they found that students look to sources like past experience, peer modeling, and encouragement from others. Bempechet (2008) concurs with this finding and adds that perceptions of support for learning are also important to a strong sense of self efficacy (80). This includes having access to additional resources or learning aides, for example.

A number of affective literacy instruments have been designed to measure various constructs of motivation (e.g., intrinsic and extrinsic motivation, focus of control, outcome expectancy etc.). Within the construct of self-efficacy, Henk and Melnick (1995) designed a Reader Self-Perception Scale (RSPS) based off Bandura's four categories of self-efficacy: performance, observational comparison, social feedback, and physiological states. Researchers tried to operationalize these four categories and design

items that would tap into them. Along these lines, Bandura (2006) advises that the self-efficacy tool should be designed with a specific purpose in mind, and he discourages the construction of generalized "all-purpose" measures that try to make broad claims of self-efficacy. "In short, self-efficacy scales must be tailored to activity domains and assess the multifaceted ways in which efficacy beliefs operate within the selected activity domain. The efficacy scales must be linked to factors that, in fact, determine quality of functioning in the domain of interest" (310-311).

Content Area Reading

The nature of assigned readings in secondary schools, by and large, has not changed over the course of the last twenty years (Heller & Greenleaf, 2007; Lee & Spratley, 2010). A good deal of research has documented the extent to which the textbook is still used, the various ways it is being used and the potential for a digital turn in the future.

Studies throughout time have indicated the dominance of the text throughout the disciplines. In math, Porter (1989) found that nearly 75% of the curriculum and activities in math classes were centered around the textbook. Witzel and Riccomini (2007) noted that 75% of mathematics teachers' instructional decisions about sequencing and targeting instructional objectives were determined by content identified in their school systems' adopted mathematics textbooks. King-Sears, E. and Duke, J.M. (2010) assert that middle and high school classrooms still rely heavily on textbooks, which they claim influences not only what is taught, but how it is taught as well.

A number of factors contribute to the prevailing dominance of the textbook across the school day. Alvermann and Moore (1991) point out that the conditions of teaching affect the practice of teaching. They argue that conditions like the schedule of the school day, the sizes of classes, the division of secondary classrooms by disciplines, the architecture of the buildings and the layout of those classrooms largely dictate the types of practices that teachers employ. Consequently, the demands of schools favor a curriculum that could be delivered efficiently and consistently, namely that of one tied to a textbook. Though Alvermann and Moore were writing about the classroom of twenty years ago, many of those conditions have not changed within schools. And since the conditions themselves have not changed, schools continue to depend on the methods and practices that the system affords.

Alvermann and Moore (1991) also explain that the continued move towards accountability favors a print-centric textbook based curriculum.

> Traditional practices fit common systems of accountability. Relying on textbooks and following up reading assignments with highly controlled question-answer routines satisfy demands for accountability by contributing to content coverage, demonstrable progress, specific learning outcomes, and feelings of solidarity. (971)

Again, the underlying conditions identified by Alvermann and Moore have not changed over the course of time. In fact with the passage of NCLB, it could even be argued that the nature of high stakes testing has only solidified the dominance of the textbook within schools today.

Despite a good deal of anecdotal evidence to the contrary, the digital shift in textbooks has not taken root in secondary schools just yet. A couple of factors have contributed to the rather slow change. First, while home internet access has increased in the last five years (74% to 84%), schools still cannot guarantee that all students have access to the internet (Kaiser, 2010). The Kaiser Report also indicated that internet access numbers were lower for Black (78%) and Hispanic (74%) students and that only 59% of all homes have access to high-speed internet, which is often needed to run the online textbook editions. Second, no single platform has been able to establish dominance in the market, a condition that would make it more palatable for school districts to make the long-term investments. And third, textbook companies have yet to develop compelling reasons to make the switch (Foderaro, 2010). As Burroughs (2010) points out, "slapping book pages onto screens wastes the potential of digital learning materials" and for the most part publishing companies have not invested heavily in transferring these texts to the screen in a meaningful way. Zach Pawlowski, technology director of a district in Wisconsin where seventh and eighth graders were given IPads acknowledges the work that still needs to be done on the part of publishers. "These other companies seem to have some ideas about expanding it beyond the regular textbook," Pawlowski said. "It's not coming out next week. Unfortunately, they move at glacial speed" (Hetzner, 2011).

Though many acknowledge the promise of digital textbooks, as of yet, their use in secondary schools has not become a reality. For the most part, schools remain print centric (King-Sears & Duke, 2010; Alvermann & Wilson 2011). Perhaps Ivey (2010)

offers the best indication that textbooks remain a strong presence in today's secondary

schools. She writes that, students today, like those for many generations, still struggle

with, resist, and fake textbook reading.

Referring back to the metaphor of Midas in Chapter 1, Midas wanted to find the

means to convert the things around him into a valuable substance. His quest is not

altogether different from the one of schools. Faced with shrinking budgets, they too are

looking to turn readily available resources (like digital technology) into educational gold,

especially if it is technology the student already owns and uses. Unlike Midas, however,

schools have not been granted the power to transform (or perhaps co-opt) these digital

devices to a meaningful degree. The aim of this study is to contribute to the body of

research that asks the question, "How can we make better use of this technology within

the way that our schools operate?"   The next chapter will offer a closer look at how the

study was designed and run.

Chapter 3

Methodology

As has been noted by many reading researchers, our understanding of literacy is changing (Corio et al., 2008; Leu et al., 2008). Social semioticians point out that the very definition of "text," which has been conventionally used to mean printed text, has been decentralized by the affordances of new technologies (Jewitt, 2005). Along this line, Lankshear and Biggum (1999) suggest that new technologies have ushered in a new era of "ethos stuff" where the production of text online (blogs, discussion boards, fanzines) has democratized the process so that there is no longer a line between those who write text and those who consume it. Others, like Coiro (2007) argue that the way we make meaning of texts in online spaces differs from the way we have done it in print text.

This changing conceptualization of literacy leads to new lines of inquiry, new ways to approach these conceptualizations, and, because of technological advances, new ways to collect, measure, and analyze data. Emboldened by the work of others within the field of new literacies, I designed a study that integrated constructs, measures and tools that have been historically segregated. Doing so offers a different, perhaps more nuanced, description of this relatively new phenomenon in reading, namely the reading of digital texts. The coming chapter will outline the methodology employed toward that end. It will include a description of my background and role as a researcher, the research design, the participants and setting, the procedures, the data sources, and finally, the data analysis.

Background and Role of Researcher

As indicated earlier, I am an eighteen year veteran of teaching at a suburban, public high school. For most of those years, I had been teaching accelerated and honors 9th grade English, but within the last eight years, I have gone back to school to get my reading specialist's degree, and have thus moved into the position as a reading coordinator for our school. This position includes three duties: teaching intervention courses, assessing students, and coordinating professional development for literacy. In working with both the students and the faculty of my school, I have often struggled with the types of readings assigned to students and how students are expected to show their understanding of the material. This frustration has led me to questions about what we could be doing with our texts to make them more accessible to students.

Additionally, I am uniquely interested in the potential that technology has to transform our schools. I believe that it holds some powerful potential to engage our students, to connect them to the world around them, and to broaden their understandings. Consequently, I believe that these digital, online spaces have been relatively untapped for their academic potential. And I am interested in studying the intersection of students' out of school digital practices and students' in school academic practices. Digital textbooks appear to be at that intersection.

My role as a researcher evolved over the course of the study. Throughout the first phase of the study, student contact was minimal. They got a chance to see me when I visited their classrooms to describe the study, and then since correspondences were in written form, they did not see me again until the day that they participated in the activity.

At that time, I dealt with students in large groups, and addressed them only so far as to give them directions about how to complete the activity. I talked only briefly, to get them on the right website and then allowed them to follow the directions as they appeared on the screen. Following the first phase, where the quantitative data were collected, some students were invited back for guided interviews, which were conducted by myself and another researcher. These interviews were conducted in the school's library which sits at the very center of the building and is an open space. The tables were set-up so that the students would sit in front of the laptops, while the interviewers would sit by their side. The seating arrangement was both functional in the sense that the interviewer would be able to view the screen as the student worked it, but also functional in the sense that it altered the power-dynamic, giving the interview the feel of a conversation around a task versus an interrogation or job interview. Still, I recognize the power differential that existed between these young men and women and the interviewers and can even identify a few responses that seemed to be offered as a socially desirable response versus perhaps an honest reaction.

Throughout the entire process, I have kept a journal about my experiences in order to both document my thoughts, and to provide a means by which I could monitor, as best I could, my biases.

Research Design

This study examines how students interact (and transact) with texts across modalities as evidenced by comprehension performance. In addition, I examine student perceptions of the texts and reading processes across each modality. A number of

epistemological assumptions underlie the conceptual framework of this study. First, the very design of the study recognizes that the constructs of reading and comprehension are multifaceted. While it can be acknowledged that the act of reading involves a number of cognitive processes and that this act is often influenced by a number of affective variables, these notions of reading do not quite capture the depth of the experience. By the same means, it can be acknowledged that some aspects of comprehension can be measured, but that this is not the only means of documenting what the reader understood or experienced as they read the text. These notions of reading and comprehension recognize the validity of both measuring what can be measured and describing what cannot be clearly counted. Even in this design, however, it must not be assumed that the totality of the reading experience can be captured. At best, the following study can be likened to the blind men and the elephant metaphor, where a group of blind men try to ascertain the description of the elephant by expressing what they can observe with their hands. Conceptualizing reading and comprehension from both a quantitative and qualitative perspective is like having another set of hands to study the elephant. At no point can a few sets of hands completely capture or cover the span of the elephant, but they can get at a better description of the magnificent beast.

This study recognizes that the construct of reading involves aspects of comprehension and self-efficacy that can be measured and aspects that cannot. This study employed a comprehension measure (based off the targets employed by NAEP reading tests), an affective survey, and a guided interview. In developing the research questions, the term "comprehension" is employed to refer to aspects of comprehension

that can be measured. "Meaning making" is employed to refer to the more general experience or process of reading. It is a look at "what happens" while one is reading. Self-efficacy is employed to refer to the feelings of belief that a student may have about their chances of successfully completing a task. It is measured by both a self-reporting survey and a series of responses to interview questions. In the study, I hoped to answer three questions regarding online textbook reading: Question 1 addresses comprehension; Question 2, the meaning making process, and Question 3 taps into self-efficacy.

Q1: What impact do different modes (print, audio, and video) of text have on comprehension?

Q2: How do students make meaning of the text as they access the text digitally? What was the process for reading the text? How did the students make use of the various affordances?

Q3: What effects do the various modalities have on a student's perception of their ability to read the text digitally? Is there a measurable difference between a student's self-reported feelings of self-efficacy across the modalities? What do students say about using online textbooks and how do they feel about having those texts available?

Participants and Setting

The study was completed at a suburban public high school with an enrollment of about 1,700 students. As of 2011, the school was predominantly white (White, 73%; Black, 14%, Hispanic, 7%, and Asian, 6%). Approximately 25% of the students received Free and Reduced Lunch (Minnesota Department of Education, 2010). Ninety students (30 in each treatment) participated in the first phase of the study (online reading

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activity with comprehension and self-efficacy measures), and another twenty-nine

students volunteered and participated in the second phase of the study (guided interview).

Fifteen students participated in the pilot study which ran before the main study. The

reading activity with comprehension and self-efficacy measures took about 20-35

minutes to complete, while the guided interviews typically lasted 20 minutes apiece.

Students completed the online reading activity after school during a three week window

in early November, while the guided interviews were conducted over the course of a

three day period in later November. The interviews were recorded using screen capture

software (Camtasia). Students were compensated with $10.00 gift certificates; one for

each of the two phases of the study.

With an understanding of the study's general design, it is necessary to take a

closer look at the procedures, data sources, and data analysis

Procedures

Selecting the Text. This study examines how the multimodal reading of an

academic text might have an impact on comprehension, self-efficacy and /or the meaning

making process. Consequently selecting the right text was an important first step. The

content area of science was selected because the texts lent themselves to multimodal

presentations. To find the right text, the 9th grade Earth Science teacher from the school

was consulted.   He recommended a section from their textbook (Earth Science, 2002)

regarding "population" since it was not one of the chapters they were planning to use this

year. The selected excerpt came from the beginning of the chapter, which provided a

good overview of the topic with some specific examples, and key vocabulary (see

Appendix B for the Experiment Text). The excerpt contained a good beginning, middle, and end, so it had a sense of a unified whole. The passage was 1,100 words long, and could be read in about 10-15 minutes. Because the text was taken from their textbook it represented the type of reading that ninth graders were typically asked to complete.

Developing the Comprehension and Self-Efficacy Measures. Once the text had been selected, comprehension measures were developed. It was decided that the National Assessment of Educational Progress (NAEP) targets would be used as a framework for the reading test. NAEP, considered to be the gold standard of reading assessments, was developed in the late 1960s. Based on research within the field, NAEP writers identified cognitive targets or mental processes that underlie reading comprehension and they used these targets (recall / retell, integrate / interpret, and critique / evaluate) to construct their test items. The test employs a variety of text types for a variety of reading purposes which are assessed by a variety of items—multiple-choice, brief constructed response, and extended constructed response.

Based on this model, a pool of comprehension items was constructed. Items tapping into each of the targets were written. A look at the distribution of those items across the cognitive targets can be found in Table 3.1.

Table 3.1

Breakdown of items by cognitive targets

Cognitive Targets (Categories of Items)	**Recall / Retell**	**Integrate / Interpret**	**Critique / Evaluate**
Percentage of Items	20%	50%	30%

The distribution here, 20% recall/ retell, 50% integrate / interpret, and 30% critique and

evaluate mirrors that of the benchmarks established by NAEP. Additionally, vocabulary

items were included within these questions along the framework developed by NAEP.

The items were then reviewed by another researcher for their construct validity.

The researcher, who had experience writing items from the targets, examined each item

and proposed changes or deletions according to their fit for the various cognitive targets.

Self-efficacy items were constructed and embedded within the reading activity.

Research has indicated that situated response items can be an effective means of

measuring a student's sense of competence (Bandura, 2006; Guthrie, McRae, & Klauda,

2007). In this case, students were simply asked to respond to two likert scale questions

regarding how they felt about reading the text and answering questions. Like the

comprehension measures, the self-efficacy items were reviewed by an experienced

researcher for their validity.

Running the Pilot Study. With the passage selected and a pool of comprehension

and self-efficacy items constructed, a pilot study was run to validate the measures (see

Appendix C for the pilot study questionnaire). One teacher from the school volunteered

an hour of her class and so a week before the designated day, her class received a brief

overview of the pilot study and the necessary forms that they would need to have signed.

(IRB requires signed permission of both the individual and, since they are not of legal

age, the legal guardian / parent as well.)

Fifteen students then participated in the pilot study. They read the passage and

answered a total of 25 questions (see Appendix C for the Pilot Study Questionaire).

Analyzing the Test Items. Once the data had been collected for the pilot study, an item analysis was run to determine the difficulty of each item and the distribution of responses. To determine whether the items were too difficult or easy a simple item difficulty test was run.

A/N X 100

Where

A= the number of students who answered the item correctly.

N= the total number of students who attempted the item.

Ideally, items will be no less than .20 and no greater than .80 with most of the items falling between .30 and .50. Table 3.2 indicates the item difficulty of the 22 multiple choice items used in the pilot study.

Table 3.2

Item Analysis Chart for Test Items in the Pilot Study

Item Number	Difficulty (p)	Outside of Range
1	.67	
2	.80	X
3	.87	X
4	.93	X
5	.87	X
6	.93	X
7	1.00	X
8	.80	
9	.93	X
10	.87	X
11	1.00	X
12	.87	X
13	.67	
14	.67	
15	.53	
16	.67	

17	.93	X
18	.60	
19	.60	
20	.80	
21	.73	
22	.53	

As is indicated in the table above, eleven of the items fell outside of the acceptable range meaning that they were not showing enough discrimination. Seven questions were eliminated completely, and another four were re-written to increase the level of difficulty. Items were also chosen to maintain the proper balance across the cognitive targets (locate / retell, integrate / analyze, critique / evaluate).

An item distribution analysis was also informally completed to see if there were any imbalances in distractors. And where necessary, adjustments were made. From this analysis the final list of stems and distractors was created (see Appendix D for Questions Categorized by Target and Appendix E for the Main Study Comprehension and Self-efficacy Items).

Creating the Treatments. While participants of the pilot study read from the original print version of the text, participants of the main study experienced the text in one of three digital formats: print only, print with audio, and print with visual / video. A wiki space (pbworks) was used to create and house the treatments. Though this platform is not particularly aesthetic, or sophisticated, it was functional for the purposes of the study. For the print only treatment, the text of the excerpt was simply transferred into the wiki page (See Figure 3.1).
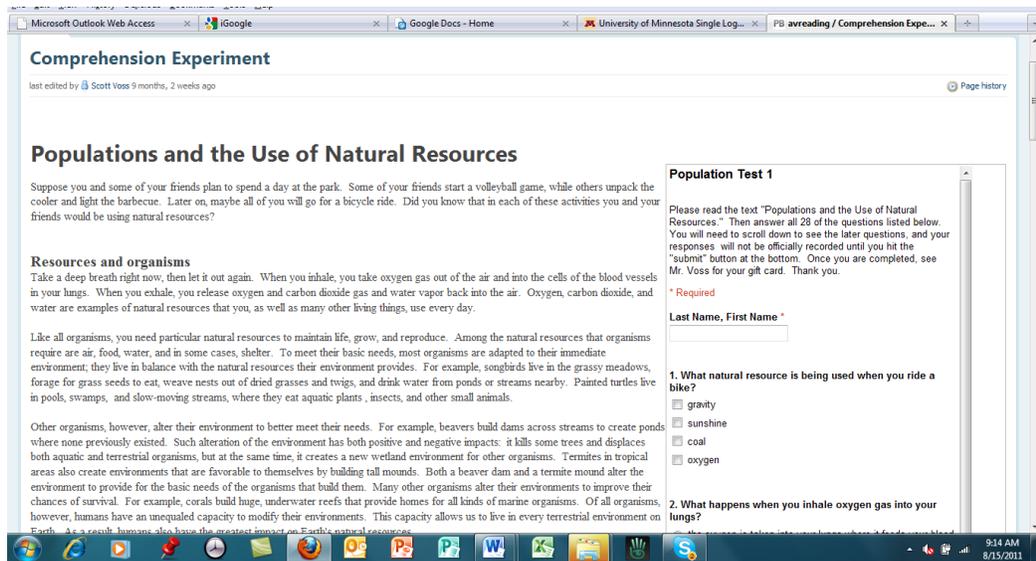
Figure 3.1. Print Only Treatment with the print text and the scrollable window.

As can be seen in the figure, the text is on the left and a scrollable window with the comprehension questions is on the right. No images or color is used for this treatment.

To make the page for print with redundant audio, a recording was made of the text. The recording was divided into five sections, ranging between one minute and three minutes per section. These recordings were then embedded at the top of each section, so that readers could click on the recording and listen to the section as they read along (See Figure 3.2).
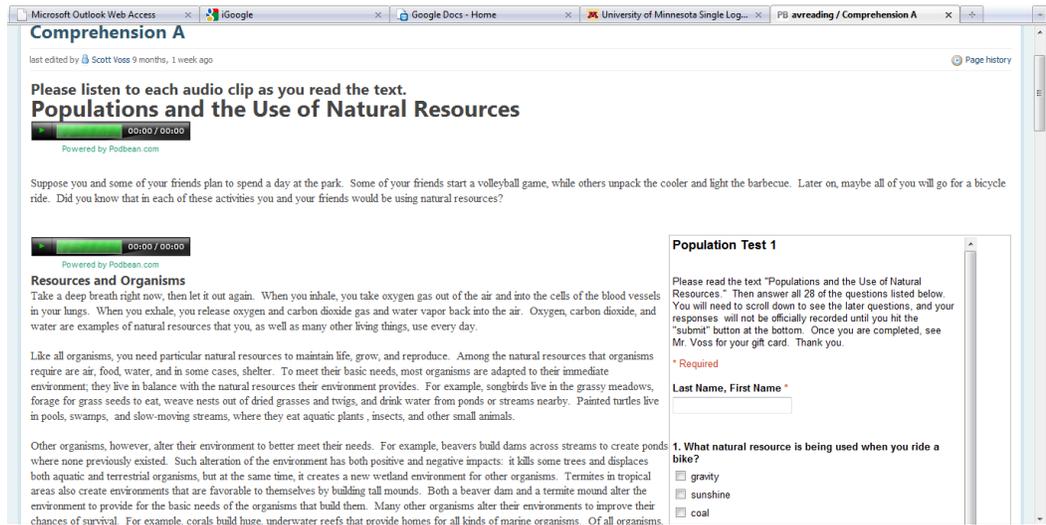
Figure 3.2. Print and Audio Treatment with the embedded audio players at the top of each section of text.

In this figure, once again, the passage's text can be found on the left side of the page with the questions in a scrollable window on the right. At the top of each section, the embedded audio players can be seen.

For the third treatment pictures, graphs and video were embedded in the text. The pictures and graphs from the textbook were included in this treatment along with three short videos which were placed throughout the text: one at the beginning, one in the middle and one at the end (See Figure 3.3).
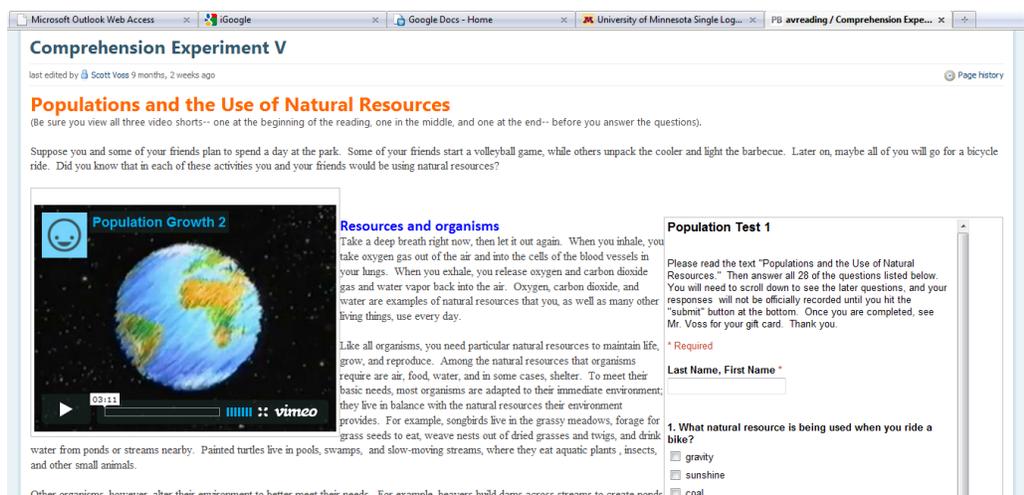
Figure 3.3. Print and Video Treatment with the first embedded video.

From this figure, the first of three embedded videos can be seen at the top of the passage.

The scrollable question window still sits to the right with the main text on the left. The

first video was a general overview of the topic of population taken from commonly used

classroom materials. The other two video shorts were constructed by the research team

to provide the information of the given passages with visual information. The videos

lasted one to three minutes apiece.

Using Google Forms, an online survey / quiz was constructed. Google Forms is

set-up to collect the survey / quiz data and send the information into a spreadsheet,

making it easy to track and manipulate the numbers and responses.

Developing the Guided Interview. While the comprehension measures offered

an indication as to what students understood of the text, and the self-efficacy measures

offered an indication as to how they felt, the qualitative data were used to offer some

insight into what students did as they read the text and to further probe their thoughts and

feelings about reading the text digitally in general and in their assigned treatment in

particular. Thus the interview took on two parts: first, participants were asked to describe their process of reading the text; and second, they were asked to talk a little about their thoughts and experiences with digital texts and digital textbooks.

Part one was constructed along the lines of research designs utilized by Corio and Dobler (2007) and Leu et al (2009), where participants were asked to talk aloud as they read various online texts. While this particular study did not employ a true talk aloud (or verbal protocol), it did involve recording their activity on the screen as they described—and in some cases—demonstrated how they navigated the screen as they read. In this sense, it does not quite resemble a talk aloud, which asks participants to say exactly what they think, as they think it—a real time peek into what might be happening in their brains.

There were a number of reasons why we chose not to utilize a true talk aloud format. First, students would be experiencing the text for a second time. Thus, their thoughts and responses would have been already filtered by the original reading experience and consequently their responses would be more processed than what is common for a true think aloud, where the responses are spontaneous and free-flowing. Second, like any method of data collection, verbal protocols have a number of limitations.

One limitation is that no verbal response can ever be truly real time, to some degree the response is always after the fact. Another potential limitation of verbal protocols is that they are heavily dependent on the verbal skills of the participant, who may not be able to fully explain or describe their thoughts, or at least do so while reading

at the same time. Within the employment of verbal protocols, there is also some

disagreement about how they are to be administered. How much direction should the

participant be given and should they ever be prompted to respond?

Instead of employing a talk aloud, we chose to conduct guided interviews where

participants could demonstrate what they did as they completed the activity. Cohen,

Manion, and Morrison (2002) describe the guided interview approach as one where the

main questions are developed ahead of time. However, the interviewer has flexibility in

both the sequencing and working of the question in the course of the interview. As

Cohen, Manion, and Morrison (2002) explain, this method "increases the

comprehensiveness of the data and makes data collection somewhat systematic for each

respondent" (271). This approach also allows the conversation to be more authentic and

conversational than the more structured interview approaches. They also point out,

however, that important or salient topics can be inadvertently left out of the interview,

and that the variability between each interview might be such that it reduces the

comparability of the responses. To minimize inadvertent omissions, a protocol was

created so that researchers would be consistent in what they asked students to do (see

Appendix F for the Guided Interview Protocol).

The protocol called for students to start the interview by simply reviewing the text

and questions. Once they had re-familiarized themselves with the activity, they were

asked to show—as best they could—how they went about reading the text and answering

the questions. Once the participant had described and / or demonstrated their process for

reading the activity online, the interview would focus on questions like their thoughts on

the texts' difficulty, the layout or formatting of the text (and features) on the screen, and their confidence in completing the quiz. A couple questions were also added to learn about their experiences with digital texts in general and with online textbooks in particular.

Data Sources

Vast amounts of data were collected for this study and the following section will outline those data sources. Since this is a mixed methodology design, the study will be described in two phases: the quantitative and the qualitative.

Phase 1 Quantitative Data. The quantitative data collected for this study included two pieces of information: a comprehension score and a self-efficacy score. These pieces of information offered quantifiable data that afforded the statistical testing of differences in reading across the various treatments. Multiple choice items were assessed as either correct or incorrect, while the constructed response items were assessed by two evaluators who had a 70% inter-rater reliability. Discrepant scores were resolved by a third evaluator.

Phase 2 Qualitative Data. The qualitative data sources included the recorded interviews, done with the assistance of Camtasia (a screencapture software), memos produced by the interviewers, and transcripts produced from the interviews.

Data Analyses

Analysis of Quantitative Data. The questions posed by this study wanted to examine if there were measurable differences between the treatments. Specifically, Question 1 asked whether the different modes (print, audio, and video) had an impact on

comprehension. To test this question, a one-way ANOVA comparing the mean scores of the three treatment groups was run.

Question 3 asked whether there might be a measurable difference between students' reported feelings of self-efficacy across the modalities. Once again, a one-way ANOVA that compared the mean self-efficacy scores of the three treatment groups was employed.

In both cases, the data were tested against important assumptions to verify if there were any potential problems with the skew or variance of the data. Differences were determined as statistically significant if $p< .05$, a generally accepted level for determining significance (Field, 2009).

A Pearson's correlation Coefficient was also run to examine whether there might be a relationship between self-efficacy and comprehension scores.

Analysis of Qualitative Data. The process for analyzing the interviews was developed from the precepts of grounded theory. The following section will describe a little about grounded theory, why it was chosen and how it was applied in this study.

Overview of Grounded Theory. At the heart of employing an inductive analysis, like grounded theory, is the very nature of theory and its relationship to research. Should theory guide inquiry, or should the theory grow naturally from the inquiry itself? Is it possible to suspend all thought and presumption during the collection and coding process, or is that an unrealistic—perhaps naïve—expectation? Does the examination of data within a theoretical vacuum confine research and theory to relatively narrow interpretations or does it protect the findings from bias?

The tenets of grounded theory try to offer some answers to the questions about this relationship of theory to research. Patton (1990) offers a general explanation. "The strategy of inductive designs is to allow the important analysis dimensions to emerge from patterns found in cases under study without presupposing in advance what the important dimensions will be" (44). Two researchers, Glaser and Strauss (1967), sought to base a methodology on the underpinnings of symbolic interactionism—" a sociological approach developed circa 1920–1950 that posits fluid and dynamic processes of interpersonal relating in which meaning is created within and derived from those social interactions" (Fassinger, 2005, p. 156). Eventually, Glaser and Strauss would part theoretical ways. At the heart of their disagreement was whether researchers should consider general models to help them examine the data (Strauss), or whether applying this type of model is inconsistent with the notion of grounded theory that advocates for the theory emerging from the data. In general, I will follow the approach of Strauss and Corbin (1990) who offer some structure to the process that will enable researchers to perhaps consider their data more deeply and richly.

Validity is established with grounded theory through the implementation of a rigorous and thorough process that generally goes as follows. Initial data are collected, written up and reviewed. The first phase of reviewing the data, referred to as "open coding" involves segmenting the data and ascribing labels or tags to these segments using words that are close to those the participant would use. Once this process has been completed the data are then interrogated again to search for alternative interpretations. During this reading, researchers also look for any units they may have missed on the

initial reading. Once the units have been labeled, then the grouping process begins. As a way of getting started, Strauss—and this is where he differs from Glaser-- suggests coding for "conditions," "interactions among actors," "strategies and tactics," and "consequences" (Miles & Huberman, 1994, p. 58). In the second phase, axial coding, the reviewer solidifies the groupings of the data through a systematic and careful interrogation of the categories. Fassinger (2005) offers the following steps, based on the earlier work of Glaser and Strauss.

> A constant comparison method is used, with four different kinds of comparisons: (a) comparing and relating subcategories to categories, (b) comparing categories to new data, (c) expanding the density and complexity of the categories by describing their properties (attributes of a category) and dimensions (ordering of the properties along a continuum), and (d) exploring variations (e.g., disconfirming instances). (Fassinger, 2005, p. 160)

The axial coding solidifies the groupings and sets the stage for the last phase, which is where the researcher looks across the codes to develop a substantive theory. Once the axial codes are set, researchers then look across the codes for patterns and place these codes into categories. For each of these categories, they establish properties that define the category. They also identify exemplars that can be used to support those properties.

Though commonly used to interpret interviews, grounded theory has been used in conjunction with a wide variety of qualitative methods from observations to surveys to verbal protocols. Ivey and Broaddus (2007) used inductive analysis to generate emergent

themes from open-ended prompts on a reading survey of middle school students. Here they describe their process.

> Each researcher kept a research log that documented the data analysis procedures undertaken: categories created, decisions made, subcategories that emerged, and the eventual saturation of data. The two researchers then met to cross-check coding units and final thematic categories for each question. We verified that the same categories and subcategories had emerged across both sites with slightly different terminology used. At this point, we created written step-by-step procedures and a sample analysis of a single classroom to provide a model for the classification of the data. With the help of three research assistants, all of the open-ended responses were classified with the use of these procedures, and each researcher cross-checked data classified by another. (Ivey & Broaddus, 2007, p. 356)

Grounded theory has also been widely used with verbal protocols. Pressley and Hilden (2004) suggest this approach, in particular, can provide new and unique conceptualizations of the reading process. They explain that previous uses of protocol analysis approached the process with assumptions about how people read and they challenged this practice. Using a grounded theory approach frees the researchers from these preconceived assumptions of the reading process and allows them to observe the act without bias. They point to the case of Wyatt et al. (1993) as a good example.

> Wyatt et al. (1993) succeeded in capturing in one study a fuller range of responses because of their general methodological tactics, particularly their use of grounded

theory to construct categories rather than coming to the study with preformed

categories (which was the universal approach to coding data in previous research).

(Pressley & Hilden, 2004, p. 312)

Application of Grounded Theory.   In this particular study, grounded theory was

used to develop a theory that might describe what happens as students read multimodal

texts. Following the completion of the interviews, the recordings were transcribed and

researchers viewed the transcripts while playing the interviews. The early phases of the

analysis were completed by two researchers, thereby allowing for some triangulation of

the data. Initially, a couple of interviews were viewed by each researcher with the task of

labeling each of the statements made by students. Following each interview, a brief

memo was created to capture any immediate or general observations regarding the

conversation. Once this was completed, the researchers met to look across the open

codes to look for groupings that could form axial codes. A code book was created (see

Appendix G for Axial Code Book) and then the primary researcher uploaded the

transcripts into NVivo, a program where the data could be more easily manipulated. In

the next review of the interviews, the transcripts were coded according to each

occurrence of the axial codes that had been developed in the code book.

From this point, the data were segregated by code within NVivo. In this step, the

iteration's placement was confirmed or adjusted, and patterns across the codes were

sought.   After revisiting each of the codes in this fashion, additional writing was

completed to once again organize thoughts and ideas, and to identify places where

different codes might share properties. Eventually, these patterns were clustered into a

general theory, supported by categories, defined by discrete properties, and substantiated by exemplars and key quotations.

In conclusion, a wide variety of instruments were used to collect both quantitative and qualitative data. Together these processes of gathering and analyzing the information have allowed for a deeper consideration of the practices and beliefs of students as they sit down to read academic texts from the screen. In the remaining chapters, the findings of these activities will be discussed. Chapter 4 will discuss the results of the two phases of data collection, and Chapter 5 will offer a discussion about what can be learned from this study and what may need further examination.

Chapter 4

Results

In this chapter I will present the results according to the data sources, beginning with the quantitative data of phase one and then ending with the qualitative data of phase two.

Phase 1 Quantitative Results

The quantitative measures included both the comprehension and self-efficacy scores that were completed in the first part of this study. I will examine the hypotheses of both questions, test key assumptions, and then determine whether there were any statistically significant differences across the treatments. Following that, the results to the Pearson's correlation between the two variables (comprehension and self-efficacy) will be offered, and then Phase 1will close with a general overview of what was found in the quantitative results.

Research Question 1. Question 1 asks whether there might be differences in comprehension across the three modalities (Print Only, Print and Audio, and Print and Video). Therefore, the null and alternate hypotheses can be stated in the following manner.

Before considering these results however, a number of assumptions needed to be met. I will began by examining the assumptions and completing an informal analysis of the data to look for anything that might indicate a flawed or irregular sampling. First, as stated earlier, the participants were randomly assigned to treatments. Though no data were collected on the race or socio-economic status of the participants, they were drawn

from a suburban, high school population that was about 73% White, 14% Black, 7% Hispanic, and 6% Asian with about 25% receiving free and reduced lunch. Students who volunteered for the activity were randomly assigned to a condition, so we can assume that with our sample size the various differences between students will be evenly spread out across the treatments. In so doing, we can then assume that in the event of a statistically significant difference in comprehension scores, we would be able to assert that those differences were the result of the conditions. We can also assume that the samples are independent, since the design of the experiment is between subject, meaning that every student completed only one condition and that their scores are independent of one another. Assumptions of variance can be examined with a look at the boxplot (Figure 4.1) and descriptive statistics.
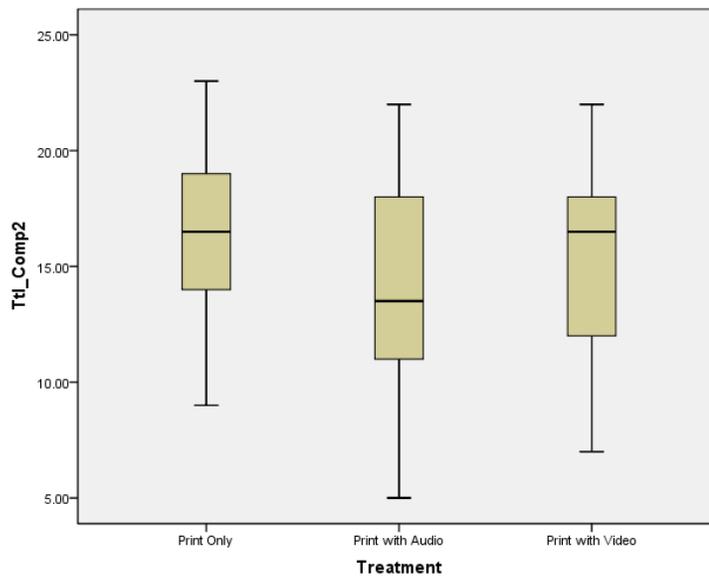
Figure 4.1. Boxplot of comprehension scores segregated by treatment.

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Looking at this data, some observations about the shape, center and variability of the various data sets can be made. Looking at the median scores, the boxplot shows that the print with video treatment and the print only have roughly the same median score, while the print with audio has the lowest. The variability is roughly the same for print only and print with video, but slightly larger for print with audio. There appear to be no outliers in the data, and there are no major problems with skew, (print with video is skewed slightly left, but does not appear to be of great concern). In general, there is nothing from the informal analysis that stands out as concerning.

To test the assumptions of variance (which considers whether any of the conditions might have an abnormally large variability), it is necessary to look at the Lavene's score (Table 4.1).

Table 4.1

Levene's Test of Equal Variances for Dependent Variable of Comprehension

F	df1	df2	Sig.
1.333	2	87	.269

In this case, the null hypotheses of equal variance (p>.05) cannot be rejected, which means that the error variance of the dependent variable is equal across groups. This equal variance can be confirmed by looking at the variance of each category by their squared standard deviations (Table 4.2).

Table 4.2

Descriptive Statistics for the Comprehension Measures

Treatment	Mean	Std. Deviation	N

Print Only	16.1000	3.56564	30
Print with Audio	14.0000	4.55616	30
Print with Video	15.2667	3.90343	30
Total	15.1222	4.07742	90

In this case, the highest standard deviation (print with audio) is not more than four times

larger than the squared deviation of the smallest (print only). Thus, these data meet the

assumption of equal variance. Looking at the residuals, a fairly normal curve in the

histogram is evident (Figure 4.2).
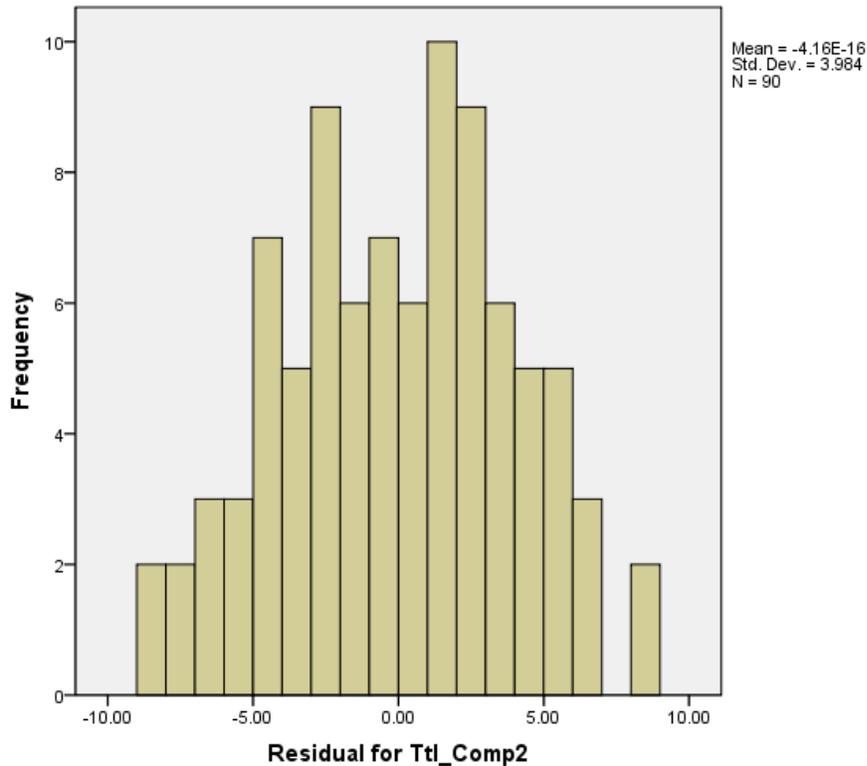
Figure 4.2. Histogram of residuals for the comprehension scores.

Although there is a slight skew in the distribution, it is not significant enough to

invalidate assumptions of the analysis. There is a slight skew to the right, but nothing

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that would indicate a problem. Consequently, the data seem to pass the key assumptions

of both variance and residual error, and it can be further tested for differences in the mean

scores.

To test these differences, a one-way ANOVA procedure was applied to the group

means (Table 4.3).

Table 4.3

ANOVA Results for the Between-Subjects Comparison of Comprehension Scores
Dependent Variable:Ttl_Comp2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	67.089[a]	2	33.544	2.066	.133	.045
Intercept	20581.344	1	20581.344	1267.605	.000	.936
Treatment	67.089	2	33.544	2.066	.133	.045
Error	1412.567	87	16.236			
Total	22061.000	90				
Corrected Total	1479.656	89				

a. R Squared = .045 (Adjusted R Squared = .023)

In looking at these data, the tests show that the differences between the mean scores were

not statistically significant $F(2,87) = 2.06$, $p > .05$. This means that while the print only

condition had a higher mean comprehension score, it could not be determined that this

higher score was the result of the conditions of the experiment. It also means that there

was not an advantage, in terms of comprehension score, to having access to a particular

affordance. A closer examination of these results will be included a little later.

Research Question 3. Research Question 3 asked if access to affordances might

have an effect on feelings of self-efficacy. The hypothesis for this question mirrors that of

the comprehension measure.

Once again, it is necessary to consider the assumptions of the design. The

samples were randomly assigned and independent of each other, so these assumptions are

met. An informal look at the box plot shows that the median scores of the three

conditions are relatively close (Figure 4.3).
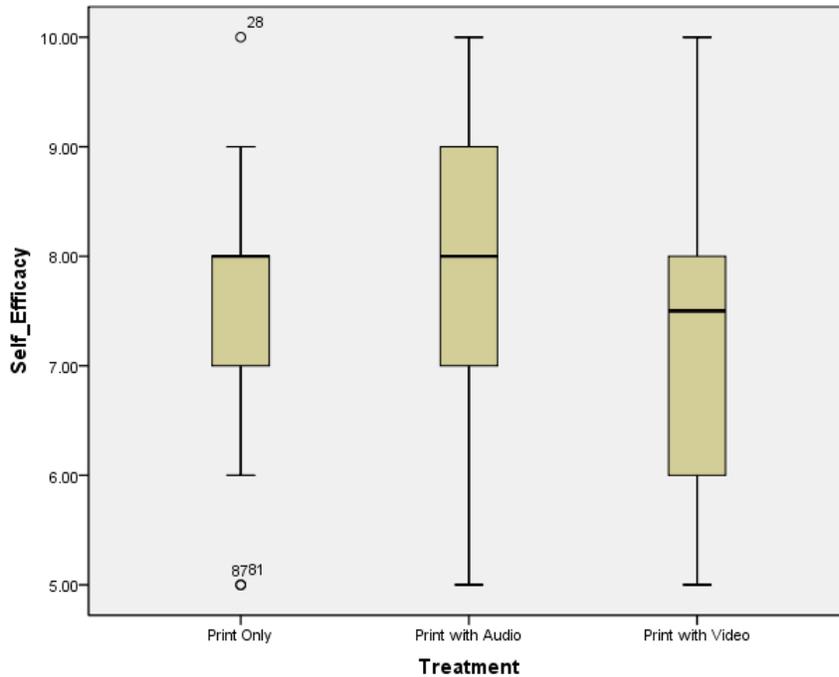
Figure 4.3. Boxplot of self-efficacy scores by treatment.

Figure 4.3 indicates that the print and audio scores seem to be slightly higher than print

only, which in turn is just slightly higher than print with video. There are a few outliers

in the print only condition. Two scores appeared to be rather low and one was rather

high. However, it should be noted that the variability, when one factors in these outliers,

wass loosely the same across the three conditions. The outliers in condition one (print

only) seem to be more a statement about the rather tight clustering of the scores than the

extremity of those individual cases. While this is notable, I decided to pursue further

tests of the data with caution. Other elements of the data look reasonably sound. There

is a slight skew for both of the other conditions, but nothing that would raise alarm.

Assumptions of homogeneity of equal variance appeared to also be met. The

squared standard deviations (Table 4.4) indicated that the smallest deviation (print with

audio) was not four times the smallest (print only).

Table 4.4

Descriptive Statistics for Self-Efficacy

Treatment	Mean	Std. Deviation	N
Print Only	7.5000	1.22474	30
Print with Audio	7.8333	1.39168	30
Print with Video	7.3667	1.37674	30
Total	7.5667	1.33282	90

This test of equal variance was consistent with the Lavene's data (Table 4.5).

Table 4.5

Levene's Test of Equality of Error Variances for Dependent Variable of Self-Efficacy

F	df1	df2	Sig.
.422	2	87	.657
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.			
a. Design: Intercept + Treatment			

Once again, since p>.05 (.655), the variance of scores across the treatments did not

indicate an irregular or extreme skew. Therefore, there is an equal amount of variance

across the groups.

Finally, an examination of the residuals did not indicate an abnormal shape or

skew (Figure 4.4).
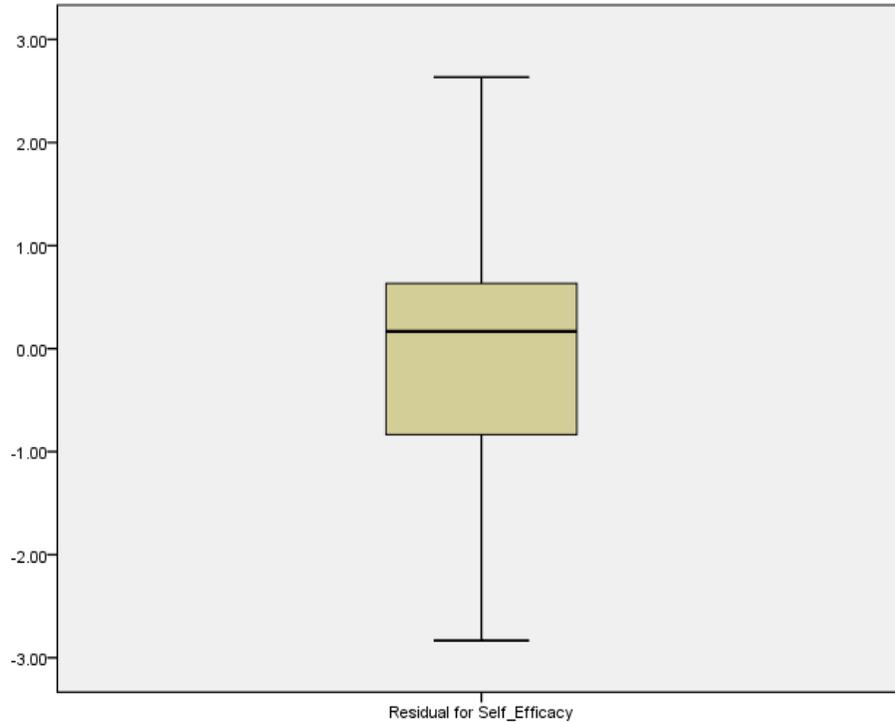
Figure 4.4. Boxplot of residuals for the self-efficacy scores.

Looking at the median score of the residual, it does not exactly split the middle

quartiles, but the skew is not severe enough to cause concern. With these assumptions

met, a one-way ANOVA procedure was run (Table 4.6).

Table 4.6

ANOVA Results for the Between-Subjects Comparison of Self-Efficacy Scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.467[a]	2	1.733	.975	.381	.022
Intercept	5152.900	1	5152.900	2899.131	.000	.971
Treatment	3.467	2	1.733	.975	.381	.022
Error	154.633	87	1.777			
Total	5311.000	90				

Corrected Total	158.100	89			

a. R Squared = .022 (Adjusted R Squared = -.001)

The results indicated that there was not a statistically significant difference in mean scores for self-efficacy across the conditions, $F(2,87)=.975$, $p> .05$. Hence, while print and audio had slightly higher mean scores, they were not significantly different from the other two conditions in regards to the self-reported scores of self-efficacy. Consequently, by this measure at least, there was not a significant difference in how students perceived the difficulty of the task according to the treatment they had been assigned.

Correlations. Previous research indicates that comprehension does correlate with self-efficacy. In order to test whether that condition held true for this activity a Pearson's Correlation test was run with the two variables (Table 4.7).

Table 4.7

Correlations

		Self_Efficacy	Ttl_Comp2
Self_Efficacy	Pearson Correlation	1	.463[**]
	Sig. (1-tailed)		.000
	N	90	90
Ttl_Comp2	Pearson Correlation	.463[**]	1
	Sig. (1-tailed)	.000	
	N	90	90

**. Correlation is significant at the 0.01 level (1-tailed).

As indicated in Table 4.7, the Pearson Correlation test indicated that there was a positive relationship between the comprehension scores and the self-efficacy scores (r=.46, p>.01). In general, students who did well on the reading activity typically believed that they had done well on it. However, it should be noted that though there was relationship, the correlation was weak ($r^2 = .21$). In practical terms, this means that self-efficacy accounted for 21% of the variation in the comprehension scores, while 79% of the variation was accounted by other factors. Though weak, it is likely a pretty important accounting of variance, considering the complex and numerous factors that contribute to comprehension as a whole. Overall, however, the correlation here is consistent with past findings.

Analysis of Quantitative Results. As indicated by both the tests for comprehension and self-efficacy, it was determined that there was not a statistically significant difference between the conditions. For comprehension, this means that according to this particular study, we could not find a difference between the print only, print and audio, and print and video treatments in regards to overall comprehension. At least, we would not be able to confidently state that any differences between these conditions were the result of the conditions themselves. Consequently, more studies along these lines would need to be developed to examine how these affordances impact reading when readers are given a choice to use an affordance.

Phase 2 Qualitative Results

I set out to examine the differences in comprehension scores and the differences in reading processes across the affordances. To do this, as mentioned in Chapter 3,

interviews were conducted that asked students to not only talk about their process for reading the text, but also their thoughts and feelings as they did so and their perceptions of reading online in general (see Appendix F). A total of 29 students were interviewed. Thirty had been scheduled, but one student never came in for the interview. Another two interviews were unusable due to technical difficulties.

Following the interviews, they were then transcribed and analyzed using constant-comparison (Glaser & Strauss, 1967). As mentioned in Chapter 3, researchers began by reading and mining the transcripts. As they did so, they begin to label each comment or iteration using open codes. Once this was completed, the researchers reviewed this coding again. In the process they merged, renamed, or eliminated the open codes into more concrete codes, which are referred to here as axial codes. After the axial codes were clearly defined, they were then reviewed again, this time for properties they might share with each other. This review resulted in the formulation of categories, which were then clearly defined using their shared properties. Exemplars were then identified for those properties. From this examination of categories and properties, assertions were made and a general theory was constructed. The following section will define these categories, and then offer subcategories, properties, exemplars, and negative case examples used to develop them. In looking across the data, I created the following categories: affordances of texts, the approaches of reading multimodal texts, and the perceptions of self-efficacy. Figure 4.5 provides a visual display of the categories and their subcategories. In the remainder of this chapter, I will define these categories and subcategories, and offer some assertions about what this data seem to say.

Affordances of Texts

- Audio Affordances
- Video Affordances
- Formatting Affordances
- Digital Affordances

Apporaches to Reading Multimodal Texts

- More Strategic
- Flexible
- Less Strategic

Perceptions of Self-Efficacy

- Unrelated to a Specifc Affordance
- Related to a Specific Affordance
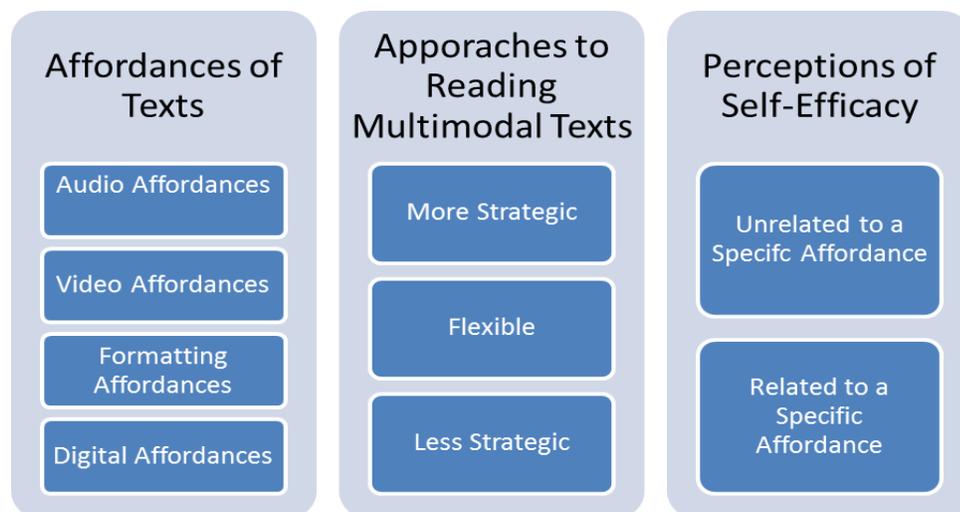
Figure 4.5. Visual display of the three categories with subcategories listed beneath each.

Throughout these responses, I will sometimes identify a student as a "struggling" or "advanced" reader. Though I was unable to collect enough data for the main experiment to segregate the scores by ability, I was able to generally identify student reading ability for this group of students by looking at their 8th grade state reading test score and / or their placement in English (e.g. Honors English, English or the reading intervention course).

Affordances of the Texts. This first category was constructed from student responses to the various affordances of the text. These thoughts and feelings address references to what they thought of the various affordances and what they perceived as the intended purpose of them in relation to what they had hoped to accomplish within this given activity. To briefly contrast this category with the other two (the process of reading multimodally and perceptions of self-efficacy), I reiterate that these responses directly related to their understandings of the affordances. In the second category, process of

reading multimodally, the responses directly address how the students used those affordances, while in the third category, the responses indicate how the students felt about those affordances in relation to completing academic reading tasks, like answering questions on a test.

The category for the affordances of texts can best be defined by its subcategories, which were created around the affordances: audio, video, formatting and other digital features. In this section, I will examine what students said about those affordances within each of those subcategories, starting with the audio.

Perceived Affordances of Audio. Throughout the interviews, we talked specifically with students about their thoughts of the affordances they had been assigned. We asked them about what they thought of having access to the audio or the video, but we also asked all students about their thoughts more generally about these modalities. In other words, regardless of their treatment group, we asked them, "What effect might audio and video features have on your ability to read the texts?"

Participants within the print and audio treatment expressed favorable reactions to the affordance. The majority expressed an appreciation for being able to complement their reading with the audio supplement. Beth's response is an exemplar of this category. "I was able to hear it as well as follow along in the reading" (interview, 11/22/10). There were four properties of the audio affordance that students mentioned. First, it allowed them to think more deeply about the material, second it helped them maintain focus, third it was easy for them to control and manipulate, and fourth, it provided help with hard to read words.

The first property of this category, affordances of audio, indicates how the audio enabled students to consider the text on a higher level. An exemplar can be taken from Carrie, a student who had a lower score on the 8th grade state mandated reading test, but who was taking honors English classes. She offered the following thought when she was asked if she liked having access to the audio recordings.

> Yeah, I kind of like this better because I can, like uhm, when he reads it to me I can comprehend in my head what I'm thinking and then go over it with the question and get more in depth and then instead of just like reading it. That's what I like about that. (interview, 11/23/10)

Another struggling reader, said, "I get caught up with all of the words –It usually jumbles up in one big sentence. But with this I can like pick out the words. It is less hard, especially with the audio" (interview, 11/24/10). This property of audio affordance shows that readers who might struggle with reading text off the page (whether they struggle with decoding or fluency, or perhaps background knowledge) might benefit from the audio feature because they would be able to "free up" the processes normally devoted to those functions, in order to concentrate on other functions like integrating, connecting or evaluating. Another student expressed this idea, but not in reference to this particular reading. She, an advanced reader, indicated that the audio was of no help to her here. However, in situations where the text might be more challenging, she said she would have found this to be a more helpful feature.

A second property of the audio affordances subcategory suggests that students were able to better focus on the text. Rachel was one of four students interviewed who

expressed this sentiment. She too would be defined as a struggling reader, testing low in

her 8th grade state reading score and taking the reading intervention course.

> It's because like when you are reading by yourself. . . it can get you off track
>
> thinking about a volleyball game or something but if someone is actually reading
>
> to you in your head you just keep listening to it without your mind going
>
> sidetracked or anything like that. (interview, 11/24/10)

Another student pointed out this same idea in reference to our reading activity. She said

that with the noise and distraction happening around her, the audio enabled her to stay on

track and reduce the stimuli that would have normally interrupted her.

Within this second property, the ability to focus with the audio affordance,

students also mentioned their tendency to multitask, which might be also be considered a

type of distraction. More than the print and video treatment, students in the print and

audio treatment were much more likely to multitask as the audio played. Brenda, a

student of average reading ability, indicated how she listened and read the text

concurrently, and then at the end of each section would stop and answer questions. If she

came across a question she could not resolve from this section, instead of re-reading it,

she would hit the play button and listen to it as she examined the question stems.

> I found it pretty easy because all the information we needed was in the reading
>
> and I was able to listen to it while reading it which helped and then I was able to
>
> hear the person 's voice and then answer the questions as he was reading.
>
> (interview, 11/23/10)

Another student expressed a similar practice, whereby he would hit play and then focus on the questions versus read along with the text. A third, who belonged to the print only condition, commented on the use of audio. He felt that if he were given the audio feature, it would work against him because his mind would be more likely to wander.

> Well, I think the audio would probably be more of the distraction because I've tried to use it during studying, but when I have something reading more tending to look away and talk to someone else since I don't need to focus. (interview, 11/24/10)

There is something about the audio affordance that appears to free the reader from having to read the text off the screen. For some, it allowed them to devote their attention to the questions being asked, while for others, it seemed to create a circumstance where they were more likely to be visually distracted. This differs from the print only and print and video treatment, where students were less likely to multitask. One reason could be that the video, unlike the audio, was designed to be used non-concurrently. In other words, the videos were not re-statements of the text, but rather general, visual overviews of concepts within those sections. Additionally, the visual affordance of the video did not lend itself as easily to the practice of multitasking with another visually demanding practice, namely that of reading.

A third property of the audio affordances was their perceptions of control over the affordance. Students within the audio condition who found the affordance to be useful stated that they could control or manipulate it to their satisfaction. For example, students like Beth seemed to appreciate the audio affordance not only because it helped her

"remember" information, but because she found a way to manipulate it. "I read the question and went back, listened to the audio again, and then paused it after I hear it, and then read" (interview, 11/22/10). Beth was able to establish a system where she could navigate back and forth from the questions, the text, and the audio in order to find what she needed. She would even manage the audio file by rewinding, and replaying sections for clarity. Jeff also commented on his adept use of the audio feature, preferring to review the text by listening to it section by section versus re-reading the text off the screen.

By the same means, others like Anna and Helen, directly linked their dissatisfaction with the affordance to their inability to control it. Anna, who would be defined as an advanced reader by her previous test scores and enrollment in honors English courses, stated that the audio read at a slower pace than she preferred. "I, well I kind of read ahead of the audio and then I would wait for it to finish the paragraph and then I would start the next one and then read ahead and I would wait for it to finish again" (interview, 11/23/10). Helen, along those same lines, expressed her thoughts on the audio.

> Helen: Except it was kind of slow, so I think if there was a way you could speed it up it would be easier.
>
> Interviewer: By slow you mean, that you would click play and there was a lag, or that it was reading it slow. . .
>
> Helen: Yeah, when I was reading, it was just, like I kind of got a little distracted. (interview, 11/23/10)

In both of their cases, they stated that the pace of the audio was too slow and that they wanted to speed it up. Once again, there seemed to be a relationship between a student's perceived ability to control the affordance and their perception of its usefulness.

Finally, a fourth property of the audio affordances was that students were aware of how the audio function could help them make sense of, and pronounce, difficult words. Speaking specifically of her experience with the reading activity, one student, another struggling reader, commented, "I thought it was helpful cause, some of the words, like, I would like, miss some and then when I would click the audio, I would hear it, and then I would get it—back in my head" (interview, 11/24/10).

In these cases, where the students had a much stronger command of the reading material, and where they did not struggle as much with the language, syntax, or content, the audio did not seem to provide any benefit to their reading experience. Helen suggested that the cause of distraction was her learning style.

> I feel like audio would probably make me more chaotic and I would understand it more, instead it being easier for me because reading texts I can normally understand it compared to hearing it and I would just be like okay. But when I read it I would understand it better. (interview, 11/23/10)

Perceived Affordances of Video. Like the thoughts for the audio affordance, students had favorable impressions of the video affordance. Shelia provides a rather simple exemplar when she stated it, "I think it helped me" (interview, 11/24/10). Properties of this subcategory include its ability to provide an overview, build interest, and improve understanding.

Providing an Overview. One property of the video afforance was that students recognized how the videos provided an overview of a section. And if students were able to accurately recognize this purpose, they would often perceive the affordance as useful. For example, Jeremy explained this when he described why he watched the videos. "Like I watched that one first, like pretty much to see what I was going to learn about and then on my way down I kept on watching the videos first and then reading the next section" (interview, 11/23/10). Along these same lines, Michael identified the purpose of the videos. "Yeah, like it [the video] just kind of gave me, the video kind of gave me an idea of what the section was about, and then what this section was about" (interview, 11/24/10). In these cases, the students found the videos to be helpful.

Some students did not find the videos to be helpful, however. Suzanne, who felt as though they were not helpful, stated that she preferred to read the text to get her information. "To me with reading things like passages and stuff uhm, videos don't really help me. Visually I need to have like the text. I don't get it as well if it is just in video and just listening" (interview, 11/23/10). Robert was another student who did not feel as though videos were necessary. "Didn't really help," he said. "They really didn't make that much sense to me" (interview, 11/22/10). Robert, who scored well on the activity, indicates here that he did not understand the intended purpose of the videos and that he could not directly answer the quiz questions from watching those clips. These case underscore the relationship between perceiving the video's purpose and finding it useful.

Building Interest. A second property of the video affordances reveals that students recognized how the videos would make the topics more interesting. Kurt, who had been assigned to the print only condition, offered the idea that video would certainly "make the page a little more like interesting so that kids would be more attracted to it rather than just being like, oh, it's a blank screen with some words on it" (interview, 11/23/10). Kate, who had been in the video treatment offered the same idea, stating that it was "a little bit interesting" to have the videos available (interview, 11/24/10).

Improving Comprehension. The third property of this subcategory is that students believed the videos would improve their comprehension. For example, Kate suggested that the video helped her keep the information in her head. She states that, "You remember it better" when you have the video (interview, 11/24/10). David, a struggling reader, explains how it would help him visualize the text better. "I think this is actually like better than the textbook because you can see videos, and textbooks has like just the pictures explaining why and what they are. And some people don't understand that, and some people get lost" (interview, 11/23/10). In this case, he suggests that not only do the pictures and video "explain" the material, but that they allow students to identify the important ideas of a text. This same idea was repeated by Michael who suggested that "I think it was easier than a textbook because like the videos you could actually like hear the person talk and. . . and this got straight to the point and stuff" (interview, 11/24/10). There was also an indication, similar to the print and audio group, that the video affordance allowed students the chance to think more deeply about the material. David indicated this when he was asked about the different types of questions that he was asked.

Interviewer: You think the video in here might have helped you do a better job on

both [the multiple choice and open ended questions]?

David: Yeah.

Interviewer: Both types of questions?

David: The video I think helped more with the open ended and reading helped

more on the multiple choice. (interview, 11/23/10)

Like some students in the audio treatment, David felt that the video essentially allowed

him to consider the text differently because it made understanding the big ideas, easier.

Perceived Affordances of Formatting. One subcategory that seemed to develop

from the patterns regarded how the screen was formatted. In other words many of the

students commented about the set-up of the screen, with the text (e.g. print text, audio

features and video) on the main part of the screen, and the questions in a scrolling box

along the right side (Figure 4.6).
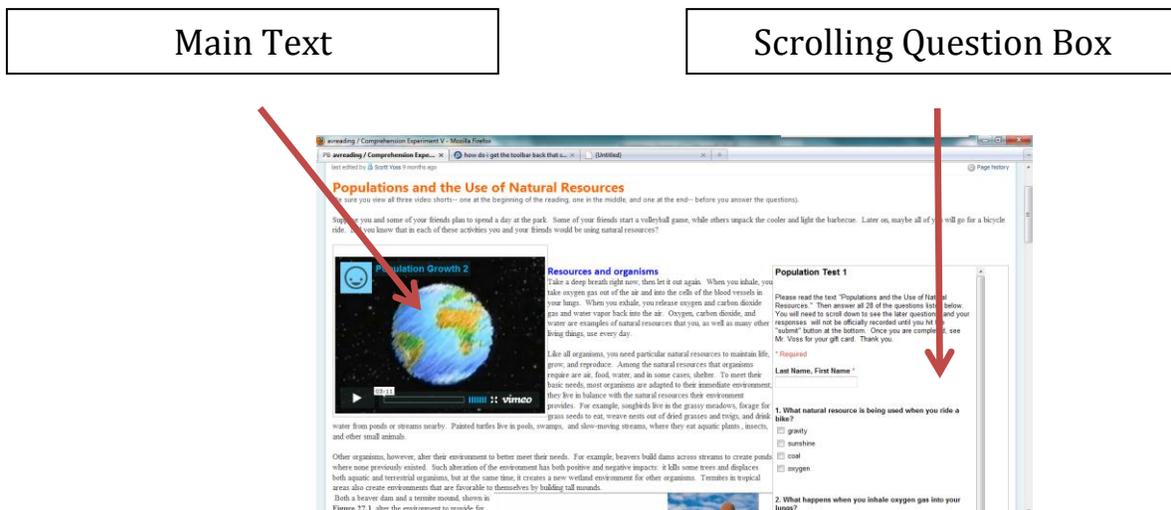
Figure 4.6. Formatting of online reading screen with scrollable question box on the right.

My co-researcher and I were surprised by the number of responses regarding the split screen. In fact, the feature was designed to eliminate the need for paper, for the convenience of not having to write answers off a screen, and for the ability to manipulate the data through the databases where the answers would be collected. What we discovered was that students across all of the treatments found this formatting (text on left, questions on right) to be a useful affordance of the digital text.

Nineteen of the 27 students offered some type of unsolicited comments about the split screen formatting of the page. Of those students, eighteen of the students commented favorably about the design. Two properties of the formatting affordances could be discerned: tracking the questions and manipulating the screen.

Tracking Questions. This property of responses indicated that student favored the formatting of the screen because it allowed them the chance to line-up the question with the text of interest. In general, many of them believed that answering the questions was easier because of the split screen. Helen, for example, who called it "the split screen" explained why she liked the set-up. "I liked this split screen. Like how you would have the questions on one side here, so you could read the questions" (interview, 11/23/10). Kurt suggested that this affordance allowed him to visually line-up the question alongside the section of text where the answer might be. "I can see both where I found the answer in the, in the reading and where the answer is on the, on the question so that I know they are corresponding, and I know that that's the answer I want to pick" (interview, 11/23/10). This visual affordance of allowing students to manipulate the text

so that the questions correspond to the general location of the text seemed to help them target the responses and to manage their searches more efficiently.

One student did not appreciate the formatting affordance of the activity, and another mentioned that it took a little time before she learned to manage the scroll bars. Carrie expressed some confusion about how the scrolling question box was supposed to work.

> I noticed that I kind of moved this bar and kind of like changed where I was supposed to be, so I had to go back and like change it because it moved around and I didn't know if they were like in certain paragraphs with it with the questions. (interview, 11/23/10)

She went on to express a frustration with her ability to control two scroll bars— one for the page as a whole, and one for the questions. Laura also expressed some initial confusion, but she stated that once she played with the scroll bars she was able to use them to her advantage.

Manipulating the Screen. This property included comments about the digital formatting that refer to how students were better able to move about the text than in other situations. These responses suggest that this affordance allowed students to more easily control the texts and thus avoid the hassle of flipping back and forth on a physical page. Eli offered the most common response by simply saying, "I liked that [the split screen] because it was easy just to switch back" (interview, 11/24/10). Robert offered a similar explanation. "You can go back easier because then you don't have to flip through all the pages. You can scroll up and down instead" (interview, 11/22/10).

Paul offered a similar response. In the following excerpt, the interviewer asks him to explain why he liked the formatting.

Interviewer: What do you like about that specifically? What's the big appeal there?

Paul: Well that you can match the specific questions to like text. Like this paragraph is about that question there.

Interviewer: So I can go over here and the questions aren't on a couple of pages away from the end of the text. They are just right here with the scroll bar.

Paul: You don't always have to be flipping back and forth to . . . (interview, 11/23/10)

Three students indicated that online versions of these textbooks would be better than the print versions specifically because of this affordance. Brenda indicated this in her response when she offered the following comment.

I found it a lot easier than reading a book and having to flip between the pages because it's all on one page because in books there is probably a couple pages of reading and on the last pages there's questions and so rather than flipping back and forth I found it a lot easier and less time-consuming and like I said is easier for me to look back and answer and understand it. (interview, 11/22/10)

Kurt expressed a similar sentiment when he compared this test to the traditional paper and pencil tests. "It's not like, like a paper test where you have the reading section and then you have like the questions on the other page, so you keep flipping back and forth, you're able to see it like right there" (interview, 11/23/10).

Perceived Affordances of Digital Texts. As students began to talk about how they interacted with the texts on the screen, what they liked and disliked about the formatting, and what they would like to see in digital online texts in the future, they referred to a number of digital affordances that stood apart from print text affordances. Students consistently mentioned four digital affordances (beyond audio, video and formatting) which I have labeled as digital affordances. These digital affordances include the properties of access, interaction, supplemental resources, and tracking. This section will examine student responses along these four patterns. And then, it will conclude with a list of other lesser mentioned affordances.

Access. Many times throughout the interviews students referred to the affordance of gaining easier access to texts when they were moved to the digital space. This property refers to the student belief that it is more convenient to access to the text online than it would be to carry around the print versions of these texts. Typically, students mentioned this in reference to either having the benefit of going online for their books when they left them at school, or the benefit of not having to carry bulky textbooks back and forth from school.

A few stated that an affordance of access enabled them to visit the text online when they forgot their print textbooks at school. Kurt stated, "It's more mobile, like I can go home and sit down with my laptop and get on" (interview, 11/23/10). While Eli mentioned, "It's like you forget your textbook, if, if you don't have it, you can just use it at home" (interview, 11/24/10). In the following interaction, the interviewer asked why digital texts might exist.

Interviewer: Why are there versions of those textbooks online? What do the teachers say about why do we have, why do they have an online version of the book?

Kate: They say that if we forget our textbooks at home or at school, we can use the textbook. . . (interview, 11/24/10)

Others mentioned that it is just convenient to not carry around their texts. Michael referred to this when he said, "If we don't want to carry your book around and you just want to leave it at school, just like for the classes, and then at home you could just use the online textbook" (interview, 11/24/10). One student said that it would mean less "hauling around" of textbooks, while still another mentioned that it would be less of a hassle. Still another expressed the convenience of carrying one laptop or tablet in her bag versus a number of textbooks. "If you have all of your textbooks online then you can carry one, you wouldn't have to carry all the textbooks you needed" (interview, 11/24/10). Brenda went into some detail about the convenience of using digital texts.

So I end up taking those home, but if I know I could access them online I probably would because it would be a lot less heavy hauling and coz sometimes I have to take two to three books home and my books weigh a lot. One time I weighed it and my backpack was over twenty pounds and so was really heavy and sometimes I have to walk home, so it would be nice if they were online, but if they're not then I have to take them home. (interview, 11/23/10)

Access was perhaps the most often mentioned affordances of moving textbooks to online spaces.

Interaction. Beyond just the property of having access to this text from any computer, a good number of students mentioned the property of interactiviting with the text. I use this term "interactive" here, largely because it was the term used by students. In their explanations of what they liked about reading texts online, or what they would like to see in the future, they frequently used this term in relationship to features that they felt would allow them to become more involved with the text.

Some students, like Jeff, simply stated that the digital versions of text were more "interactive" (interview, 11/23/10). Others, like Jackie, a struggling reader, mentioned that the online versions allowed her to do more with her hands, referring to the ability to highlight text on the screen, to track words with the cursor, or to click on hyperlinks. Kurt mentioned a number of features that could make the text more interactive.

> I think you could make it like a little more, like put some more interactive things
> into it, like maybe after you're done reading a section you watch like a video that
> summarizes it or you have like a little activity that . . . helps you understand what
> you just read. (interview, 11/23/10)

Laura mentioned two other common interactive features of digital spaces, playing games and chatting. "I like playing games, so you could put the text into a, like, game, I don't know. Like chatting with people—if they were on the same server, or whatever or if they want to comment on stuff" (interview, 11/24/10).

This property is also defined by features like chatting, instant messaging and networking around online digital textbooks. These affordances I will classify as uniquely

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interactive since they seem to blur the lines between producing and consuming text.   A

good exemplar is provided by Shelia in the following exchange.

> Shelia: I think that how you have that chat and then click on there for like instant
>
> messaging, like maybe between the teacher or someone, you would be able to ask
>
> them questions.
>
> Interviewer: (Jokingly) You could bug the teacher all the time.
>
> Shelia: (Laughter)
>
> Interview: But you could post comments, post questions that your friends could--
>
> Shelia: Yeah that would definitely be good. (interview, 11/24/10)

Lisa indicated the same thought when she stated, "People can start little chat sites and

start talking about this stuff and, I guess, it would be easier then" (interview, 11/24/10).

Michael got a little more detailed with his explanation.

> Like if someone writes a book then they could just say what the book is and stuff
>
> like that, and people could help each other with stuff like this if they had a little
>
> chat room or something down there, and they could both have the same page, and
>
> questions. (interview, 11/24/10)

Though the last two discernable properties of digital affordances—supplemental

resources and tracking-- could be classified as interactive as well, I have separated them

out because their stated purpose appeared to be something more than just a means of

"interacting" with the text. Though both properties (supplemental resources and

tracking) would allow for greater interaction, they could be more clearly defined by other

purposes.

Supplemental Resources. The third property of the digital affordance subcategory highlights the additional materials that are offered with the digital versions. Students mentioned hyperlinks on words, concepts, or ideas that might need more explanation. Jackie offers a key quotation. "Usually when like there is text online they have sites you can click on too, like, if they like give you an example of carrying, say like the carrying capacity, you would be able to click on that and view like, like the actually definition" (interview, 11/24/10). In the following exchange, Jeremy explains that he likes the online versions better than the print texts because of this feature.

> Jeremy: I like the computer better than on the book just because I can understand it better, and…
>
> Interview: Why do you think you can understand it more on the computer versus-
>
> Jeremy: Because they lay it out easier and they, like if you don't understand a word sometimes they like have it highlighted and click it or you can look it up on like a different page. (interview, 11/23/10)

Five other students explained how they liked using "vocabulary" features on websites, especially within the content area of Spanish. They appreciated not only the chance to click on the word and hear it, but other additional resources like making flash cards from which they could study. A few others mentioned that just being able to read the texts on a computer would make it easier to search for additional materials on their own. For example, Margaret said, "If you are on a laptop you could look up stuff on the internet if you needed to, so that would work too" (interview, 11/23/10).

The property of having additional resources proved to be an important factor to students. It was an affordance that they usually voiced while comparing digital online texts to print texts. The last pattern of the digital affordances was not quite as popular as the other three; however, it was mentioned frequently enough to warrant discussion here.

Tracking. As mentioned above, students offered their thoughts on a wide variety of digital affordances. The first three include the properties of access, interaction, and supplemental resources were affordances unique to the digital realm. The fourth property of tracking, though , is an affordance that can be done in either print or digital texts. In their descriptions, however, students typically suggested that it was easier to track on the screen than on paper. The term tracking will be used here to describe how a student would manipulate screen features to focus their visual field on words or sections of text. They described this affordance in a number of ways.

A few students mentioned how they would use the browser window or frame to visually track their reading. Brandon stated, "You can also use the top thing (pointing to the window frame of the screen) as a guideline if you keep re-reading the same" (interview, 11/24/10). In the following excerpt, Andrew talked about a similar practice that he employed when reading the text on the screen.

> Andrew: Scroll up and down and then have, where, having what I am reading at
> the top, and then just scroll down to the top. Like I read this, I scroll down and I
> read that. And that's how I basically read the entire thing.
> Interviewer: Just to clarify, were you using, in other words, this, essentially this
> top to help you track the lines, you mean?

Andrew: More like the paragraphs but yeah. (interview, 11/22/10)

Jackie offered the idea that she would use the cursor as she read to track words. After

watching her do this, I asked her about it.

Interview: I noticed that you were likely to use the cursor to follow or track where

you were reading then, as well.

Jackie: Yeah. Like I'll do it with my pencil or something but it ends up by

drawing it in the book and I'll have to erase it. (interview, 11/24/10)

Throughout the activity, I observed a number of students who made use of the cursor in

this way. It served almost like a finger, or as Jackie mentioned a pencil, that would move

across the page to focus the visual field of the reader. Looking through my observation

notes for the activity, I made note of six students who tended to do this on a regular basis,

a practice shared by students across treatments and abilities. Terry mentioned this

practice in her interview when she referred to what she could do on the screen when

reading the text. "Like you can move like your cursor. Like for like text you can

highlight it sometimes if you need to" (interview, 11/22/10).

Terry actually indicated two different types of tracking. The first was with her

cursor, and the second was the practice of highlighting text as she read along. A few

other students mentioned this practice as well. In some cases, like Andrew, students

mentioned that they would do this to a section as they read it. Other students, mentioned

that this was a good way to essentially mark things (albeit temporarily) in order to find it

more easily when they had to move back and forth from the questions. An example of

this can be found in an internal memo I had written about Kate. "When referring back to

the text with the questions on the side, she [Kate] would use the highlighting affordance to hold her place in the text while she navigated back and forth form the text" (internal memo, 4/12/11). Terry found that this affordance was unique to digital texts since readers cannot write or highlight in their school textbooks. "You can highlight stuff that you want to make sure that you remember. But in a textbook you can't do that because you can't write in it" (interview, 11/22/10). Extending his thoughts above, Brandon also pointed out this affordance. "Also, I'm not sure if this would really count, but you would be able to highlight and copy so you can get more information on something if you needed to" (interview, 11/24/10).

Beyond these four properties of digital affordances (access, interaction, supplemental resources, and tracking), there were a host of other creative and interesting potential affordances that students discussed. However, most of them were mentioned by only one or two students, so it would be misleading to suggest that these were shared properties. Some of the affordances, like copying and pasting, according to students, might allow for better note taking or the means by which they could more readily organize or manipulate their readings (e.g. create their own study guides). Three of them described visual affordances (e.g. use of more color, graphs, pictures, and videos). And a few suggested that digital texts were often shortened for the screen to accommodate that environment. In a memo I wrote after Jeff's interview, I wrote, "Jeff also felt that reading online would be easier because you would not have to page through the text to find the assigned reading and that you would have shorter texts" (internal memo, 4/12/11). Some students seemed to think that transferring the texts to online spaces

would mean changing the very nature of those texts, converting lengthy print-centric descriptions to more visual, less print-centric displays.

Students talked a lot about the affordances of these texts. Not only did they discuss the affordances we asked about explicitly (e.g. audio and video) but the affordances that they perceived on their own (e.g. formatting and other digital affordances). Though their thoughts indicated how they perceived these affordances, they do not offer much insight into how they were used or how they might have had an impact on a student's sense of self-efficacy. The next two sections of this chapter will define these categories: processes of reading multimodal texts and perceptions of self-efficacy.

Approaches to Reading Multimodal Texts. An important part of our interviews centered on a student description of how they worked their way through the text. Students were told at the outset of the interview to re-familiarize themselves with the text and the questions, and in some cases they spent five to ten minutes working their way through the text. This gave us the opportunity to watch and record their screen activity to see what types of things they did within the digital format. Following that opportunity to review the text and questions, students were simply asked to describe the process they employed as they completed the activity. These responses have been grouped into the category of approaches to reading multimodal texts.

Upon a review of the responses, it was evident that students had a variety of approaches to reading the texts, which could be examined across the treatments. These

approaches could be subcategorized as those that were strategic, those that were flexible, and those that were less strategic.

In general, these subcategories can be defined by the following properties. A student with a strategic approach previewed the text and / or questions before they started reading, they read the text and referred to the questions during the reading process, they had some sort of strategy to monitor or fix comprehension and they reviewed questions or passages that were unclear or difficult. If an affordance was available, students employed the affordance within the reading itself, stopping periodically to answer questions as they went along. Students who were flexible in their strategy also previewed the text and / or questions and moved alternately between the reading and the questions. They monitored and fixed comprehension, but unlike the previous group, they might leave questions unresolved until they finished reading the text, at which point they would return and resolve those items. A reader who had less strategy would generally work their way through the text (print, audio and video) and then return to answer the questions without any type of previewing or alternating back and forth between the text and items as they read. In some cases, less strategic readers would utilize the affordance out of context, choosing to listen to all of the audio after the fact, or watch all of the videos at the outset. Still others from the less strategic subcategory were either unclear or perhaps uncertain of exactly what they did.

In the Table 4.8 provides a general overview of the subcategories with their properties organized by treatment. The table also indicates the names of students who

reflected those properties in their responses.   In the coming pages, I will offer a closer

look at each of these subcategories and properties by treatment.

Table 4.8

Overview of Subcategories and Properties of the Approaches to Reading Multimodal Texts

	Properties of Print Only	Properties of Print and Audio	Properties Print and Video
More Strategic	Previewed text and / or questions. Read text and answered questions by section. Monitored and fixed comprehension.	Previewed text and / or questions. Listened to audio and read along. Answered questions by section (defined by audio segments). Monitored and fixed comprehension.	Previewed text and / or questions. Viewed video at top of section. Answered questions by section. Monitored and fixed comprehension.
	Brandon, John	Carrie, Brenda, Helen	Robert, Shelia, Jeremy, Paul
Flexible	Previewed text and / or questions. Read text and answered some questions as they went but left uncertain questions for later review. Reviewed unanswered questions and returned to text to answer questions when necessary.	Previewed text and / or questions. Listened to audio and read along. Answered some questions as they went but left certain questions for later review. Reviewed unanswered questions and returned to either print or audio text to answer questions when necessary.	Previewed text and or questions. Viewed video at top of section. Answered questions when possible. Returned to unanswered questions and reviewed text when necessary.
	Kurt		
Less Strategic	Read all text then answered all questions. Or Read first question, looked for answer	Listened to audio as they read and waited until very end to answer questions. Or Hit play on audio	Watched videos out of sequence. Or Answered questions as video played. Or

	and then repeated.	and tried to answer questions as they read. Or Used a complicated combination of reading, playing audio and answering questions.	Watched videos and read by section but waited until very end to view or answer questions.
	Lisa, Jackie, Kelly, Andrew, Terry	Beth, Eli, Jeff, Rachel, Laura, Anna	Kate, David, Suzanne, Michael, Margaret

Reading Approaches of Print Only. The three subcategories—more strategic, flexible, and less strategic-- were evident in the approaches of those students belonging to the print only condition. The following descriptions will review the properties of those subcategories.

Strategic. John displays the properties of a strategic reader from this subcategory. In the following clip, he explains his process, which includes previewing the questions, reading and alternating between the text and items, and monitoring comprehension.

John: I read all of the questions first. I read the paragraph and read the question and just kept going until I found the question. So, I read the questions and then read to find the answer.

Interviewer: So you went through all of the questions?

John: Yes

Interviewer: So you went through all of the questions, including the constructed response questions and then went all of the way back up to the top?

John: Yes

Interviewer: So you read and then stop when you found something that might be an answer to a question?

John: Yeah, yeah.

Interviewer: Do you recall reading through any part of it again?

John: Yeah, a couple of times. I read through here (John points to paragraph one with the cursor). (interview, 11/23/10)

Flexible. Kurt described an approach that was also strong, but slightly different. He displays the properties of a flexible approach to reading the text and answering the questions because he described a process that indicated both an awareness of strategy and an understanding that one might need to stray from the strategy at times in order to make meaning of the text. He described his process for reviewing the text, for reading the material, for alternating between the two, for answering the questions, and for setting aside unresolved items for further review at a later time.

Kurt: Uhm, well, I, first I went through and I read the titles of each section. So I could kind of see what I'm doing. Then I . . .

Interviewer: So you read the main title, then you went down to here and you read this, and then you went down to this and read the sub headings.

Kurt: Yup. And then I skimmed through the questions, I didn't like read all of the, I just kind of skimmed through to see what I was looking for. And then as I was reading. . .

Interviewer: So then you read these titles and subtitles, then you went and skimmed through the questions.

Kurt: Yup. And then as I started reading, I read each section, and then I tried to answer the questions that I thought went with that section. So, then while I was reading, and like answering the questions, I kind of used like, I looked at the questions, and I thought like, okay, now what do I already know that I could use to answer these questions that don't come from the reading. And then once I finished that section, I backed up what I'd already knew with what was said in the, in the text and then I would go on to the next section and do the same thing.

Interviewer: Now if you did that with each section, then did you go back and . . . re-read it.

Kurt: Yeah, I re-read the questions I was unsure about. I kept a mental note in my head of what questions I was unsure about and then once I was done answering everything, and not like the essay questions towards the end, but once I was done with the multiple choice questions I went back and tried ta, see if I could get a better answer for the questions. (interview, 11/23/10)

In this case, Kurt exhibits the properties of a flexible reader since he seemed to apply the strategy while he could, but when he encountered ambiguity or uncertainty, he would decide to suspend the strategy long enough to move ahead in the reading and develop a more general understanding of the text. It was as if he read for the main ideas, and answered the resolvable questions as he went along, and saved the items that would require a more holistic understanding until then end.

Less Strategic. A good number of students, however, exhibited the properties of less strategic reading in their approach. Two students, like Jackie, chose to read the entire text and only then read the questions.

> Interviewer: When you did it the first time, did you read the entire article first and then come back and answer the questions?
>
> Jackie: Yeah.
>
> Interviewer: Okay, so instead of flip flopping back and forth you could do that. . .
>
> Jackie: Yeah.
>
> Interviewer: And then when you answered the questions would you go back into the text?
>
> Jackie: Yeah. (interview, 11/24/10)

Two students were classified as less strategic because they essentially read the text only to answer the questions. Andrew provides a good example of this approach.

> I would read, find the question, answer the question, and then go to the next question, find what it was and make sure the question after that, kind of is not between the two but after it, after I noticed that they were almost in numeric order I just went through the text. (Interview, 11/22/10)

Finally, one student exemplified a strategy that was rather complicated and inefficient. Lisa described her process in this way.

> Lisa: All right. So I usually read the questions first,
>
> Interviewer: Ahuh.
>
> Lisa: I read all the questions first, and then , uhm, I started reading titles,

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Interviewer: Ahum,

Lisa: And then I read the stories. And then I read them twice and then I finally answer the questions and I go back just to make sure I got all the questions, okay, just to make sure, just to clarify anything and that's pretty much what I do.

(interview, 11/24/10)

While Lisa seemed to have the right idea in previewing the questions, she then seemed to set the questions aside completely until she had read the text through two times. A process that appears to be rather time intensive and inefficient.

Reading Approaches of Print and Audio. Like the print only treatment, patterns were recognized for both readers who were more strategic and less strategic in the print and audio treatment. In this case, no students were identified as uniquely flexible.

Strategic. Unlike the print only condition, the print and audio condition required another layer of affordances to manage and navigate. Therefore, students who were able to manage the audio affordance as they read typically seemed to be more effective than those who chose to use the audio as a separate tool—used either before or after the reading, but not concurrent to the reading. Carrie, Brenda, and Helen seemed to navigate this affordance with a meaningful strategy. Brenda offers a representative description for this subcategory.

I listened to it, and read it and follow along and then once it is over before going on to the next section I would answer the questions in mainly about this paragraph that I just read so I would go over here and scroll down and answer all

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questions about that …. Then I would go on to the next one and answer the questions about that. (interview, 11/23/10)

Less Strategic. For the most part, however, the students we interviewed could be placed in the subcategory of less strategic. Properties of this subcategory included practices like listening to the audio and reading the text without previewing the text or studying the questions ahead of time. Some would hit play on the audio and try to answer the questions as it played, while others employed strategies that were overly complicated or inefficient, like reading text, then listening to the text, then listening to the text as they studied the questions, or variations like this.

Students like Eli, Beth, Rachel and Jeff made use of the affordance by hitting play, listening to the audio, and reading along as they went. However, instead of stopping at the end of each audio clip to answer questions, or even previewing the questions, they chose to work through the entire text and then return to the questions only after they had worked completely through the passage. The following sequence offers some insight into how Eli did this.

Interviewer: So the first thing you remember doing is going to the first part of this and then clicking on the audio.

Eli: Yeah.

Interviewer: And then while the audio was going you. . .

Eli: I read along with it.

Interviewer: Uhuh. Then when you were done with the first section, then what did you do?

Eli: I pressed down and started the second.

Interviewer: So you went down here, and so you read through the whole section down to here and when that was done you went down to the next audio bar here. Okay, so then, so that's interesting. Okay so then. You're listening to the audio, looking at the print then what were you doing with the questions?

Eli: Uh, I would wait until the end.

Interviewer: So would you wait until the end of a section or the end of the whole thing to do the questions?

Eli: The whole thing. (interview, 11/24/10)

Three other students, Laura, Anna, and Nate, offered strategies that simply seemed to be either complicated or inefficient. In Nate's case, the description he offered seemed rather complicated, and his explanation seemed to change and shift, so his strategy was a bit unclear. Laura, employed a complicated strategy as well. In her case she would read the text through by section, then return to the top of that section and listen to it. Only at that point, would she look at the questions. And then, if need be, she would return to the text by replaying the audio clip.

Laura: First I read it through—like each section. And then I played the audio--to like, comprehend what I read, and then I read it one more time, and if I didn't get it, I would play it again—I would just keep going back and forth until I got it.

Interviewer: So, when you say you read it through, you like, read a little section? Then played the audio, then read the next section? And then played the audio for that section?

Laura: Yeah.

Interviewer: And after you read it, played the audio, read it, played the audio, and you did this with each of these [Interviewer is scrolling the cursor up and down the section to denote the sections "each of these"] sections, then you went back and read through the whole thing?

Laura: Yeah.

Interviewer: So you read everything twice and listened to the audio once?

Laura: Yeah.

Interviewer: And after you did that, you went to the questions?

Laura: And then I would go back to the front [audio?]

Interviewer: So you didn't read and then look at questions and then go back and read some more?

Laura: (Affirmed the question.) (interview, 11/24/10)

Anna also offered a rather inefficient strategy for using the audio. She followed the directions of the reading activity by playing the audio, however, instead of reading along with the audio, she read ahead because she felt that it did not move fast enough. Once she got to the end of a section, she waited for the audio to finish, and then she repeated the process on another section. After working her way through the entire text, she went back and answered the questions. Anna's case stands out as unique, not only because she seemed to largely ignore the audio, but because despite the distraction, she still did quite well on the reading measures. So it could be said that even though the affordance proved to be a distraction to her, she still performed well on the

comprehension measures. This was not the case for the other readers in this category, where the poor strategy seemed to coincide with lower comprehension scores on the activity.

Reading Approaches of Print and Video. The processes described for the third treatment (print and video) share some similarities with the second (print and audio). However, it is worth noting that the two affordances, by their very nature, differ in how they can be used. Whereas the audio lends itself to be used concurrently (students can read along as they listen to the text), the video lends itself to non-concurrent use (students watch the video and then read the accompanying text).

More Strategic. Students who were coded in the subcategory of more strategic would typically demonstrate properties like previewing the text and questions, viewing the videos as they came to them, referring to the questions as they went along, and monitoring comprehension. Shelia offers a good representation of this subcategory.

> Well, first I read all of the stuff up here, all this, and then I read some of the
>
> questions, but I didn't read all of them and then I read down and as I was reading,
>
> I went and answered the questions and then I just kept doing that all of the way
>
> down. And like if, when I came to this paragraph I would watch this video, down
>
> here I would watch this video, when this ended and stuff. So yeah, that's what I
>
> did. (interview, 11/24/10)

Paul, another self-proclaimed avid reader, offers another exemplar of a strategic reader. In his case he alternated between the videos, text, and questions, and then upon finishing the text in its entirety, he returned to the top of the text to answer the items.

Paul: Well he [the primary investigator] asked us to watch the videos at the point

that we came across them so I did that first. And . . .

Interviewer: So does that mean like did you start down here, did you start reading

and then doing the video?

Paul: I read over here . . . I just hit and clicked that.

Interviewer: So the first thing you did was, is hit play and wait for the video.

Paul: Yeah,

Interviewer: And then just watched that. And then so you watched the video

before you…

Paul: Started reading? Yeah.

Interviewer: Before you started reading.

Paul: And that actually didn't help. It kind of confused me.

Interviewer: So it really didn't help your reading to watch the video first.

Paul: Yeah. I am an avid reader so I prefer reading to watching anything. And

then after that I just kind of read through this. . . and I think I glanced over at the

questions a couple of times. I didn't answer any of them though. I just glanced at

them. (interview, 11/23/10)

Paul indicated that he did not struggle with the text, but he also admitted that the videos

did not seem to help him at all.

Less Strategic. Other students were identified with the subcategory of less

strategic. They displayed properties that could be defined as less effective or efficient.

These properties include watching the videos out of sequence, answering questions as the

videos played, or referring to questions only after working all of the way through the text.

Michael serves as an exemplar of a less strategic approach. He chose to watch the videos and read the paragraphs in their intended sequence, but he also chose not to preview the text or items and he waited until he had made his way completely through the passage before he looked at the questions.

Two students, Kate and Suzanne decided to watch the videos out of sequence. Suzanne, for example, decided to read the entire text first, and then watch all three videos one right after the other, as opposed to viewing them as she encountered them within the text. She explains that process in the following passage. "When I finished reading the whole thing and I got most of the answers or the ones that I understood, I went back and watched the videos and then took in what the videos were saying" (interview, 11/23/10). In this case, Suzanne seemed to use the videos only after she was unable to resolve test items.

Another student, who did well on the comprehension measure and appeared to be a strong reader, chose to read the text by section, and then once she completed a section she moved back to the top of that section, hit play on the video, and proceed to answer the questions as she let the video play. Here is how she described her approach.

Margaret: Uhm, I read the first two paragraphs and then watched the video and tried to answer the questions at the same time.

Interviewer: Okay so you answered questions, in other words, while the video was playing.

Margaret: Yeah.

Interviewer: And then once the video was done, then where would you go from there?

Margaret: Just kept reading the next part. (interview, 11/23/10)

As can be seen throughout the various subcategories, there were many different approaches that students employed. In addition to describing the various approaches and strategies used to read or make meaning of the text though, we also wanted to hear what students thought about whether these affordances might influence their feelings of confidence or self-efficacy. In the next segment, we will take a look at student responses to this line of inquiry.

Perceptions of Self-Efficacy. Though the statistical analysis showed no difference between the treatments in terms of a student's sense of self-efficacy, it was important to explore this more deeply by asking students to explain their thoughts in the interviews. There were a number of times throughout the interviews when the discussions may have turned to the concept of self-efficacy. One of the questions asked students directly if they would feel more confident completing their readings and assignments in this digital format. However, students would also refer to self-efficacy throughout the interviews when they referred to any affordance that might make the process of reading academic texts "easier". All of these responses were placed in the category of perceptions of self-efficacy.

Though we had hoped to find a pattern within the various conditions, this did not appear to be the case. Our questions did not consistently ask students to confine their responses to their assigned treatments, nor even to those we offered within the

experiment. Instead, the questions generally started by asking them about their assigned condition and then we expanded the question to include their thoughts about other affordances. Our interview questions simply did not do enough to delineate these thoughts by condition. We discovered that students were more likely to talk about their feelings of competence in relation to a broad range of conditions or affordances. In the next few pages, I will examine those student reactions according to three subcategories: feelings of self-efficacy not directly related to any particular affordance, feelings of self-efficacy directly attributable to a given affordance, and negative case examples of students who did not feel that the digital affordance improved their competence as readers.

   Feelings of Self-Efficacy Unrelated to Specific Affordances. Throughout the interviews, students would sometimes make general statements about how the online or digital versions of text would be easier for them to read, or that they would feel more confident completing reading activities on the screen versus in the print text format. These were subcategorized as perceptions of self-efficacy not related to a specific a affordance. Properties of this subcategory include statements about the value of digital texts without a particular justification. It appears to be a faith in the digital mode as somehow inherently better than the older, more outdated versions of those texts. Another property of this subcategory is the belief that the digital texts can improve their ability to comprehend texts in certain content areas.

   Rachel, for example, displays the property of that general belief in what digital texts have to offer.   Rachel is classified as a struggling reader and has been enrolled in

the intervention reading course for ninth graders. In her daily life, however, she is an avid reader of anime and she often spends time online visiting a fanfiction website where she often reads stories written by her friends. She also enjoys drawing her favorite characters and has dabbled with making her own. She stated that she believes the online version of texts would be better for her, and at first she really struggled to explain why. "Ah!" she exclaimed. "Do I have to explain it all?" After moving from the subject, she later came back to the thought. She eventually commented, "I can't think of a word to explain it. This [digital text] makes me feel like I'm smarter than reading in a book. I don't know why, but it just does" (interview, 11/24/10). Terry also mentioned that she prefers online texts because "it's just like easier to read" (interview, 11/22/10). Lisa was another student who couldn't quite identify a reason for increased feelings of confidence but was generally convinced that it was easier.

> If I am reading something on textbook it's something like I have to like try and
> keep reading and reading and reading and remembering what I was trying to read
> on the paper. Other than when I am reading on the computer for some reason it's
> easier. Like I can just memorize it for some reason. (interview, 11/24/10)

Beyond a faith in the digital texts, Shelia's response indicates the property of self-efficacy tied to a content area. This differs from the next category, which ties a feeling of self-efficacy to an affordance. In this case, she still indicates a general belief that the digital texts would be easier to read but only in a given content area, like science.

> I think I kind of like reading it on the computer better but I guess it depends on
> the subject. Some like math, I like reading it in a regular book but if in English

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there is an online textbook I would, I would like to read it on the computer better

and for like science, might be easier. (interview, 11/24/10)

In all of these cases, students were convinced that the computer could help them access

texts in some general way.   However, the majority of students who indicated increased

feelings of self-efficacy did so within the context of specific affordances.

   Feelings of Self-Efficacy Related to Specific Affordances. All but one student,

Brandon, offered an indication that either the digital texts as a whole, or a specific

affordance in particular, would make the reading of academic texts easier. Some argued

that as a whole, reading off the screen would not help, but that when considering a given

affordance it would. It is important to note that even though many responses indicated

student preference for digital texts, these responses should not be construed as

unqualified votes of approval. Thus, they would typically bound their responses by

stating that the process of reading would be easier if a particular affordance were

available. Properties of these responses include feelings of self-efficacy tied to

formatting, audio and video, supplemental resources, and annotation.

   Formatting. The most often cited property for an increase in confidence was the

formatting affordance. Seven students specifically referred to this affordance in direct

reference to how they felt more confident reading the text off the screen. Anna gave

perhaps the most common explanation. "It was a lot easier like if I had like a question

and I couldn't remember the answer, it was a lot easier to back than to flip through the

pages of a textbook, just be able to like scroll up and down and stuff. See that was a lot

easier I guess."   She would eventually offer the following example.

It could be helpful in improving test scores since you can like look back on the

text to help you answer the questions easier than like searching for stuff and the

textbook like, example like just in civics I think last Friday or something we had

to answer a bunch of questions about the Constitution. And like questions, it was

like find where what abilities Congress has to, I don't remember any of them, and

then we would have to you know search through the articles and find the right

article and the right section and the right clause. And it's pretty long, you have to

flip through a ton so it would have been easier if you could have scrolled around

to find stuff. (interview, 11/23/10)

Robert offered another exemplar from this property when he said, "It was easier because

then it was like you didn't have to keep on looking back and forth from like the paper and

through the pages and stuff" (interview, 11/22/10). In the following sequence, Shelia

mentions the same idea when she says that she likes having all the information "right

there."

Shelia: I think it is easier, like if you do it on like an MC, or whatever it is on the

computer when you type it out, I think, it seems easier.

Interviewer: MAP test?

Shelia: Yeah, it seems easier. Instead of writing it out, it's just right there and I

can type it. (interview, 11/24/10)

Audio and Video. The second property of self-efficacy responses related to

specific affordances included those that mentioned the audio and video affordances.

Students frequently stated that these affordances made reading the text easier for them.

Nate who is a struggling reader said he would depend quite heavily on the audio function.

> The textbook would be harder because I would not have something that read back
> to you.   I would have to keep reading for the answer. With the audio I can just
> look for what they are saying   like if it was here and I was here [Nate points to
> different places in the text]. (interview, 11/22/10)

Within this property, two students referred to increased feelings of self-efficacy related to audio and video because they matched their "learning style." Jackie, for example, admits that she would be more likely to complete reading assignments if it were available with these affordances. "I think that would be a lot better cuz some people are visual like readers okay, I'm also a visual learner. Readings okay for me, but I'd rather see someone do it, or do it myself with somebody there" (interview, 11/24/10). Kelly, in reference to the audio, had a similar response. "I am a better learner if I listen to it rather than just read it, because then I can figure it but if someone tells me it than [I] learn easier" (interview, 11/24/10).

Additional Resources and Annotation. Two other properties of self-efficacy responses indicated the affordances of additional resources and annotating the text. Students like Andrew felt that simply having more resources in the digital realm made reading these texts easier. In talking about how he prefers online textbooks, Andrew mentioned this affordance of additional or supplemental material

> I usually use them because I am too lazy to bring my book home and I actually do
> like it because it's, you can actually, it usually has hyperlinks and stuff. You can
> click on this and it goes somewhere else and you can get in depth with this kind of

reading stuff, and it makes it easier because you have more, you have a wider

array of information instead of just right on the page that's all you get. (interview,

11/22/10)

Three students mentioned annotating affordances (highlighting, embedding comments

etc.) as something that made them feel more confident about reading material off the

screen. "You can highlight where you stop and come back to it," Kate said when asked

why reading off the screen was easier for her (interview, 11/24/10). Kelly stated, "If it

was like, if it was online I could write little notes where like I knew I would have to

remember it, then yeah, it would be easier," a thought repeated by Andrew as well.

Negative Case Examples. A final subcategory of self-efficacy perceptions

included responses where students did not feel the digital affordances were helpful.

Though the general consensus clearly seemed to indicate that students favored the digital

affordances, there were examples of a few students who felt as though this were not the

case. Properties of these responses include those who categorically disapproved of the

digital texts, and those who did so conditionally.

Only one student, Brandon, categorically ruled out any benefit of a digital text.

Again, Brandon considers himself an avid reader (of print text), and we had a few

conversations about books and reading in our various meetings. Some students, like

Paul, another avid reader, voiced a similar opinion. Throughout his interview Paul

referred to his preference to physically hold the book, and when it was mentioned by the

interviewer that sometime in his lifetime, books may no longer be available in print, his

response was, "I severely hope not" (interview, 11/23/10).

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Other students were more conditional in their disapproval. In other words, they seemed to believe that some affordances would help them succeed, while other aspects of the digital text would be a hindrance. Helen offers a good exemplar of someone with reservations about the digital versions.

> I like textbooks so it's right in front of me, but I know other people like internet. I just, I don't feel as comfortable with. . . It's just easier when I have a constructed book compared to the ability of it to shut down on me or just having it, scroll and scroll and scroll. And if I scroll too fast I lose it and I have to go back . . . It's easier. (interview, 11/23/10)

Though Helen seemed to feel more confident with the print text in general, like Paul, she spoke a few times about how the various affordances could help her read texts, which reflects a rather nuanced, perhaps complex, reaction to this new medium.

Interpretation of Qualitative Data. In looking across these categories, affordances of texts, processes of reading, and perceptions of self-efficacy, I offer the following theory based on assertions taken from the data. The successful use of affordances is influenced by the reader's ability to both perceive the affordance and strategically utilize it. The last pages of this chapter will outline the assertions of that theory, while the final chapter will synthesize the findings. To best describe this theory, I will make the following assertions. First, the successful use of the affordance may be related to student perception of the affordance; and second, the successful use of the affordance may be related to their ability to meaningful use it.

Perceptions of the Affordance. First, to successfully navigate digital texts, I assert that students needed to not only perceive that the affordance existed but also perceive that this affordance would improve their reading of the text. This means that students must either recognize the affordance-- or be aware of the affordance-- for either its intended purpose (as many indicated for both the audio and video) or for unintended purposes (as many indicated for the formatting and various other digital affordances).

Beyond just recognizing that the affordance exists, students had to also recognize that the affordance would somehow benefit them, that it would improve their likelihood of success on the activity in some way. Again, many students indicated that the affordances would make the reading of academic texts easier. Closely related to this notion of usefulness is one of control. Students would suggest that their ability to manipulate the affordance (most noticeably in the audio affordances) seemed to shape their perceptions of whether it would ultimately help them or not. Students who felt like they could control the affordance (e.g. stop and start it, replay sections) seemed to suggest that it would help them read the text while those who felt that they could not control the affordance (e.g., speed up the audio) did not think that it would help.

Strategic Use of Affordance. Second, I assert that the affordance seems to be most effective when it is used strategically. Although it could not be concluded that strategy alone determined the outcome or performance on the reading activity, there certainly seemed to be a continuum of efficiency in regards to strategy use. And I suspect that students who were strategic readers in print text, were also strategic in the digital text. This means that students who were likely to be less strategic readers in print text,

were not necessarily helped by the affordances. Theoretically, the audio affordance would have lightened the "cognitive load" of readers, thereby allowing them to take on more complex cognitive tasks as they read. Some of the students mentioned, along these lines, how the affordances made reading the text a little easier. A few students, like Anna, Paul and Margaret, suggested that the specific affordances they had been assigned were not helpful. Each of those students, though, would be classified as either an avid reader or a strong reader (either by their own admission or by their placement in Honors English classes).

This suggests that the affordances might adversely affect struggling readers more than they affect their peers. There were a few cases, like Anna and Margaret, where despite employing a poor strategy, they appeared to do well on the activity. However, these examples only seem to further the idea that the affordances might have a stronger negative effect on struggling readers than on strong readers like Anna and Margaret. In their cases, they seemed to score well in spite of the distraction created by those affordances, whereas the opposite of that was not true: other readers were less likely to overcome the distractions that the affordances may have provided, especially in the print and audio treatment, where I suspect that students were more likely to either multitask as they listened to the audio, or struggle with how or when to make use of that affordance. Thus, the incorporation of affordances does not negate bad strategy. The affordances do not, in and of themselves, level the playing field of reading, or for that matter, make the reading process any easier if readers do not know how to manage or effectively utilize them.

A closer look at how this theory addresses our broader research questions and the theoretical perspectives from which these questions were developed, will be the subject of the last chapter.

Chapter 5

Discussion and Conclusion

This study set out to explore an aspect of the Digital Midas Phenomenon, namely how it might be that though today's students are surrounded by a wealth of text, they do not seem to be any richer for the experience in terms of their reading ability. In general, this study indicates that the quality of that digital experience is as important as exposure. In other words, access to digital affordances alone, does not guarantee that students will improve their reading scores. This study showed that though there is no statistically significant difference in comprehension and self-efficacy across the affordances, there seems to be a pattern of successful affordance use when a student can perceive that affordance and strategically utilize it. The closing chapter of this study will bring together the evidence that led to this conclusion by revisiting the research questions and theoretical perspectives of the study. It will also provide a discussion on the limitations and implications of this study and offer some future research questions.

Research Questions, Conclusions and Theoretical Perspecitves

In synthesizing the analysis of the study's two phases, it is necessary to discuss the conclusions that could be made around the research questions, and examine these findings within the context of the theoretical perspectives that originally guided the questions.

1. What impact do different modes (print, audio, and video) of text have on comprehension?

2. How do students make meaning of the text as they access the text digitally? What was the process for reading the text? How did the students make use of the various affordances?

3. What effects do the various modalities have on a student's perception of their ability to read the text digitally? Is there a measurable difference between a student's self-reported feelings of self-efficacy across the modalities? What do students say about using online textbooks and how do they feel about having those texts available online?

Conclusions. In looking at these questions and the data that were collected throughout the study, I was able to make the following conclusions.

First, there was no statistically significant difference in comprehension across the treatments. Once again, this means that when comparing the mean scores of print only, print and audio, and print and video, there was no discernable difference that could be specifically attributed to the conditions. This, however, does not mean that a difference does not exist when affordances are made available. It does, however, suggest that there is no difference when those affordances are mandated, an important distinction that will get more discussion as this chapter continues.

Second, a general theory of affordance use could be formulated based on the patterns. In looking at how the students navigated the texts and affordances, it could be observed that the strategic readers appeared to be more efficient and effective in answering the comprehension questions. Less strategic readers on the other hand seemed to be less efficient in their use of the affordance, and in some cases could have been

distracted by them. Adding another level of planning to the reading process, may have complicated-- not simplified-- the reading event. Students, for example, had to make additional decisions about when to play the audio or video, and how to manage or control it. And in some cases, they had to determine the relationship of that affordance to their task at hand. In the case of the embedded videos, for example, they had to consider how the video might connect to the text and the questions. If that connection was not made, or if a process for using the affordance was not determined ahead of time, then the reading experience became a little more complicated for those who were already struggling. Though I do not have hard, statistical evidence to support this claim, I suspect that strategic readers of print, were more likely to be strategic readers of digital texts, a quality that allowed them to more effectively use the various tools.

Third, despite the non-significant findings of the experiment in self-efficacy, students often expressed a greater sense of competence when given access to these affordances. This may seem like a contradiction. However, there is a significant difference between how the question was set up for the two phases of the study. In the experimental phase, the self-reporting self-efficacy questions were asked within the context of the affordance they had been assigned (e.g. print, audio or video). The self-efficacy responses provided in the interviews, however, were much more open ended. In those interviews, students were less inclined to admit that their assigned affordance was helpful, but more inclined to identify a wide variety of digital affordances that would enable them to be more competent readers. In this sense, that element of choice appears to be quite important. To use an analogy, the experiment was set up so that each student

was given a house to build using only one or two tools, and they did not get to choose what those tools would be or whether they could use them or not. Accordingly, students did not seem to believe (as the self-efficacy scores indicate) that any one tool was better than the others in building their houses. Instead, when they talked about building their dream homes, they mentioned the many different tools that they would like to incorporate into that tool box.

Theoretical Perspectives. Returning to the theory that was generated from this data, it can be stated once again that even though there did not appear to be a measurable difference in student comprehension or self-efficacy, there seemed to be a pattern to how students successfully utilized these affordances that depended on their awareness of that affordance and their ability to use it meaningfully.   Looking back on the theoretical perspectives that guided my questions, a few connections can be made to previous findings.

New Literacies. This study's findings are consistent with a number of other studies that have been completed within the field of new literacies, like Corio and Dobler (2007) who suggest that the print text reading processes are necessary but not sufficient for making meaning online. This study certainly seems to bolster that claim, but it also extends it. These strategic reading processes become more important as the demands of a given reading task increase. So, for example, if an online reading task requires, not offers but requires, a reader to make use of multimodal features, a strategic approach becomes fairly important to the completion of that task. This is important because the general assumption seems to be that if the affordances are simply made available, students will

use them in a meaningful way. However, using them does not necessarily improve their chances of doing well on a reading task. Using them strategically does. This study also seems to hold consistent to the findings of Leu, Kinzer, Corio, and Cammack (2004) who found that there are additional reading processes that are required of reading online. My findings suggest that in addition to doing things like questioning, making connections, and summarizing, they need to know how to strategically approach a digital text when it offers various affordances.

   Ecological Psychology. This particular study does not resolve the ongoing debate mentioned in Chapter 2 regarding the very nature of an affordance. This study does not refute Gibson's (1979) claim that an affordance is the product of the object or tool itself. Students did not inherently know how to use the tools. As suggested, the affordance needs to be used meaningfully, which suggests that they have to not only perceive the tool, but perceive that it is useful. Nor does the study refute Stoffregen's (2003) claim that an affordance is a perceived notion of an animal or agent. Perception alone did not guarantee that the affordance was helpful. A number of readers (e.g. David, Rachel, Lisa) have strong feelings about the usefulness of the assigned tools, but were unable to capitalize on them, as their scores indicated. Perhaps, this study affirms the dynamic interaction of many elements coming together to create the affordance, elements like the object, agent, environment, and the context or situation (Lopresti-Goodman et al, 2011). These findings also coincide with Stoffregen's idea that, "Affordances are what one *can* do, not what one *must* do" (119). This suggests, again, that perhaps the results would

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have been different if we had made the affordances available versus mandating that students use them.

Self-Efficacy. Though there were no new discovers that could be connected to the previous body of research on self-efficacy, these findings do confirm the idea that as students grow older, they are less likely to generalize their feelings of self-efficacy and more likely to tie them to specific tasks (Schunk & Miller, 2002). In this case, it was observed that students were more likely to express a greater sense of competence in reference to specific tools (e.g. formatting affordances, supplemental resources etc.). In other words, many students tied their sense of competence to particular tools versus a generic belief about the internet or digital texts as a whole. It was also confirmed that students believed access to more resources would make these academic reading tasks "easier". This plays out as significant on two levels. First, student responses indicated that the tools themselves (audio and video) when seen as resources versus requirements were more meaningful to students and their feelings of competence. Second, student responses frequently discussed how access to additional features (e.g. hyperlinks, vocabulary flashcards) would make their reading assignments less difficult. Bempechet (2008) states that access to resources is a strong factor in shaping what students believe about their ability to complete a task.

Content Area Reading. Discussions with students about their assigned readings were consistent with King-Sears' and Duke's (2010) assertion that textbooks remain firmly affixed in today's high school classrooms. Though this was not part of the main

study, a number of observations could be made about the beliefs, practices and perceptions of students in regards to online digital textbooks.

First, students generally indicated a preference or desire to read their textbooks online. Twenty of the students directly indicated in our discussions that they would prefer to read their texts online. Two more gave qualified responses, noting both the advantages and disadvantages of the digital versions. Only three students seemed to state a specific preference for the print textbook over the digital version. In all three cases, the students were either self proclaimed avid readers, or were enrolled in Honors English or both.

Second, students almost unanimously indicated that they generally do not use the online versions, even though everyone of them had access to at least two books online. This disconnect between their stated preference (going online) and their actual practice (reading print text) is of interest. Looking across the student responses, a few potential reasons for this disconnect surfaced. It became evident that students were not likely to visit the online version unless the teacher told them specifically to do so. Making the digital version available, in-and-of-itself, did little to generate student interest in that version. Three students, Carrie, Brenda, and Anna, all indicated a middle school class where they made frequent use of the online version. In each case, they discussed going to that space because the teacher made regular use of the text in that format. It could also be argued that students were not accessing the text online because, as of yet, there is not a compelling reason to do so. In other words, the benefits of reading the text in print still outweigh the benefits of reading it off the screen. That seems hard to believe,

considering all of the technological advances of recent years. However, as indicated in the earlier research, these innovations have not really trickled down to the online textbooks. For the most part, the digital versions of the textbook have been little more than scanned PDFs of the print copies, which is a tremendous waste of the resource (Burroughs, 2010; Foderaro, 2010). Of those twenty students who indicated a desire to view their textbooks online, the vast majority offered only one reason for doing so—the convenience of not having to carry a textbook. Consequently, when weighed against all of the other affordances that the print version still offers over the digital, this does not seem surprising. After all, it is easier to hold and manipulate a book in comparison to a desktop computer, and in some cases a laptop. Students can tag main ideas with post-it notes, and take notes off the page easily. And they do not have to worry that their batteries are running low, that their computer has frozen, or that their internet is down, in order to access these texts. Again, as odd as it may seem, the print text still offers more affordances than the digital texts—as they currently exist.

This suggests that three things will need to happen before schools can make the digital turn. Teachers will need to make a concerted effort to incorporate these digital texts into their curriculum. Publishers will need to design digital texts that make viewing them digitally worthwhile. And finally, schools will need to insure that all students have access to the technology.

Limitations and Implications of the Study

Despite the tremendous amount of time, thought, and effort that goes into any given study, there is inevitably something that could be improved, and this study is by no

means an exception to that maxim. There are two limitations that may have had an impact on the final results of this study.

Within the design of the experiment, students were mandated to use their assigned affordance (e.g. audio or video). The study was designed from research suggesting that these affordances would lighten the cognitive load of the reading process, thereby allowing students the ability to further concentrate on content versus the decoding of that content (Low & Sweller, 2005; Mayer, 2005; Mayer & Johnson, 2008). However, this study did not necessarily find this to be true. In fact, it became apparent as students discussed the affordances that the study lacks a type of ecological validity. Though the experiment had been designed using an authentic reading text (one they are currently using) for an authentic reading purpose (a quiz similar to one they might experience in class), the manner in which we asked them to read the text may have been inauthentic. In a more naturalistic condition, students would not be forced to use the affordance. Instead, they would have the affordance available and would be able to use it if they chose to do so. Returning to an idea stated earlier, the very requirement to use an affordance changes the nature of that affordance to something else, since an affordance is something you *can* use, not something you *must* use. In a more ideal circumstance, the experiment would be designed so that students would have a specific affordance available to them if they felt like it might be of help. Yet even in that circumstance, it is not clear that an effect would be discernible. As this study indicates, not only do students need to choose the affordance, they need to be able to use it strategically.

The comprehension measures's inability to discriminate may have been another limitation of the study. Following the pilot study, it was determined that the items did not discriminate enough between the readers. Students generally did well on the test items. Consequently, there was not a lot of distinction between those who read well and those who did not. Though a number of items were thrown out, and a few more were re-written, the final results still indicated that one of the multiple choice items (#12) exceeded the acceptable range, and two more items (#3 and #6) were on the upper limits of that range. One of the following corrective measures could be taken to mitigate this limitation in the future. Either the items would have to be re-written again to make them more complex, the text selected would have to be more difficult, or more lower ability readers would need to be included in the study.

A third, and final, limitation of the study was that it did not account for ability. Though we had originally intended to correlate scores against other standardized measures, it was discovered that too many students included in the study did not have adequate test scores on file. It also should be recognized that it takes extra effort on the part of reading researchers to recruit low ability readers at the high school level. Even the enticement of gift cards is not enough, often times, to convince students to do something that they find especially difficult or repugnant.

Setting aside these limitations, the study does contribute new knowledge to the field. Among other things, it paves the way for more studies on digital textbooks, which many believe will be a regular part of our classrooms in the future. Beyond that it suggests that while technology might hold a powerful place in our future educational

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plans, they are not, as many others have also indicated, the silver bullet. Even in the framing of this study, the researchers started with the hunch that some inherent aspect of the technology (like the audio or video affordance) would make reading easier for students. However, the study suggests that many of these students will need training in how to strategically utilize these affordances. Simply put, giving students access to these affordances will not be enough. Finally, this study offers some insight on how students perceive digital texts and academic readings. It suggests that if schools continue to invest heavily in textbooks, they will need to more carefully consider both the print and online versions of the text.

Future Research Questions

As it was pointed out in the limitation section of this paper, a considerable amount of work has yet to be done in our research of reading multimodal texts. Even though plenty of studies have taken up questions of the new literacies, few have specifically examined the online digital textbooks and the digital turn that will most likely occur in years to come. Here are some questions that need to be considered.

Though this study did not segregate the data by ability, it would be of interest to run a similar study where that is taken into account. Can the affordances of multimodal texts help students who struggle with academic texts? Do they offer a bridge between the digital literacies of their out-of-school lives and the academic literacies of their in-school lives? Would these new digital formats engage students, or would they serve as a novelty that would eventually become less interesting? Further study within this line of

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questioning can help us determine how to best use these affordances, as well as how they might distract or hinder readers.

Another future area of study would examine the potential uses of other affordances with online academic texts. While this study focused on the affordances of audio and video, future studies could examine how the ability to highlight, tag, share, or annotate academic texts might have an impact on comprehension, self-efficacy and the reading process.

Affordances like these could have an impact on how students access the text, and on the text itself. Some researchers, like McEneaney (2006) point to technologies where the text can read the reader and respond in such a way that the text itself appears to have a life of its own. Other researchers, point to the thin line that separates the "consumption" of text from the "production" of text, challenging our very notions of what it means to read. How might the digital turn in academic texts impact the very structure, formatting, and syntax of these academic texts? As the affordances of the screen privilege more visual elements over print centric texts, how will this change the way students access that information, how we teach reading, and how we use technology within our classroom?

These are but a few of the questions and challenges that face researchers in the future. Planning our next steps in reading and literacy research depend on discussions about what should be or can be constituted as "text," what it might afford a reader, the role that digital texts might be able to play in in our classrooms, and whether current

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instructional practices and assessments will be adequate for readers entering today's

complex world of work, politics, medicine, and personal fulfillment.

References

Alvermann, D. (2008). Why bother theorizing adolescents' online literacies for classroom practice and research?. *Journal of Adolescent & Adult Literacy, 52*(1), 8-19. doi:10.1598/JAAL.52.1.2

Alvermann, D., & Moore, D. (1991). Secondary school reading. In R. Barr, M. Kamil, P. Mosenthal & P. D. Pearson (Eds.), *Handbook of reading research* (pp. 951-983). New York: Longman.

Alvermann, D. E., & Wilson, A. A. (2011). Comprehension strategy instruction for multimodal texts in science. *Theory into Practice, 50*(2), 116-124. doi:10.1080/00405841.2011.558436

Ayers, P., & Sweller, J. (2005). The split-attention principle in mutlimedia learning. In R. E. Mayer (Ed.), *The cambridge handbook of multimedia learning* (pp. 135-146). New York: Cambridge University Press.

Bandura, A. (2006). Guide for creating self efficacy scales. In F. Pajares, & T. Urdan (Eds.), *Self efficacy beliefs of adolescents* (pp. 307-337). Greenwich, Conn: Information Age Publication.

Bandura, A., & Locke, E. A. (2003). Negative self-efficacy and goal effects revisited. *Journal of Applied Psychology, 88*(1), 87-99. doi:DOI: 10.1037/0021-9010.88.1.87

Bempechat, J. (2008). Reading success: A motivational perspective. In R. Fink, & S. J. Samuels (Eds.), *Inspiring reading success: Interest and motivation in an age of high-stakes testing* (). Newark, DE: International Reading Association.

Bennett, E. (2002). Inexorable and inevitable: The continuing story of technology and assessment. *Journal of Technlogy, Learning and Assessment, 1*(1), 1-23.

Burn, A. (2008). The case of rebellion: Researching multimodal texts. In J. Corio, M. Knobel, C. Lankshear & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 151-178). New York: Lawrence Erlbaum Associates.

Burroughs, D. (April 2010). Bye the book: In educational publishing, the only certainty is change. *PRISM, http://www.prism-magazine.org/apr10/feature_01.cfm*

Carrington, V. (2009). From blog to bebo and beyond: Text, risk, participation. *Journal of Research in Reading, 32*(1), 6-21. doi:10.1111/j.1467-9817.2008.01378.x

Chemero, A. (2000). What events are. *Ecological Psychology, 12*, 37-42.

Cohen, L., Manion, L., & Morrison, K. (2002). *Research methods in education* (5th ed.). New York: RoutledgFalmer.

Coiro, J., & Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the internet. *Reading Research Quarterly, 42*(2), 214-257. doi:10.1598/RRQ.42.2.2

Coiro, J., Knobel, M., Lankshear, C., & Leu, D. (2008). Central issues in new literacies and new literacies research. In J. Corio, M. Knobel, C. Lankshear & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 1-21). New York: Lawrence Erlbaum Associates.

Coiro, J. (2003). Reading comprehension on the internet: Expanding our understanding of reading comprehension to encompass new literacies. *Reading Teacher, 56*(5), 458.

Conole, G., & Dyke, M. (2004). What are the affordances of information and communication technologies? *ALT-J, Research in Learning Technology, 12*(2), 113-124.

Cook, C., Goodman, N. D., & Schulz, L. E. (2011). Where science starts: Spontaneous experiments in preschoolers' exploratory play. *Cognition, 120*(3), 341-349. doi: 10.1016/j.cognition.2011.03.003

Cope, B., & Kalantzis, M. (2009). "Multiliteracies": New literacies, new learning. *Pedagogies: An International Journal, 4*(3), 164-195.

Duke, N. (2001). For the rich it's richer: Print experiences and environments offered to children in very low- and very high-socioeconomic status first-grade classrooms. *American Educational Research Journal, 37*(2), 441-478.

Duke, N. (2005). Comprehension of what for what: Comprehension as a nonunitary construct. In S. A. Stahl, & S. G. Paris (Eds.), *Children's reading: Comprehension and assessment* (pp. 93-104). Mahwah, NJ: Lawrence Erlbaum Associates.

Earth science: Geology, the environment, and the universe (2002). The McGraw-Hill Companies.

Entwisle, D., Alexander, K., & Olson, L. S. (1997). *Children, schools, and inequality*. Boulder, CO: Wesview.

Ericsson, K. A., & Simon, H. A. (1984). *Protocol analysis: Verbal reports as data*. Cambridge, MA: MIT Press.

Fassinger, R. E. (2005). Paradigms, praxis, problems, and promise: Grounded theory in counseling psychology research. *Journal of Counseling Psychology, 52*(2), 156-166. doi:10.1037/0022-0167.52.2.156

Field, A. (2009). *Discovering statistics using SPSS* (Third ed.). Los Angeles: SAGE.

Foderaro, L. (2010, 10/09/2010). In a digital age, students still cling to paper textbooks. *New York Times,* Retrieved from *http://www.nytimes.com/2010/10/20/nyregion/20textbooks.html?_r=1*

Gibson, J. J. (1979). *The ecological approach to visual perception*. New York, New York: Taylor and Francis Group.

Glaser, B. G., & Strauss, A. L. (1967). *Discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.

Gottfried, A. E., Fleming, J. S., & Gottfried, A. W. (2001). Continuity of academic intrinsic motivation from childhood through adolescence: A longitudinal study. *Journal of Educational Psychology, 93*(1), 3-13.

Guthrie, J., Hoa, L., Wigfield, A., Tonks, S., Humenick, N., & Littles, E. (2007). Reading motivation and reading comprehension growth in the later elementary years. *Contemporary Educational Psychology, 32*, 282-313.

Guthrie, J. T., Wigfield, A., & Perencevich, K. C. (2004). *Motivating reading comprehension*. New Jersey: Lawrence Erlbaum Associates, Inc.

Guthrie, J. T., McRae, A., & Lutz Klauda, S. (2007). Contributions of concept-oriented reading instruction to knowledge about interventions for motivations in reading. *Educational Psychologist, 42*(4), 237-250. doi:10.1080/00461520701621087

Heller, R., & Greenleaf, C. L. (2007). *Literacy instruction in the content areas: Getting to the core of middle and high school improvement*. Washington, D.C.: Alliance for Excellent Education.

Henk, W. A., & Melnick, S. A. (1995). The reader self-perception scale (RSPS): A new tool for measuring how children feel about. *Reading Teacher, 48*(6), 470.

Hetzner, A. (2011, 1/15/2011). Teachers watch to see how laptop use affects learning. *Journal Sentinel,* Retrieved from http://www.jsonline.com/news/education/113828984.html

Hodge, R., & Kress, G. (1988). *Social semiotics*. Ithaca, New York: Cornell University Press.

Hutchby, I. (2001). Technology, texts, and affordances. *Sociology, 35*, 441-456. doi:10.1177/S0038038501000219

Ivey, G. (2010). Texts that matter. *Educational Leadership, 67*(6), 18-23.

Ivey, G., & Broaddus, K. (2001). "Just plain reading": A survey of what makes students want to read in middle school classrooms. *Reading Research Quarterly, 36*(4), 350-377.

Jewitt, C. (2005). Multimodality "reading," and "writing" for the 21st century. *Discourse: Studies in the Cultural Politics of Education, 26*(3), 315-331.

Kaiser Family Foundation. (2010). *Generation M: Media use in the lives of 8–18 year-olds.* Menlo Park, CA: Kaiser Family Foundation.

Kalyuga, S. (2007). Enhancing instructional efficiency of interactive E-learning environments: A cognitive load perspective. *Educational Psychology Review,* (19), 3-387. doi:10.1007/s10648-007-9051-6

Kalyuga, S., Chandler, P., & Sweller, J. (2004). When redundant on-screen text in multimedia technical instruction can interfere with learning.(training, education, instructional systems). *Human Factors, 46*(3), 567(15).

King-Sears, M. E., & Duke, J. M. (2010). Using secondary texts to assess reading demands and skills required for students with high incidence disabilities. *Intervention in School and Clinic, 45*(5), 284-293. doi:10.1177/1053451209359079

Kress, G., Jewitt, C., Ogborn, J., & Tsatsarelis, C. (2001). Mutlimodal teaching and learning: Rhetorics of the science classroom. London: Continuum.

Lankshear, C., & Bigum, C. (1999). Literacies and new technologies in school settings. *Pedagogy, Culture and Society, 7*(3), 445-465.

Lee, C. D., & Spratley, A. (2010). *Reading in the disciplines: The challenges of adolescent literacy*. New York: Carnegie Corporation.

Leu, D., Castek, J., Hartman, D., Coiro, J., Henry, L., Kulikowich, J., & et al. (2005, June). *Evaluating the development of scientific knowledge and new forms of reading comprehension during online learning*. Final report to the North Central Regional Educational Laboratory/Learning Point Associates: Albany, NY.

Leu, D., Coiro, J., Castek, J., Hartman, D., Henry, L., & Reinking, D. (2008). Research on instruction and assessment in the new literacies of online reading comprehension. In C. Block, L. Morrow & S. R. Parris (Eds.), *Comprehension instruction:*

Researched-based best practices (2nd ed., pp. 321-340). New York, New York: Guilford Press.

Leu, D., Kinzer, C., Coiro, J., & Cammack, D. (2004). Toward a theory of new literacies emerging from the internet and other information and communication technologies. In *Theoretical models and processes of reading* (5th ed., pp. 1570-1613). Newark, Delaware: International Reading Assocation.

Leu, D., Reinking, D., Carter, A., Castek, J., Coiro, J., Henry, L. A., . . . Zawilinski, L. (2009). *Defining online reading comprehension: Using think aloud verbal protocols to refine A preliminary model of internet reading comprehension processe.* Retrieved, 2010, from https://docs-google-com.ezp2.lib.umn.edu/Doc?id=dcbjhrtq_10djqrhz&pli=1

Lewin, T. (2009, In a digital future, textbooks are history. *The New York Times,* Retrieved from http://www.nytimes.com/2009/08/09/education/09textbook.html?pagewanted=all

Lopresti-Goodman, S. M., Turvey, M. T., & Frank, T. D. (2011). Behavioral dynamics of the affordance of "graspable". *Attention, Perception, and Psychophysics, 73*, 1948-1965. doi:10.3758/s13414-011-0151-5

Low, R., & Sweller, J. (2005). The modality principle in multimedia learning. In R. Mayer (Ed.), *Cambridge handbook of multimedia learning* (pp. 147-158). New York: Cambridge University Press.

Macedo-Rouet, M., Rouet, J. :. E., I., & Fayard, P. (2003). Reading and understanding a science report through paper and hypertext. *Science Communication, 25*(2), 99-128.

Maher, D. (2011). Using the multimodal affordancesof the interactive whiteboard to support students' understanding of texts. *Learning, Media & Technology, 36*(3), 235-250.

Mayer, R. (2005). Introduction to multimedia learning. In R. Mayer (Ed.), *Cambridge handbook of multimedia learning* (pp. 1-16). New York: Cambridge University Press.

Mayer, R. E., & Chandler, P. (2001). When learning is just a click away: Does simple user interaction foster deeper understanding of multimedia messages? *Journal of Educational Psychology, 93*(2), 390-397. doi:10.1037/0022-0663.93.2.390

Mayer, R. E., & Johnson, C. I. (2008). Revising the redundancy principle in multimedia learning. *Journal of Educational Psychology, 100*(2), 380-386. doi:10.1037/0022-0663.100.2.380

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Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology, 90*(2), 312-320. doi:10.1037/0022-0663.90.2.312

McEneaney, J. (2006). Agent-based literacy theory. *Reading Research Quarterly, 41*(3), 352-371.

Michaels, C. (2003). Affordances: Four points of debate. *Ecological Psychology, 15*(2), 135-148.

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

Mills, K. A. (2010). A review of the "digital turn" in the new literacy studies. *Review of Educational Research, 80*(2), 246-271.

Minnesota department of education website. Retrieved, June 24th, 2011, from http://education.state.mn.us/ReportCard2005/demographics.do?SCHOOL_NUM=097&DISTRICT_NUM=0196&DISTRICT_TYPE=01

Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments: Special issue on interactive environments: Contemporary issues and trends. *Educational Pscyhology Review, 19*(3), 309-326. doi:10.1007/s10648-007-9047-2

Murphy, E., & Manzanares, M. A. R. (2008). Instant messaging in a context of virtual schooling: Balancing the affordances and challenges. *Educational Media International, 45*(1), 47-58. doi:10.1080/09523980701847180

Neuman, S. B. (1999). Books make a difference: A study of access to literacy. *Reading Research Quarterly, 34*(3), 286-311.

National Center for Education Statistics. (2009). *The nation's report card: Reading 2009*. Washington D.C.: Institute of Education Sciences, U.S. Department of Education.

O'Brien, D., & Scharber, C. (2008). Digital literacies go to school: Potholes and possibilities. *Journal of Adolescent & Adult Literacy, 52*(1), 66-68. doi:10.1598/JAAL.52.1.7

Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart, and Winston.

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

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

Porter, A. (1989). A curriculum out of balance: The case of elementary school mathematics. *Educational Researcher, 18*(5), 9-15.

Pressley, M., & Afflerbach, P. (1995). *Verbal protocols of reading: The nature of constructively responsive reading*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Pressley, M., & Hilden, K. (2004). Verbal protocols of reading. In *Literacy research methodologies* (pp. 308-321). New York, New York: Guilford Press.

RAND Reading Study Group [RRSG]. (2002). *Reading for understanding: Towards an R&D program in reading comprehension*. Santa Monica, CA: RAND.

Randerath, J., Goldenberg, G., Spijkers, W., Li, Y., & Hermsdorfer, J. (2011). From pantomime to actual use: How affordances can facilitate actual tool-use. *Nueropsychologia, 49*(9), 2410-2416. doi: 10.1016/j.neuropsychologia.2011.04.017

Robertson, J. (2011). The educational affordances of blogs for self-directed learning. *Computers & Education, 57*(2), 1628-1644. doi:10.1016/j.compedu.2011.03.003

Rosenblatt, L. (1978 / 1994). *The reader, the text, the poem* (Paperback ed.). Carbondale and Edwardsville, IL: Southern Illinois Press.

Scharber, C. (2009). Online book clubs: Bridges between old and new literacy practices. *Journal of Adolescent & Adult Literacy, 52*(5), 433-437.

Schnotz, W., & Rasch, T. (2005). Enabling, facilitating, and inhibiting effects of animations in mutlimedia learning: Why reduction of cognitive load can have negative results on learning. *Educational Technology Research and Development, 53*(3), 47-58. doi:10.1007/BF02504797

Schunk, D., & Miller, S. (2002). Self efficacy and adolescent's motivation. In *Academic motivation of adolescents* (pp. 29-52). Greenwich, CT: Information Age Publishing.

Schunk, D. H. (2003). Self-efficacy for reading and writing: Influence of modeling, goal setting, and self-evaluation. *Reading & Writing Quarterly, 19*(2), 159.

Serafini, F. (2011). Expanding perspectives for comprehending visual images in multimodal texts. *Journal of Adolescent & Adult Literacy, 54*(5), 342-350. doi:10.1598/JAAL.54.5.4

Stein, P. (2008). Multimodal instructional practices. In J. Corio, M. Knobel, C. Lankshear & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 871-898). New York: Lawrence Erlbaum Associates.

Stipeck, D., & Mac Iver, D. (1989). Developmental change in children's assessment of intellectual competence. *Child Development, 60*, 521-538.

Stoffregen, T. (2003). Affordances as properties of the animal-environment system. *Ecological Psychology, 15*(2), 115-134.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage Publications.

Surdin, A. (2009, October 19). More schools experimenting with digital textbooks. *The Washington Post,* Retrieved from http://www.washingtonpost.com/wp-dyn/content/article/2009/10/18/AR2009101802360.html

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257-285. doi: 10.1016/0364-0213(88)90023-7

Sweller, J. (1989). Cognitive technology: Some procedures for facilitating learning and problem solving in mathematics and science. *Journal of Educational Psychology, 81*(4), 457-466. doi:10.1037/0022-0663.81.4.457

Thagard, P. (2008). *Cognitive science.* Retrieved from <http://plato.stanford.edu.floyd.lib.umn.edu.ezp2.lib.umn.edu/archives/fall2008/entries/cognitive-science/>.

Van leeuwen, T. (2005). *Introducing social semiotics*. London: Routledge.

Warren, W. H. (1984). Perceiving affordances: Visual guidance of stair climbing. *Journal of Experimental Psychology: Human Perception and Performance, 10*(5), 683-703. doi:10.1037/0096-1523.10.5.683

Wigfield, A., & Eccles, J. S. (2001). Introduction. In A. Wigfield, & J. S. Eccles (Eds.), *Development of achievement* (pp. 1-11). San Diego: Academic Press.

Wilson, A. A. (2008). Moving beyond the page in content area literacy: Comprehension instruction for multimodal texts in science. *The Reading Teacher, 62*(2), 153-156. doi:10.1598/RT.62.2.7

Witzel, B. S., & Riccomini, P. J. (2007). Optimizing math curriculum to meet learning needs of students. *Preventing School Failure, 52*(1), 13-18.

Wyatt-Smith, C., & Elkins, J. (2008). Multimodal reading and comprehension in online evironments. In J. Corio, M. Knobel, C. Lankshear & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 899-940). New York: Lawrence Erlbaum Associates.

Zucker, A., & Hug, S. (2007). *A study of the 1-to-2 laptop program at the denver school of science and technology*. http://www.scienceandtech.org/documents/Technology/DSST_Laptop_Study_Report.pdf: Unpublished Manuscript.

Appendices

Appendix A: IRB Approval

UNIVERSITY OF MINNESOTA

Twin Cities Campus

Human Research Protection Program
Office of the Vice President for Research

D512 Mayo Memorial Building
420 Delaware Street S.E.
MMC 820
Minneapolis, MN 55455

Office: 612-626-5654
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10/06/2010

Scott M Voss
8350 141st Street West
170 Wentworth Ave West
Apple Valley, MN 55124-6785

RE: "The affordances of multimodal texts and their impact on comprehension and self-
        efficacy"
        IRB Code Number: 1009P88733

Dear Mr. Voss:

The Institutional Review Board (IRB) received your response to its stipulations. Since this
information satisfies the federal criteria for approval at 45CFR46.111 and the requirements set
by the IRB, final approval for the project is noted in our files. Upon receipt of this letter, you
may begin your research.

IRB approval of this study includes the consent and assent form, both received October 5, 2010.

The IRB would like to stress that subjects who go through the consent process are considered
enrolled participants and are counted toward the total number of subjects, even if they have no
further participation in the study. Please keep this in mind when calculating the number of
subjects you request. This study is currently approved for 130 subjects. If you desire an increase
in the number of approved subjects, you will need to make a formal request to the IRB.

For your records and for grant certification purposes, the approval date for the referenced project
is September 9, 2010 and the Assurance of Compliance number is FWA00000312 (Fairview
Health Systems Research FWA00000325, Gillette Children's Specialty Healthcare
FWA00004003). Research projects are subject to continuing review and renewal; approval will
expire one year from that date. You will receive a report form two months before the expiration
date. If you would like us to send certification of approval to a funding agency, please tell us the
name and address of your contact person at the agency.

As Principal Investigator of this project, you are required by federal regulations to inform the
IRB of any proposed changes in your research that will affect human subjects. Changes should
not be initiated until written IRB approval is received. Unanticipated problems or serious
unexpected adverse events should be reported to the IRB as they occur.

The IRB wishes you success with this research. If you have questions, please call the IRB office
at 612-626-5654.

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Appendix B: Experiment Text

Populations and the Use of Natural Resources

 Suppose you and some of your friends plan to spend a day at the park. Some of your friends start a volleyball game, while others unpack the cooler and light the barbecue. Later on, maybe all of you will go for a bicycle ride. Did you know that in each of these activities you and your friends would be using natural resources?

Resources and organisms

Take a deep breath right now, then let it out again. When you inhale, you take oxygen gas out of the air and into the cells of the blood vessels in your lungs. When you exhale, you release oxygen and carbon dioxide gas and water vapor back into the air. Oxygen, carbon dioxide, and water are examples of natural resources that you, as well as many other living things, use every day.

Like all organisms, you need particular natural resources to maintain life, grow, and reproduce. Among the natural resources that organisms require are air, food, water, and in some cases, shelter. To meet their basic needs, most organisms are adapted to their immediate environment; they live in balance with the natural resources their environment provides. For example, songbirds live in the grassy meadows, forage for grass seeds to eat, weave nests out of dried grasses and twigs, and drink water from ponds or streams nearby. Painted turtles live in pools, swamps, and slow-moving streams, where they eat aquatic plants , insects, and other small animals.

Other organisms, however, alter their environment to better meet their needs. For example, beavers build dams across streams to create ponds where none previously existed. Such alteration of the environment has both positive and negative impacts: it kills some trees and displaces both aquatic and terrestrial organisms, but at the same time, it creates a new wetland environment for other organisms. Termites in tropical areas also create environments that are favorable to themselves by building tall mounds. Both a beaver dam and a termite mound, alter the environment to provide for the basic needs of the organisms that build them. Many other organisms alter their environments to improve their chances of survival. For example, corals build huge, underwater reefs that provide homes for all kinds of marine organisms. Of all organisms, however, humans have an unequaled capacity to modify their environments. This capacity allows us to live in every terrestrial environment on Earth. As a result, humans also have the greatest impact on Earth's natural resources.

Resources and Population Growth

Any type of organism can have an impact in on its environment if its population becomes large enough. For example, your consumption of oxygen and release of carbon dioxide usually has little effect on your immediate environment. However, if you were in a closed room crowded with people, there would soon be less oxygen and more carbon dioxide than the amount people are used to. If no additional fresh air entered the room, everyone eventually would become uncomfortable and would leave the room. As any population increases, its demand for natural resources increases as well.

Population growth is defined as an increase in the size of a population over time.   A graph of a growing population resembles a J-shaped curve at first. Whether the population is one of dandelions in a lawn, squirrels in a city park, or herring gulls on an isolated island, the initial increase in population is small because the number of adults capable of reproducing is low. As the number of reproducing adults increases, however, the rate of population growth increases rapidly. The population then experiences exponential growth, a pattern of growth in which a population grows faster as it increases in size. **E**xponential growth results in a population explosion.

Limits to Population Growth

If exponential growth was extended for a longer period of time, what do you think would happen to the size of the population? Would it continue to grow exponentially? Many of Earth's natural resources are in limited supply, and therefore, most populations cannot continue to grow forever. Eventually one or more *limiting factors*, such as the availability of food, water, or clean air, will cause a population to stop increasing. This leveling-off of population size results in an S-shaped curve**.**

 The number of organisms that any given environment can support is its **carrying capacity.** When population size has not yet reached the carrying capacity of a particular environment, there will continue to be more births than deaths. If the population size exceeds the carrying capacity temporarily, the number of deaths will increase or the number of births will decrease, until the population size returns to the carrying capacity. A population that is at the carrying capacity for its environment is in equilibrium. It continues to fluctuate around the carrying capacity as long as natural resources remain available.

Environmental Limits

Have you ever seen television or newspaper coverage of the aftermath of a tornado or other violent storm? Storms are environmental factors that limit population growth. Environmental factors that affect population growth, such as storms, extreme changes in temperatures, droughts, floods, and pollution, are **density independent factors**. These factors affect all populations that they come in contact with, regardless of population size. A flood affects not only the humans whose homes are destroyed, but also trees, birds, and many other populations of organisms.

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Other environmental factors that affect population growth, such as disease, parasites, and lack of food, are called **density-dependent factors**. Density-dependent factors increasingly affect a population as the population's size increases. For example, in a large population members may live close together. This enables disease organisms to spread quickly from one member of the population to another. If a population is very dense, disease may wipe out the entire population.

Human Population Growth

No matter where you live, you probably have seen an increase during your lifetime in the number of cars, houses, and roads. The human population on Earth is still growing. The growth curve of the human population is still in the J-shaped stage. The human population is expected to continue to grow for at least another 50 years.

Although the human population has not yet reached the carrying capacity of Earth, the current rate of growth clearly cannot continue forever. As the population continues to increase, human demand for natural resources also will continue to increase steadily. Although humans are not the most abundant species on Earth, our use of natural resources has impacted the environment on a global scale.

(Earth Science, 2002)

Population Test

Please read section 27.1 of the Earth Science textbook (pages 711-715). Once you have read the section, answer all of the questions below. Fill in the oval or circle the correct response.

1. What natural resources is being used when you ride a bike?
A. gravity
B. sunshine
C. coal
D. oxygen

2. What happens when you inhale oxygen gas into your lungs?
A. The oxygen is take into your lungs where it feeds your blood cells.
B. the oxygen combines with carbon dioxide to make energy
C. the oxygen is converted to a nutrient
D. the oxygen is sent to your brain

3. What, according to the second paragraph on page 711, is an example of a natural resource people use everyday?
A. electricity
B. energy
C. paper
D. Water

4. What natural resource do people need to survive?
A. electricity
B. energy
C. water
D. oil

5. How do the authors suggest that organisms live in balance with their environments?
A. They show how a painted turtle depends on the insects, bugs, and water of a pond.
B. They show how an oil spill can influence a coral reef.
C. they show how the painted turtle needs oxygen.
D. They show how the painted turtle has its own shelter on its back.

6. Which organism or living being has the greatex capacity to modify its environment?
A. ants
B. bears
C. termites

D. humans

7. As a population increases, what rises along with it?
A. the level of the oceans
B. the age of the population
C. the size of the planet
D. the population's demand for natural resources

8. Why is population increase originally small?
A. There is not enough food to feed the organism.
B. There is not enough space for the organisms to survive.
C. Populations do no originally know how to survive within their environments.
D. The number of adults capable of reproducing is low.

9. According to the first paragraph on page 713, what is exponential growth?
A. growth at a consist rate
B. a pattern of growth in which a population grows faster as it increases in size
C. growth of just a small part of te population
D. the population growth in comparison to related populations

10. Why can't populations continue to grow forever?
A. All living organisms eventually die.
B. Earth's natural resources are in limited supply.
C. Wars and natural disasters stop population from growing.
D. People decide to stop having children.

11. Imagine a population of rabbits grew uncontrollably on an island where it had no predators. What would be a limiting factor?
A. air
B. food
C. sunshine
D. mating opportunities

12. "Carrying capacity" refers to. . .
A. the amount of weight that can be carried.
B. the number of organisms that any given environment can support.
C. the amount of space an environment can provide.
D. the limit of what someone can carry.

13. A synonym for "equilibrium" would be?
A. balance
B. equality
C. unfair
D. alike

14. Why would deaths increase if the population grows too big?
A. The would not increase.
B. Too much carbon dioxide would be consumed.
C. More natural disasters would occur.
D. Diseases would spread more quickly.

15. What does the word "fluctuate" mean in the sentence, population "continues to fluctuate around the carrying capacity as long as natural resources remain available?"
A. stay the same
B. increase
C. decrease
D. change

16. Which of the following is an example of a density independent factor?
A. disease
B. lack of clean water
C. lack of food
D. hurricane

17. How much longer is the human population expected to continue to grow?
A. 30 years
B. 40 years
C. 50 years
D. 60 years

18. Human overpopulation has not been a problem in the past because. . .
A. animals have outnumbered humans.
B. people could not travel very far.
C. the Earth has not reached its carrying capacity.
D. people were aware of the problem.

19. What position do the authors seem to suggest in the sentence, "the current rate of growth clearly cannot continue forever"?
A. Something must be done soon to stop or slow down population growth.
B. Overpopulation will take care of itself.
C. Humans will solve this problem.
D. The current rate of growth is okay if we simply look for new technological solutions that will increase the Earth's carrying capacity.

20. As the population increases. . .
A. the size of families will decrease.
B. the demand for natural resources will increase.
C. the role government will decrease.

D. the number of natural disasters will increase.

21. The text relies primarily on what form of evidence as a support for its argument that human overpopulation will become a bigger problem in the future?
A. quotations from scientists
B. definitions of scientific terms
C. statistics and charts
D. descriptions of different methods of population control

22. What is the purpose of the passage's last line, "Although humans are not the most abundant species on Earth, our use of natural resources has impacted the environment on a global scale"?
A. to show that the world is going to survive
B. to show that the world's future is uncertain
C. to focus the reader's attention on global warming
D. to focus the reader's attention on overpopulation

23. This section seems to suggest that the problem of human overpopulation could be solved by conserving natural resources or controlling populations. Which do you see as the better option? Explain your choice.

24. Based on the information, which was the best argument for population control? Why?

25. Evaluate the strength and quality of evidence used by the authors to support their position to conserve natural resources.

26. I can read and understand this text. 0-5 (zero means you cannot understand it at all, and 5 means you feel very confident about your abilty)
0 1 2 3 4 5

27. How do you feel that you did on this assessment?
I did very poorly 0 1 2 3 4 5   I did really well

Appendix D: Questions Categorized by Target

#	Question Target	Question stem with listed distractors	Paragraph
1	Integrate / Interpret	What natural resource is being used when you ride a bike? (gravity, sunshine, coal, oxygen).	1
2	Locate / Recall	What happens when you inhale oxygen gas into your lungs? (the oxygen is taken into your lungs where it feeds your blood cells, the oxygen is sent to your brain where it is used for functions that keep your body running, the oxygen is converted to a nutrient, the oxygen is converted into carbon dioxide.)	2
3	Locate / Recall	What is an example of a natural resource people use everyday? (Electricity, Energy, Paper, Water)	2
4	Integrate / Interpret	How do the authors suggest that organisms live in balance with their environments? (they show how a painted turtle depends on the insects, bugs, and water of a pond, they show how an oil spill can influence a coral reef, they show how the painted turtle needs oxygen, they show how the painted turtle has its own shelter on its back).	3
5	Locate / Recall	Why is the population increase originally small? (there is not enough food to feed the organism, there is not enough space for the organisms to survive, the number of adults capable of reproduction is high, the number of adults capable of reproducing is low).	6
6	Locate / Recall	Why can't populations continue to grow forever? (All living organisms eventually die, Earth's natural resources are in limited supply, Wars and natural disasters stop populations from growing, Deaths begin to outnumber births).	7

7	Locate / Recall	Carrying capacity" refers to . . .(the amount of animals that can fit in an area, the amount of , the number of organisms that any given environment can support, the amount of space an environment can provide, the limit of what someone can carry)	8
8	Integrate / Interpret	A synonym for "equilibrium" would be? (balance, equality, unfair, alike)	8
9	Integrate / Interpret	Why would deaths increase if the population grows too big? (Infants and newborns will be unable to survive, Too much carbon dioxide would be consumed, More natural disasters would occur, Diseases would spread more quickly)	8
10	Integrate / Interpret	What does the word "fluctuate"mean in the sentence, Population "continues to fluctuate around the carrying capacity as long as natural resources remain available"? (stay the same, increase, decrease, change)	8
11	Integrate / Interpret	Which of the following is an example of a density independent factor? (disease, unclean water, scarcity of food, hurricane).	9
12	Integrate / Interpret	Human overpopulation has not been a problem in the past because (animals have outnumbered humans, people could not travel very far, the Earth has not reached its carrying capacity, global warming has not been a problem).	12
13	Integrate / Interpret	What position do the authors seem to suggest in the sentence, "the current rate of growth clearly cannot continue forever"? (something must be done soon to stop or slow down population growth, overpopulation will take care of itself, humans will solve this problem, the current rate of growth is okay if we simply look for new technological solutions that will increase the Earth's carrying capacity.)	12

14	Critique / Evaluate	The text relies primarily on what form of evidence as support for its argument that human overpopulation will become a bigger problem in the future? (quotations of famous scientists, definitions of scientific terms, statistics / graphs / charts, stories about what will happen if the problem is not addressed)	
15	Integrate / Interpret	What is the purpose of the passage's last line, "Although humans are not the most abundant species on Earth, our use of natural resources has impacted the environment on a global scale"? (to show that the world is going to survive, to show that the world's future is uncertain, to focus the reader's attention on global warming, to focus the reader's attention the problems of overpopulation)	
16	Critique / Evaluate Open Ended	This section seems to suggest that the problem of human overpopulation could be solved by conserving natural resources or controlling populations. Which do you see as the better option? Explain your answer.	
17	Critique / Evaluate Open Ended	Based on the information, which is the best argument for population control? Why?	
18	Critique / Evaluate Open Ended	Evaluate the strength and quality of evidence used by the authors to support their position to conserve natural resources.	

Appendix E: Main Study Comprehension and Self-Efficacy Items

Please read the text "Populations and the Use of Natural Resources." Then answer all 28 of the questions listed below. You will need to scroll down to see the later questions, and your responses will not be officially recorded until you hit the "submit" button at the bottom. Once you are completed, see Mr. Voss for your gift card. Thank you.

1. What natural resources is being used when you ride a bike?
A. gravity
B. sunshine
C. coal
D. oxygen

2. What happens when you inhale oxygen gas into your lungs?
A. The oxygen is take into your lungs where it feeds your blood cells.
B. the oxygen is sent to your brain where it is used for functions that keep your body running
C. the oxygen is converted to a nutrient
D. the oxygen is converted into carbon dioxide

3. What is an example of a natural resource people use everyday?
A. electricity
B. energy
C. paper
D. Water

4. The author's use the example of the painted turtles to show. . .
A. how organisms live in balance with their environments.
B. how some animals do not require shelter as a natural resource.
C. how some animals may overpopulate an area.
D. how an animal alters its environment to meet its need.

5. Why is population increase originally small?
A. There is not enough food to feed the organism.
B. There is not enough space for the organisms to survive.
C. The number of adults capable of reproduction is high.
D. The number of adults capable of reproducing is low.

6. Why can't populations continue to grow forever?
A. All living organisms eventually die.
B. Earth's natural resources are in limited supply.
C. Wars and natural disasters stop population from growing.
D. Deaths outnumber births.

7. "Carrying capacity" refers to. . .
A. the amount of animals that can fit in an area.
B. the number of organisms that any given environment can support.
C. the amount of space an environment can provide.
D. the limit of what someone can carry.

8. A synonym for "equilibrium" would be?
A. balance
B. equality
C. unfair
D. alike

9. Why would deaths increase if the population grows too big?
A. Infants and newborns will be unable to survive.
B. Too much carbon dioxide would be consumed.
C. More natural disasters would occur.
D. Diseases would spread more quickly.

10. What does the word "fluctuate" mean in the sentence, population "continues to fluctuate around the carrying capacity as long as natural resources remain available?"
A. stay the same
B. increase
C. decrease
D. change

11. Which of the following is an example of a density independent factor?
A. disease
B. unclean water
C. scarcity of food
D. hurricane

12. Human overpopulation has not been a problem in the past because. . .
A. animals have outnumbered humans.
B. people could not travel very far.
C. the Earth has not reached its carrying capacity.
D. global warming has not been a problem until recently.

13. What position do the authors seem to suggest in the sentence, "the current rate of growth clearly cannot continue forever"?
A. Something must be done soon to stop or slow down population growth.
B. Overpopulation will take care of itself.
C. Humans will solve this problem.

D. The current rate of growth is okay if we simply look for new technological solutions that will increase the Earth's carrying capacity.

14. The text relies primarily on what form of evidence as a support for its argument that human overpopulation will become a bigger problem in the future?
A. quotations from scientists
B. definitions of scientific terms
C. statistics and charts
D. stories about what will happen if the problem is not addressed

15. What is the purpose of the passage's last line, "Although humans are not the most abundant species on Earth, our use of natural resources has impacted the environment on a global scale"?
A. to show that the world is going to survive
B. to show that the world's future is uncertain
C. to focus the reader's attention on global warming
D. to focus the reader's attention on overpopulation

16. This section seems to suggest that the problem of human overpopulation could be solved by conserving natural resources or controlling populations. Which do you see as the better option? Explain your choice.

17. Based on the information, which was the best argument for population control? Why?

18. Evaluate the strength and quality of evidence used by the authors to support their position to conserve natural resources.

19. I can read and understand this text. 0-5 (zero means you cannot understand it at all, and 5 means you feel very confident about your abilty)
0 1 2 3 4 5

20. How do you feel that you did on this assessment?
I did very poorly 0 1 2 3 4 5   I did really well

21. Would you be interested in participating in the second phase of this study for an additional $10.00 gift certificate. You would be asked to read the passage again and talk about your thoughts as you do so. The activity would take about 30 minutes.

Appendix F: Guided Interview Protocol

The following is a script was used for the guided interviews in this study.

"Today, we are going to spend some time looking through the passage you read earlier about population growth. I am going to ask you to read back through both the text and the questions and talk about what you were thinking and what you noticed as you completed the activity. We are trying to learn about how students think as they work through different types of texts and so we would like to have the chance to hear your thoughts about the reading and how you read it.

On a few occasions, I will stop to ask you some specific questions about what you might be thinking or doing.

To help us analyze your thoughts, we are recording both the sound of your voice and the things you will be doing on screen. Later, we will go back and review this recording for more information.

Does this activity make sense to you? Do you have any questions?

At this point, go ahead and read back through the text to remember what you did as you read it. Then I want you to tell me about what you were thinking as you completed the activity.
- What did you think of the texts' difficulty?
- Did you find the text to be interesting?
- What did you notice about the way the text was set-up on the screen?

What is your reaction to reading this text on the screen versus within a textbook?   What can you do reading this on the screen that you cannot do if you were reading the regular textbook?

What has been your experience reading textbooks online?

And did you feel more confident about answering the questions when you had access to the text on the screen? How might reading this on the screen improve or not improve your chances of reading the text? What effect might audio and video features have on your ability to read the texts?

Thank you for your time here today. We appreciate your willingness to help us out."

Appendix G: Axial Code Book

Code	Code Label	Sources	References
ACCess	ACC	4	4
Alternate reading answering questions	ARAQ	26	40
Audio support of reading	ASR	23	53
Audio support of reading\Concurrent	ASR-C	8	10
Audio support of reading\Non-concurrent	ASR-NC	6	10
Awareness of affordances	AOA	30	57
Comprehension Monitoring	CM	16	23
Design Factors	DF	16	32
Digital Affordance	DigA	23	43
Discource Affordances	DA	10	11
Formatting Affordances	FA	29	48
Future Research Question	FRQ	1	1
Multimodal question response strategey	MQR	3	3
Online Deterrence	OD	14	23
Online Textbook Experience	OTE	6	8
Other Digital Experiences	ODE	11	17
PHysical Affordances	PHA	18	21
Prevalence of Online Reading	POR	30	61
Quotable	QU	3	3
Reading Preference	RP	29	68
Repeated reading	RR	8	10
Scrolling Affordances	SA	14	19
Self Efficacy	SE	26	44
Systematic use of affordances	SUA	32	53
Video Support of Reading	VSR	19	45
Visual Affordance	VA	9	16
Vocabulary	VO	5	6