ABSTRACT

Title of dissertation: THE EXPRESSION AND ENACTMENT OF INTEREST AND CURIOSITY IN A MULTIPLE SOURCE USE TASK

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Selecting and incorporating multiple text and non-text sources is an academic task that has been identified as both commonplace and challenging for undergraduate students. Although the term *digital natives* is frequently used to describe students of this generation, the degree to which undergraduate students prefer or effectively use digital as compared to print sources has been relatively unaddressed. Additionally, although individual differences such as knowledge have been identified as important for multiple source use and comprehension, the role of motivational variables has been under-examined and has focused on source use within a single medium (i.e., digital or print). This study investigated the role of two motivational variables, interest and curiosity. It examined the degree to which the confluence of these motivational variables in conjunction with knowledge predicted source selection, source use, and task performance when students were provided with multiple print and digital sources. Undergraduate students wore a head-mounted videocamera as they developed a PowerPoint presentation on Alzheimer's disease based on 16 available resources (8 print and 8 digital). Follow-up

interviews were conducted to determine the degree to which interest and curiosity influenced students' selection and use of sources. Measures of topic knowledge, topic interest, and epistemic trait curiosity were assessed a priori. A coding scheme for capturing use of print and digital sources was developed for the purpose of this study. Differences across source medium and source type (e.g., textbook, image) were evident. Although students exhibited preferences for selecting several types of sources in a digital format, they spent twice as long using print sources, incorporated more print sources into their presentations, and developed more inferences based on print sources. Students with more knowledge, interest, and curiosity spent more time using print sources but less time using digital sources. Further, students' presentations revealed a tendency to replicate material from sources rather than to draw inferences, make conclusions, or integrate material across sources. Findings suggest the tendency for undergraduate students to focus their processes on the management of information rather source integration particularly when using digital compared to print sources.

THE EXPRESSION AND ENACTMENT OF INTEREST AND CURIOSITY IN A MULTIPLE SOURCE USE TASK

by

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Acknowledgments

When I started my dissertation I perceived it as an isolated event—as somehow separate from the rest of my graduate education and all that I had learned. This was, of course, a silly notion. Inevitably, much change and growth happened over these past years. Yet, it was not until I was deep into the conclusions that I found myself distant enough to notice this change. In many ways I feel like the lion—brave all along, but needing to reach Oz in order to finally recognize it. And much like the lion, this was not an easy journey, but it was one that was tremendously enhanced by these gifts that others shared. *From Alex*: Collaboration, friendly competition, and the motivation to think deeply about how students use sources. Many of the ideas presented here are a direct result of our years working together. *From my committee, professors, Emily, Liliana, Meg, Dan, and Sandra*: The ability to critically question the ideas of previous scholars and the encouragement to endlessly challenge my own. *From Denis, Sophie, Lauren, Lily, Courtney, and the rest of my lab family*: Conversations that sparked novel ideas, generous time for editing and coding, and enduring confidence in my success. *From Steve, Sabrina, Cynthia, Spencer, Micha, Lijuan, and the TLTC staff*: The space to enact my research into practice and unquestioned time, support, and belief in my abilities. *From Sarah*: An open ear for my student woes and the opportunity to live vicariously through your struggles and many successes teaching amidst challenge. *From my mother, Nancy*: Love, unconditional support, and never a sense of doubt. *From Ryan*: More than anyone else, you repeatedly endured the phrase *because I have to write my dissertation*. Although I am not sure you knew what you were getting into, without question you gifted me abundant motivation and love, abiding patience, and a balanced perspective on my

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Table of Contents

Acknowledgments ii
Table of Contents iv
List of Tables vii
List of Figures ix
CHAPTER 1 1
INTRODUCTION 1
Statement of Problem 1
Purpose of the Study 10
Research Questions 13
Key Terms 14
CHAPTER 2 17
REVIEW OF THE LITERATURE 17
Multiple Source Use 18
Curiosity 30
Interest 39
Potential Relations between Curiosity and Interest 46
Knowledge, Interest, and Curiosity 49
Interest, Curiosity, and Knowledge in Relation to Multiple Source Use 52
Summary 58
CHAPTER 3 61
METHODOLOGY 61
Pilot Study 1 62
Participants 62
Measures and Procedure 62
Results 63
Pilot Study 2 66
Participants 67
Measures and Procedure 67
Results 67
Pilot Study 3 68
Main Study 70
Participants 70
Demographics Questionnaire 72
Independent Measures 73
Topic Interest 73
Epistemic Trait Curiosity 73
Topic Knowledge 75
Dependent Measures 77
Source Selection and Use 77
Performance Outcomes 79
Procedure 81
Coding Print and Digital Source Use 86
Source Selection 86

Source Use Processes....87
Coding Post-Hoc Expressions of Interest and Curiosity....95
Coding Task Performance....99
Summary....106
CHAPTER 4....107
RESULTS: MULTIPLE SOURCE SELECTION, USE, AND OUTCOMES....107
Research Question 1....108
Source Selection....109
Source Use....113
Relations Between Source Selection and Use....119
Research Question 2....122
Overview of Task Performance....122
Task Performance in Relation to Multiple Source Use....126
Source Use and Task Performance Across Mediums....127
CHAPTER 5....133
RESULTS: INDIVIDUAL DIFFERENCE VARIABLES AND MULTIPLE SOURCE USE....133
Research Question 3....134
Research Question 4....136
Interest/Curiosity for Content....137
Interest/Curiosity for Source Features....140
Interest/Curiosity of the Audience....140
Research Question 5....142
Individual Difference Variables and Multiple Source Selection and Use....142
Post-Hoc Expressions and Multiple Source Selection and Use....154
Research Question 6....155
A Priori Indicators and Task Performance....155
Post-Hoc Expressions and Task Performance....157
CHAPTER 6....159
CONCLUSION AND DISCUSSION....159
Key Findings....160
Multiple Source Use as Management versus Integration....161
Interaction of Source Type and Medium....164
Role of Individual Differences in Multiple Source Use....167
The Experience of Interest and Curiosity during Multiple Source Use....173
Implications for Theory, Research, and Practice....175
Implications for Theory and Research....175
Implications for Practice....180
Limitations, Delimitations, and Future Directions....182
Conclusion....194
Appendix A: Demographic Questionnaire....195
Appendix B: Topic Interest Questionnaire....197
Appendix C: Trait Curiosity Questionnaire....198
Appendix D: Topic Knowledge Measure....199
Appendix E: Source List....201

Appendix F: Source Comparability 203
Appendix G: Coding Scheme for PowerPoint 204
Appendix H: Interview Protocol 205
Appendix I: Source Use Coding 206
Appendix J: Two-Level Coding Scheme for Post-Hoc Expressions of Interest/Curiosity208
References 209

List of Tables

Table 1 *Summary of Pilot 1 Data for Individual Difference Measures* 64

Table 2 *Topic Knowledge Measure Pilot 1 Item Statistics* 65

Table 3 *Pilot 2 Topic Knowledge Test at Time 1 and Time 2* 67

Table 4 *Scores on Topic Knowledge Measure* 76

Table 5 *Summary of Source Selection and Use Variables* 110

Table 6 *Comparison of Source Selection by Medium* 111

Table 7 *Frequency of Source Selection by Source Type and Medium* 112

Table 8 *Time Spent on Compositional Source Use by Source Type and Medium for Participants Using Each Source* 114

Table 9 *Time Spent on Focused Source Use by Source Type and Medium for Participants Using Each Source* 115

Table 10 *Time Spent on Source Use by Source Type and Medium Including Zero Values* 117

Table 11 *Bivariate Correlations Between Compositional Source Use Indicators* 119

Table 12 *Bivariate Correlations Between Focused Source Use Indicators* 119

Table 13 *Bivariate Correlations Between Indicators of Print Source Selections and Use* 121

Table 14 *Bivariate Correlations Between Indicators of Digital Source Selections and Use* 121

Table 15 *Summary of Performance Indicators* 123

Table 16 B*ivariate Correlations Between Surface-Level Indicators* 124

Table 17 *Bivariate Correlations Between Deep-Level Indicators* 124

Table 18 *Bivariate Correlations Between Surface-Level and Deep-Level Performance Indicators* 125

Table 19 *Bivariate Correlations for Surface-Level Indicators and Source Selections and Use* 129

Table 20 *Bivariate Correlations for Deep-Level Indicators and Source Selections and Use* 130

Table 21 *Comparison of the Origin of Performance Indicators across Print and Digital Sources* 131

Table 22 *Frequency and Proportion of Sources Incorporated in the Presentation Compared to Sources Selected* 131

Table 23 *Summary of Individual Difference Measures* 135

Table 24 *Bivariate Correlations Between Individual Difference Variables* 135

Table 25 *Summary of Post-Hoc Expressions of Interest/Curiosity* 137

Table 26 *Bivariate Correlations Between Individual Difference Variables and Source Selection and Use Separated by Print and Digital Sources* 148

Table 27 *Beta Coefficients for Individual Difference Factors as Predictors of Digital Source Selections* 148

Table 28 *Individual Difference Factors as Predictors of Time Spent Using Digital Sources* 149

Table 29 *Individual Difference Factors as Predictors of Digital Compositional Use Per Source* 150

Table 30 *Individual Difference Factors as Predictors of Digital Focused Use Per Source* 150

Table 31 *Bivariate Correlations Between Post-Hoc Expressions of Interest/Curiosity and Print vs. Digital Source Selection and Use* 154

Table 32 *Bivariate Correlations Between Performance and Individual Difference Variables* 156

Table 33 *Individual Difference Factors as Predictors of Inclusion of an Image* 156

Table 34 I*ndividual Difference Factors as Predictors of Number of Presentation Source Switches* 156

Table 35 *Bivariate Correlations Between Post-hoc Expressions of Interest/Curiosity and Performance Indicators* 158

Table 36 *Predictors of Digital Focused Use Per Source* 171

Table 37 *Predictors of Print Focused Use Per Source* 171

Table 38 *Average Reported Use of Print and Online Materials When Doing Research For Class* 182

Table 39 *Summary of Interest and Curiosity for the Main Study and Pilot Studies* 191

List of Figures

Figure 1. Conceptual model of the study.....13

Figure 2. Screenshot of the online interface.....83

Figure 3. Participant workstation. 84

Figure 4. GoPro camera.....84

Figure 5. Sample phase 1 and phase 2 coding in Excel.....94

Figure 6. Percentage of print and digital sources selected by participants that were incorporated into the presentation.....132

Figure 7. Interaction of knowledge and interest on per source digital compositional source use across low and moderate levels of interest with I-type and D-type curiosity held constant. 153

Figure 8. Interaction of knowledge and interest on per source digital focused source use with I-type and D-type curiosity held constant.....153

CHAPTER 1

INTRODUCTION

Statement of Problem

Positive motivations toward schools and school achievement have been shown to be critical in supporting students' momentum when learning and completing academic assignments (Côté & Levin, 2000; Guthrie et al., 2007; Zimmerman, Bandura, & Martinez-Pons, 1992). Yet, there is evidence that students often enter learning environments academically unmotivated (Hidi & Harackiewicz, 2000; Ryan & Deci, 2009). Further, it has been found that students' motivations toward academics generally decline over the course of their educational career (Anderman & Maehr, 1994; Pan & Gauvain, 2012; Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006). In particular, it is important to consider the trajectories of interest and curiosity, two motivations that may have particular relevance for students engaging in academic tasks in today's information-rich environments (Bowler, 2010; Dickey, 2011). Interest and curiosity experience both increases and decreases throughout schooling and the lifespan (Alexander, 2003; Gold & Henderson, 1990). At the same time, both have been tied to educational outcomes from preschool through college (e.g., Alexander, Jetton, & Kulikowich, 1995; Fortner-Wood & Henderson, 1997; Neblett et al., 2006).

Scientific discussions of interest and curiosity, which extend over more than a century (Dewey, 1910; James, 1890/1950), have received increasing attention within the past few decades (e.g., Ainley, Hidi, & Berndoff, 2002; Bowler, 2010; Hidi & Renninger, 2006; Litman & Spielberger, 2003; Reio, Petrosko, Wiswell, & Thongsukmag, 2006). Throughout this document I refer concurrently to interest and curiosity with an

acknowledgment that their distinctiveness remains open to debate (Grossnickle, 2014). In fact, some researchers have speculated that interest and curiosity may be inseparable (Kashdan, 2004; Silvia, 2006). However, others have described interest as leading to curiosity (Boscolo, Ariasi, Del Favero, & Ballarin, 2011), curiosity as leading to interest (Dewey, 1910; Silvia, 2008), or have depicted them as reciprocally related (Arnone, Small, Chauncey, & McKenna, 2011; Engel & Randall, 2009; Hidi, 2006; Renninger, 2000; Schmitt & Lahroodi, 2008). The overlap or interrelation between interest and curiosity has not been reconciled, in part because few studies have included measures of both constructs (for exceptions see: Boscolo et al., 2011; Connelly, 2011; Silvia 2005, 2008; Silvia, Henson, & Templin, 2009).

Additionally, empirical attention to these two motivational constructs within the psychological literature has been uneven. Specifically, while interest and curiosity have both been implicated as factors related to student learning (Alexander et al., 1995; Neblett, Philip, Cogburn, & Sellers, 2006; Wavo, 2004), interest has received significantly more attention in the educational literature (e.g., Frenzel, Goetz, Pekrun, & Watts, 2010; Hidi, 1990; Schiefele, 1996). Interest has been defined as the "processes by which the underlying needs or desires of learners are energized" (Alexander, Murphy, Woods, Duhon, & Parker, 1997, p. 128). Research has suggested that interest is a positive motivator for learning in a wide range of contexts and domains (Köller, Baumert, & Schnabel, 2001; Murphy & Alexander, 2002; Rotgans & Schmidt, 2011). There is also evidence that interest is related to text recall and comprehension (Alexander et al., 1995; Schiefele, 1999; Wade, Buxton, & Kelly, 1999), test performance and grades (Dennisen, Zarrett, & Eccles, 2007; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005), and

strategic processing (Ainley & Ainley, 2011; Alexander & Murphy, 1998; Bråten & Strømsø, 2006; Wade, Schraw, Buxton, & Hayes, 1993). Interest has been studied as an individual characteristic that can develop over time in relation to specific content and domains (i.e., individual interest) or topics (i.e., topic interest). Additionally, examinations have investigated interest as a transient state that arises due to contextual and task factors (i.e., situational interest).

Although less prevalent within the literature, curiosity has also been regarded as a potential motivator for learning (Arnone, Grabowsky, & Rynd, 1994; Berlyne, 1954; Dewey, 1910; Spielberger & Starr, 1994). Yet, such potential has not been extensively empirically substantiated, although some investigations have recently taken place (Neblett et al., 2006; Smalls, White, Chavous, & Sellers, 2007; Wavo, 2004). Theoretically, curiosity has been described as a motivational drive (Berlyne, 1954; Schmitt & Lahroodi, 2008) and a condition of optimal arousal (Berlyne, 1960; Spielberger & Starr, 1994). Additionally, it has been depicted as a motivation to reduce knowledge gaps (Bowler, 2010; Loewenstein, 1994) and motivator of exploration (Kashdan, 2004; Koo & Choi, 2010; Litman & Spielberger, 2003). Curiosity has been examined both as an enduring disposition (i.e., trait curiosity) and as a momentary experience (i.e., state curiosity). While the specifics of these theoretical orientations demand further exploration, they suggest that curiosity has the potential to serve as an impetus for learning.

Although there is a paucity of empirical research on curiosity in academic contexts, a limited number of studies have supported theoretical beliefs that curiosity is a positive motivator for academic performance (Neblett et al., 2006; Smalls et al., 2007;

Wavo, 2004). Since Dewey's (1910) separation of curiosity into physical, social, and intellectual curiosity, research within educational contexts has tended to focus on intellectual curiosity. This is frequently termed either *epistemic curiosity* (i.e., the need for knowledge; Loewenstein, 1994), or *academic curiosity* (i.e., the desire for knowledge, information, or the exploration of learning environments; Kang et al., 2009; Litman & Silvia, 2006).

More recently, examinations of curiosity have suggested that as a motivational construct it may be particularly relevant in technology-rich environments such as those facing students today (Bowler, 2010; Dickey, 2011). Scholars have suggested that the speed and ease of the current technological environment, which gives students the potential to find information and learn new knowledge quickly and easily, is an optimal time for the increase of empirical research on curiosity (Arnone et al., 2011). Indeed, the technologically-based and information-rich environments in which learners function offer unique opportunities to investigate the role of interest and curiosity in task performance.

Tasks requiring the use of multiple sources have been integrated into school and university curricula to an ever-increasing extent (Common Core State Standards, 2012). Likewise, the research literature has examined academic tasks requiring students to access and utilize diverse sources ranging from print texts to online videos to graphical representations and hypertexts (Lawless & Kulikowich, 1996; List, Grossnickle, & Alexander, 2012, 2013; Scheiter & Gerjets, 2007; Wineburg, 1991). The availability of a wide range of sources accompanies the nearly ubiquitous use of computers, handheld devices, and Internet sources in the schools and households of students today (Purcell, Heaps, Buchanan, & Friedrich, 2013; Wells & Lewis, 2006). These developments mean

that students are frequently tasked to identify, select, and use multiple sources to complete class assignments (Brand-Gruwel, Wopereis, & Vermetten, 2005; Bråten, Britt, Strømsø, & Rouet, 2011; Rouet, 2006). These tasks require students to select which sources to read or scrutinize for understanding, to corroborate and integrate information across sources, and to evaluate both pictorial and textual evidence (Britt & Aglinskas, 2002; Cerdán & Vidal-Abarca, 2008; Rouet, 2006; Wineburg, 1991).

Despite recent standards and curricula, such as the Common Core State Standards (CCSS, 2012), recommending the implementation of multiple sources as a part of daily academic assignments, the understanding and integration of multiple sources remains a challenge for many students (Bråten & Strømsø, 2006; Britt & Aglinskas, 2002; Rouet, 2006). Indeed, students are often unable to make differentiations between sources and fail to corroborate information across sources, instead favoring texts that demonstrate relevance to the task regardless of source quality (Gerjets, Kammerer, & Werner, 2011; List et al., 2012). Although providing students with multiple sources may hinder comprehension as compared to presenting similar information as a single source (Wiley & Voss, 1999), the use of multiple sources provides benefits such as what Wiley and Voss (1999) referred to as deeper-level understanding (i.e., a constructive, transformative process and effortful engagement with multiple sources). This compares to surface-level performance, which is associated with more superficial representations and limited effortful engagement with multiple sources (Scardamalia & Bereiter, 1987; Wiley & Voss, 1999).

At the undergraduate level, students are expected to be able to identify, select, and use multiple sources (Cerdán & Vidal-Abarca, 2008), a task that is often done

independently with little guidance from instructors or other specialists (Thompson, 2003). However, students often fail to evaluate online sources (Grimes & Boening, 2001) and may overestimate the credibility of online sources (Metzger, Flanagin, & Zwarun, 2003). This can lead to students using single sources for tasks that are designed to involve the integration and corroboration of multiple sources (Graham & Metaxes, 2003). Moreover, there is a mismatch between the sources that instructors expect their students to use and the sources that students actually use (Grimes & Boening, 2001). The well documented challenges for students to do so successfully (Bråten, Ferguson, Anmarkrud, & Strømsø, 2013; Cerdán & Vidal-Abarca, 2008) suggest the pivotal need to understand multiple source use at the undergraduate level.

Given the frequency and importance of multiple source use tasks in academic assignments, it is necessary to consider factors that might play a role in students' source use, namely knowledge and motivation (Bråten & Strømsø, 2006; Rouet, 2006). While knowledge and motivation have been extensively examined and identified as critical factors in studies of single texts (Fox, 2009), they have been investigated within the multiple source use literature to a more limited extent. Yet, certain trends can be identified. First, differences in knowledge have been examined at topic and domain levels. For one, differences have been observed between secondary students and experts (Wineburg, 1991) and among individuals nearing expertise in different disciplines (Rouet, Favart, Britt, & Perfetti, 1997). At the topic level, greater topic knowledge (i.e., understanding of topics within a domain; Alexander et al., 1995) has been associated with more success in the integration of information across multiple sources (Gil et al., 2010; Stadtler & Bromme, 2008; Strømsø, Bråten, & Britt, 2010).

However, while knowledge may play a fundamental role for single and multiple source comprehension, Bråten and colleagues (2013) have argued that motivation may play an even more critical role in multiple source as compared to single text comprehension due to the high level of cognitive engagement necessary to comprehend multiple potentially conflicting documents. Although research in this area is in its early stages, differences in motivation have been identified as key factors across several aspects of the multiple source use process, including source evaluation (Braasch, Bråten, Strømsø, Anmarkrud, & Ferguson, 2013) and source comprehension within as well as across sources (Salmerón, Gil, Bråten, & Strømsø, 2010; Strømsø et al., 2010).

Although investigations surrounding multiple source use have proliferated in the past decade (e.g., Braasch et al., 2009; Bråten, Strømsø, & Salmerón, 2011; Cerdán & Vidal-Abarca, 2008; Kienhues, Stadtler, & Bromme, 2011; Le Bigot & Rouet, 2007), several gaps exist in this line of research. First, research on multiple source use has not frequently examined the use of both print and digital sources. Rather, these studies have typically focused on source characteristics (e.g., author or publication date) and have implemented sources all within the same medium, either print or digital (Stadtler & Bromme, 2007; Strømsø & Bråten, 2009). While changes in technology have provided for greater access to digital sources and supported their use in classrooms, other more traditional sources such as print books and physical models have retained a place for use in classrooms, often used alongside digital sources (Purcell et al., 2012). As such, understanding students' selection and use of various types of sources, both print and digital, is important for gaining a more accurate understanding of multiple source use in the academic lives of students.

A second gap that this study addressed was students' use of sources when they are freely able to select among multiple sources. While studies of multiple source use have focused on source evaluation and trust (Braasch et al., 2013; Bråten, Strømsø, & Britt, 2009), less is known about how students select sources. Studies of multiple source use have frequently implemented a methodology that requires participants to read all given sources (e.g., Bråten & Strømsø, 2006; Britt, Perfetti, Sandak, & Rouet, 1999; Wineburg, 1991) rather than allowing participants to select a subset of sources or to identify their own sources to meet their academic needs. Studies requiring students to read all given sources gain useful information about students' comprehension of single and multiple sources in addition to providing for comparisons of features across sources (e.g., trustworthiness, Bråten et al., 2009). However, this methodology does not necessarily provide an accurate representation of students' source use in typical academic tasks. Thus, the current study examined students' source selection when learners were presented with an array of print and digital sources.

Third, research in multiple source use often lacks connections between source use and the outcomes of academic tasks. For example, the task participants are instructed to complete frequently differs in important ways from the actual task given as an outcome measure (e.g., Bråten et al., 2013). For instance, participants are sometimes asked to read texts in order to prepare a presentation, but are then asked to respond to essay questions (Bråten et al., 2013). Successful use of multiple sources cannot be determined without an understanding of the intentions and goals behind the use (Rouet, 2006). Therefore, a clear understanding of the context and the purpose of academic tasks is essential for

understanding whether individuals are demonstrating competence in their use and integration of sources (Bråten & Strømsø, 2010a; Maggioni, Fox, & Alexander, 2010).

Within academic contexts, the purpose of multiple source use is frequently prescribed for students in the form of an assignment or task. Students are asked to select and comprehend single and multiple sources to create a summary, provide an argument, or answer questions about the texts (Bråten & Strømsø, 2006, 2010b; Bråten, Strømsø, & Samuelstuen, 2008; Cerdán & Vidal-Abarca, 2008). Although multiple source use studies have frequently provided students with academic tasks to guide their source use, these studies at times have not measured student performance on outcomes (e.g., Bråten & Strømsø, 2003). Moreover, participants have often been required to complete memory-based tasks, such as identifying sentences (Strømsø & Bråten, 2009) or creating essays from memory that integrate information from multiple sources (Braasch et al., 2013). These tasks do not always adequately capture the range of tasks that students engage in during typical academic activities. Consequently, these studies cannot examine relations among source use, individual factors, and performance outcomes.

Fourth, although motivations have been implicated as an important factor within models of multiple source use (Perfetti, Rouet, & Britt, 1999; Rouet, 2006), there has been limited research in this area, and motivational constructs such as interest and curiosity have been particularly underexamined. Although interest and curiosity have been studied in relation to single-text processing (Knobloch, Patzig, Mende, & Hastall, 2004; Shirey & Reynolds, 1988; Wade et al., 1993), these variables have not received the same attention in the multiple source use literature. In fact, no studies of which I am aware have explicitly examined curiosity as a factor in multiple source use, despite

evidence that it may be critical for information search (Arnone et al., 2011; Zhao, Lin, Wang, & Huang, 2011). By comparison, studies that have included interest have frequently used it as a control variable (Strømsø & Bråten, 2009), sometimes even excluding it from analysis (Stadtler & Bromme, 2007, 2008). However, interest has been identified as positively related to multiple source comprehension (Salmerón et al., 2010) and has been reported by students as a justification for source usefulness (Braasch et al., 2013).

Thus, as discussed, multiple source use tasks represent a rich context in which interest and curiosity may hold particular value for understanding differences in multiple source use processes and outcomes. In effect, characteristic of interest and curiosity is the enactment of exploratory behaviors as a means to address one's motivation (Spielberger & Starr, 1994; Subbotsky, 2010). Given the potential for selection of and engagement with a variety of sources, multiple source use provides a means by which interest and curiosity have the potential to be enacted in the form of exploration. In this way, multiple source use has the potential to illustrate manifestations of these motivations in academic contexts.

Purpose of the Study

The purpose of this study was to address these major gaps in the multiple source use and motivation literatures and address the following five aims. First, this study examined students' use of multiple types of sources in print and digital mediums as they engaged in a multiple source use task. Although it has been found that students are required to use print resources in conjunction with digital resources (Purcell et al., 2012), there have been limited empirical investigations that target students' use of the multiple

sources that are available within both of these mediums. Building on prior research that provided participants either multiple print or multiple digital sources (e.g., Braasch et al., 2013; Stadtler & Bromme, 2008), the current study provided students with a combination of digital and print sources. Moreover, consistent with recent research examining students' selection of sources when provided with choices of whether or not to use particular sources, the current study sought to understand the number of sources and the types of sources that students used when provided with an open-ended academic task.

The second major aim of this study was to examine expressions of interest and curiosity and their relation to students' source selections and use. A robust line of research has indicated the importance of interest in text processing, with interest typically serving as a positive motivational factor in the comprehension of and memory for texts (Alexander et al., 1995; Schiefele & Krapp, 1996), particularly in relation to higher-level processing tasks (Schiefele, 1996). Despite a recent resurgence of research on the related motivational factor of curiosity, there has been limited inquiry into the relation between curiosity and text processing, with some notable exceptions (e.g., Boscolo et al., 2011; Knobloch Patzig, Mende, & Hastall, 2004). Moreover, the relation between interest, curiosity, and the selection of multiple types of sources within print and digital mediums has not been investigated. This study examined topic interest, trait curiosity, and post-hoc expressions of interest and curiosity related to the task.

Third, this study investigated the degree of overlap and uniqueness between interest and curiosity. This study attempted to disentangle these relations at the level of individual interest and trait curiosity. The relations between these variables were examined, as well as their unique relations to multiple source use and task performance.

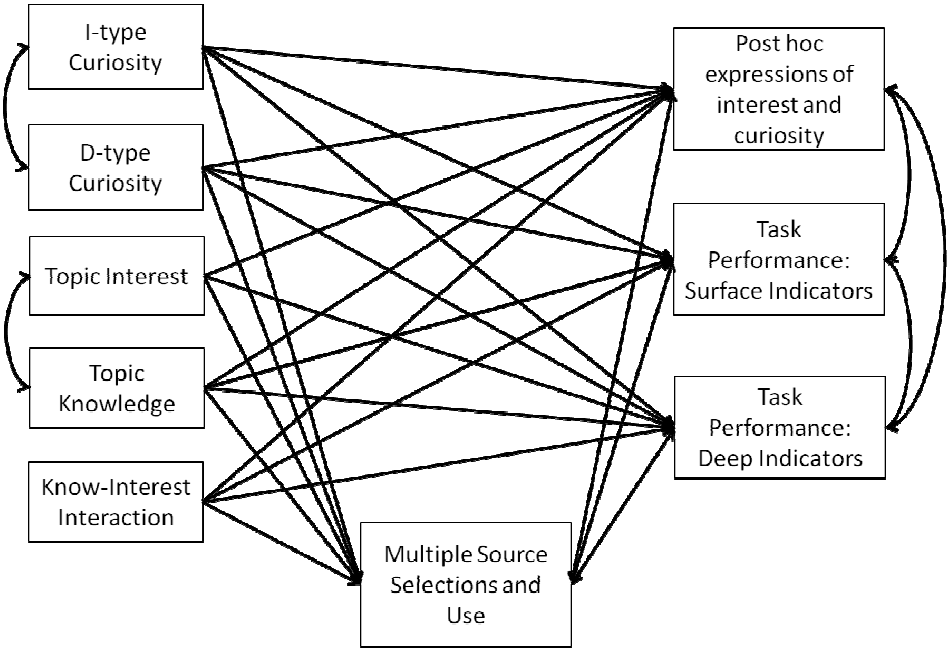
No attempt was made to disentangle interest and curiosity in their momentary expressions, given the previously identified challenges (Grossnickle, 2014).

Fourth, in this investigation, knowledge was examined in relation to topic interest, post-hoc expressions of interest and curiosity, and multiple source use. Given the robust association of knowledge and individual interest (e.g., Alexander et al., 1995; Alexander & Murphy, 1998), the relation between topic knowledge and topic interest was investigated. Additionally, the association between topic knowledge and expressions of curiosity and interest were examined to address the relation between a priori topic knowledge and expressions of interest and curiosity articulated following the completion of a multiple source use task. Further, given the importance of knowledge in multiple source use (Gil et al., 2010; Stadtler & Bromme, 2008; Wineburg, 1991), topic knowledge was examined in relation to the number and types of sources that students used when completing the multiple source use task.

Finally, the current study examined students' performance on the outcome of a multiple source use task as it related to students' multiple source use processes as well as their interest, curiosity, and knowledge. Investigations of students' multiple source use frequently examine source use processes, without making a distinct connection to the intended outcome, and often do not require students to complete an outcome measure. Given the purpose of multiple source use as a means for completing academic tasks, this study provided students with a representative academic task (i.e., creating a PowerPoint presentation), and examined the relations between the number and types of sources that students selected. Additionally, it examined the relation between a priori expressions of

interest and curiosity, and students' a posteriori expressions of interest and curiosity. Figure 1 presents a conceptual model of the examined relations.

Figure 1. Conceptual model of the study.



Research Questions

To meet the described purposes consistent with the conceptual model provided in Figure 1, the following six research questions were addressed:

1. How many, what types of sources (e.g., textbook and image), in what mediums (i.e., digital and print/physical), and for what length of time do students use different types of sources when completing an academic multiple source use task?
2. How are students' source selections and use related to their performance on an academic task?

3. What are the relations among students' topic interest, trait curiosity, and topic knowledge?
4. How are students' topic interest, trait curiosity, and topic knowledge related to their post-hoc expressions of interest and curiosity?
5. To what extent are students' source selections and use related to their topic interest, trait curiosity, topic knowledge, and their post-hoc expressions of interest and curiosity?
6. How are students' topic interest, trait curiosity, topic knowledge, and their post-hoc expressions of interest and curiosity related to their performance on an academic task?

Given interactive relations between knowledge and interest identified within the empirical literature (Alexander et al., 1995; Fox, Dinsmore, & Alexander, 2010; Linnenbrink-Garcia, Pugh, Koskey, & Stewart, 2012; Murphy & Alexander, 2002; Toboada, Tonks, Wigfield, & Guthrie, 2009), for research questions 5 and 6 the data were examined to determine whether an interaction between knowledge and interest was present. The results from research questions 1 and 2 are presented in Chapter 4, and the results from questions 3-6 are presented in Chapter 5. Chapter 6 provides conclusions and a discussion related to all research questions.

Key Terms

Academic curiosity. A need or desire for knowledge, information, or the exploration of academic environments (Kang et al., 2009; Litman, 2010; Litman & Silvia, 2006).

Deep-level performance. Indicators demonstrating a constructive, transformative process and effortful engagement with multiple sources (Scardamalia & Bereiter, 1987; Wiley & Voss, 1999).

Epistemic curiosity. A need or desire for knowledge (Loewenstein, 1994).

Individual interest. An enduring disposition toward and propensity to reengage with particular content or subjects (Ainley, Hidi et al., 2002; Schiefele, 2009).

Multiple source use. The identification, selection, comprehension, and/or evaluation of more than one print or digital source or physical or virtual resource (Goldman, 2011; Rouet, 2006; Wineburg, 1991).

Situational interest. The momentary experience of interest triggered by environmental features and characteristics or brought about through the enactment of individual interest (Hidi, 1990; Schraw & Lehman, 2001).

Source characteristics. Explicit and implicit features of documents related to author characteristics and intentions, type, presentation format, and publication information (Braasch et al., 2013; Britt & Aglinskas, 2002).

Source medium. The format of a source, either in print or digital.

Source type. Overarching category or form of a source, describing whether it is a newspaper, magazine, textbook, primary account, official record, or other type (Anmarkrud, Bråten, & Strømsø, 2014; Britt & Aglinskas, 2002), or describing whether it is print or digital.

Surface-level performance. Indicators of more superficial representations and limited effortful engagement with multiple sources (Scardamalia & Bereiter, 1987; Wiley & Voss, 1999).

State curiosity. The momentary experience of curiosity expressed by the individual in response to features of the environment (Loewenstein, 1994).

Topic interest. Form of individual interest that involves a relatively stable propensity for increased attention and desire to engage in response to specific topics (Schiefele, 1996).

Topic knowledge. Understanding of topics within a domain (Alexander, 2003; Alexander et al., 1995).

Trait curiosity. An enduring dispositional tendency for individuals to experience the desire for new knowledge or experiences either through frequent response to environmental features sparking curiosity or through seeking out opportunities to be curious (Kashdan, Rose, & Fincham, 2004; Litman & Silvia, 2006).

CHAPTER 2

REVIEW OF THE LITERATURE

In this chapter, the relations among constructs within the conceptual model displayed in Figure 1 are explicated. Specifically, this literature review addresses three main questions implicated in that conceptual model. First, this review scrutinizes the literature on how students use multiple types of multiple sources, including print and digital sources. To address this question, theoretical and empirical research in multiple source use is overviewed. Multiple source use is used as the overarching framework guiding this study because theories of multiple source use consider both individual and source characteristics—the central concepts for this study—as factors influencing source use. Descriptions of empirical research focus on the multiple source use literature related to the selection and use of multiple types of sources in association with source types and characteristics. Individual differences within models of source use are described generally in this first section, with greater emphasis on the specific characteristics important for this study (i.e., interest, curiosity, knowledge) during the third section.

Second, this review examines how interest and curiosity have been conceptualized in the literature and how they relate to the processing and products of academic tasks. Given the paucity of research on curiosity, particularly within educational settings, curiosity as it pertains to academic contexts is exhaustively reviewed. By comparison, as interest has been extensively reviewed and examined as it pertains to learning (for reviews see Ainley, 2006; Hidi, 2006; Schiefele, 2009), that literature is selectively sampled, with a particular focus on the relations among interest and text processing. Further, within discussions of interest and curiosity, relations among

individual or trait aspects of the constructs with situational expressions (represented in this study by post-hoc interview data) are considered. Additionally, the relations among knowledge and interest and knowledge and curiosity are addressed.

Third, this review examines the relations among individual difference characteristics and multiple source use processes and products. Specifically, this survey of the literature focuses on interest, curiosity, and knowledge as they pertain to the selection and use of multiple sources, as well as to the outcomes from multiple source use tasks.

Multiple Source Use

In order to address the first major question of this literature review, how do students use multiple sources and what is the role of source type in students' source use, an examination of the multiple source literature was undertaken. This includes an overview of theoretical models of multiple source use and empirical findings of the relations between source characteristics and multiple source use processes and products. Given the influence of task specifications in multiple source use, the role of tasks and the outcomes of multiple source use is discussed. Finally, the relation between knowledge and multiple source use is described, and a rationale provided for its relations to multiple source use variables in the present study.

Theoretical Accounts of Multiple Source Use

Although academics and students have historically relied on the use of multiple sources to answer questions and engage in academic tasks, research on the use of multiple sources has only recently entered into the educational psychology literature. A combination of seminal studies by Wineburg, Rouet and others (Rouet, Britt, Mason, &

Perfetti, 1996; Wineburg, 1991), aligned with the advent of new techonologies such as the Internet that allow easy access to and responsibility for the selection of online resources, set the groundwork and became an impetus for this growing area of research.

The theoretical underpinnings of multiple source use research developed out of theoretical models of reading (Kintsch, 1998, 2005; Rouet, 2006) and information search (Guthrie & Kirsch, 1987; Dreher & Guthrie, 1990). One model of multiple source use that guides the theoretical framing for the current study is the Multiple Documents Model (MDM) put forward by Rouet, Britt, Perfetti, and others (Britt et al., 1999; Perfetti et al., 1999). The MDM was later expanded as the Multiple Documents Task-based Relevance Assessment and Content Extraction (MD-TRACE) Model to account for the search for multiple sources in relation to features of the task (Rouet, 2006). The MDM draws on theoretical models of reading research, namely Kintsch & van Dijk's Construction Integration model (Kintsch, 1988, 1998; Kintsch & van Dijk, 1978). The Construction Integration (C-I) model is based on the tenant that reading is an activity that involves a reader, text, and the interactions between reader and text. From this overarching principle, the C-I model posits that there is both a text-base and situation model formed during the reading of a text (Kintsch, 1998, 2005). The text-base includes the information exclusively presented in the text, and refers to the textual propositions. The situation model is the interaction of the text-base and a reader's prior knowledge to form an integrated understanding of the content presented in the text (Kintsch, 1998). The situation model includes inferences made within and beyond the text as well as elaborations (Kintsch, 1998). While a reader's understanding of the text-base involves memory for the propositions included within the text (Kintsch & van Dijk, 1978), the

development of the situation model is associated with deeper understanding and text comprehension (Kintsch, 1988).

The Multiple Documents Model builds on the C-I model by accounting for the development of a situation model across multiple texts in addition to the development of text-specific situation models (Perfetti et al., 1999; Rouet, 2006). This accounts for common content presented across several texts in addition to material presented in a single text or that contradicts across texts (Bråten et al., 2013; Salmerón et al., 2010). Building this type of mental model supports students' integration across texts as well as their corroboration of evidence (Britt et al., 1999), two common multiple source use tasks. By using multiple sources, students may be asked to weigh evidence, determine the credibility of sources, or identify contradictory information (Anmarkrud et al., 2014; Strømsø Bråten, Britt, & Ferguson, 2013). While these tasks are not uncommon when using a single source, particularly within the refutational text literature (e.g., Broughton, Sinatra, & Reynolds, 2010), their importance and difficulty increases when using multiple sources (Rouet, 2006). The creation of a situation model that includes common and distinct source material requires attention to and memory for source information (Bråten et al., 2009).

The MD-TRACE model expanded upon the MDM and C-I model to incorporate theoretical and empirical research on search behaviors as a means of explaining the task of selecting multiple sources (Rouet, 2006). The MD-TRACE model is a process-based model that depicts individuals as progressing through a series of stages and decision rules in their selection and use of sources. In addition to developing a documents model of texts, which was important for the MDM, the MD-TRACE model includes an added step

of evaluation. This is of particular importance for tasks in which the sources are not provided or for which use of all available sources may not be prudent, because individuals need to evaluate their task model to determine whether selecting and using additional sources is necessary to complete the task.

While accounting for the relation between the individual and the text(s), the MD-TRACE model also emphasizes task characteristics and specifications (Rouet, 2006). With regard to task specifications, the model acknowledges both the given task conditions as well as individuals' interpretations and representations of the task (Rouet, 2006). Included in this are the individuals' motivations and goals. Although motivations and goals have been examined fairly extensively in theoretical and empirical research on single texts (Fox, 2009), some have argued that the focus on the goals of individuals should be increased with tasks requiring multiple texts (Bråten et al., 2011). This argument is based on the challenge of using multiple sources and the idea that without a specific goal, this activity would be too daunting. The MD-TRACE model refers to the determination of goals and purposes for multiple source use as the formation of the task model (Rouet, 2006). The task model results from a combination of external specifications such as the given question and the documents provided, and the internal characteristics of the individual completing the task, such as knowledge and motivations (Rouet, 2006). Within the process of multiple source selection and use, the task model is not regarded as stagnant, rather the MD-TRACE model acknowledges the reconfiguration of the task model as an important part of the process (Rouet, 2006). Just as individuals update and revise their intra- and inter-text situation models, so too do they adjust their task model. The MDM and the MD-TRACE models were selected for use in

this study because they explain multiple facets of the source use process (e.g., source selection and use), and they highlight individual differences such as knowledge and motivation as influential characteristics.

Source Characteristics and Multiple Source Use

Research in multiple source use has investigated the relations between source characteristics and students' source selection and use (Braasch et al., 2009; Brem, Russell, & Weems, 2001). These examinations have typically focused on characteristics such as usefulness (Rouet et al., 1996) and trustworthiness (Bråten et al., 2009; Wineburg, 1991). Much of the multiple source use literature, particularly research surrounding source characteristics, has focused either on digital sources (Naumann, Wechsung, & Krems, 2009; Stadtler & Bromme, 2007, 2008) or print sources (Braasch et al., 2013; Strømsø & Bråten, 2009; Strømsø et al., 2010; Wineburg, 1991). What has not been well examined in the literature is the selection of digital versus print sources, and how students select among these categories of sources and integrate information between them when responding to academic tasks. The current study directly addressed this gap in the literature. While the literature uses the terms *source features* (e.g., Braasch et al., 2013) and *source characteristics* (e.g., Britt & Aglinskas, 2002) to discuss aspects of sources such as author, reliability, and usefulness, the term characteristic is conceptualized more broadly, allowing for the comparison of print versus digital sources. As such, the term *source characteristics* is used throughout the present review when considering the collection of features and characteristics more broadly. Source medium is used to specify print versus digital sources.

Within the empirical literature, the comparison of students' selection and use of sources in multiple mediums has received limited attention. Moreover, these studies have emphasized source characteristics such as trustworthiness, and differences in categories of sources (e.g., primary vs. secondary; Rouet et al., 1996; Wineburg, 1991) as opposed to digital versus print presentations. Previously, much of the interest in print and digital comparisons has focused on the usability of digital compared to print sources (Rouet, 2006). Given the paucity of research comparing the use of digital and print sources, this review focuses on source characteristics and source types broadly, providing applications to differences in print and digital sources as warranted.

The Multiple Documents Model suggests that in order to form an accurate documents model, characteristics of sources such as publication date, author motivation, and author credentials should be stored in conjunction with the content of a particular source (Britt & Aglinskas, 2002; Rouet, 2006). Citing accounts of contradictory historical documents, Rouet (2006) argued that these types of source characteristics provide necessary information for the selection between conflicting accounts. The MDM additionally suggests that while some source features are explicit (e.g., date of publication) others such as author intent must be inferred by the reader (Rouet, 2006). Attention to source characteristics, explicit and implicit, has been linked to the characteristics of the individual engaging in multiple source use (Strømsø & Bråten, 2009; Wineburg, 1991). Within the MDM, expertise within a domain is one characteristic of individuals that has been related to attention to source characteristics. Specifically, experts are presumably aided in their creation of more accurate document

models by more developed schemas for types of sources (e.g., novels vs. official documents; Rouet, 2006).

Consistent with the MDM and MD-TRACE models of multiple source use (Rouet, 2006), empirical research has indicated that students are sensitive to source characteristics (Bråten et al., 2009; Rouet et al., 1996). The characteristic of trustworthiness of sources has been addressed in both print and online sources (Bråten et al., 2009; Wineburg, 1991), and has implications for understanding students' comprehension of different source types (e.g., primary documents vs. textbooks). For instance, Wineburg (1991) examined students' and experts' evaluations of print text and pictorial sources when they were engaged in historical reasoning and measured their relative judgments of trustworthiness of different types of documents (e.g., textbook, primary accounts). For this task, participants were provided with a set of somewhat contradictory documents related to the Battle of Lexington and were asked to think aloud while reading or viewing the documents with the purpose of understanding the events of the battle. For students and experts, ratings of trustworthiness differed across types of sources. This was demonstrated more directly in a follow-up study by Rouet, Britt, Mason, and Perfetti (1996), who identified differences in students' average trustworthiness ratings of historian essays, participant accounts, textbooks, and primary sources. Moreover, students' reported justifications for the trustworthiness of documents varied according to document type (Rouet et al., 1996).

Recent studies have found differences in students' ratings of trustworthiness by source type in domains other than history (Anmarkrud et al., 2014; Bråten et al., 2009; Stadtler & Bromme, 2008). For instance, when reading a set of texts on global warming,

students rated a textbook and sources from government organizations as significantly more trustworthy than newspaper and magazine sources (Bråten et al., 2009). Although trustworthiness was not a characteristic of focus in the current study, prior studies in trustworthiness imply that students differentially examine broad categories of source types (e.g., magazines, textbooks, primary accounts). Specifically, these studies suggest that both students and experts, when engaging with print or digital sources, are sensitive to source type. The current study extends the examination of source type by ascertaining whether individuals are sensitive to differences in digital as compared to print sources.

Although students vary in their ratings of sources across source types, implying that they differentiate source types based on certain characteristics, the question remains whether they acknowledge features such as source type, author, and publication information in their justifications for such ratings. Findings suggest that the amount of attention that students pay to source characteristics varies across source types (Strømsø et al., 2013). For instance, undergraduates thinking aloud while studying sources in order to provide advice to a friend regarding a science topic spontaneously noted source features such as document type, publication venue, title, author, and source citations (Strømsø et al., 2013). Moreover, the extent to which students focused on particular source features (e.g., publication venue vs. author) differed according to the type of source.

However, other studies have suggested that students are not well attuned to source information when reading and studying multiple documents. Such studies note that students infrequently use source characteristics to evaluate information online (Britt & Aglinskas, 2002; Walravin, Brand-Gruwel, & Boshuizen, 2009). In response to these findings, interventions such as the *Sourcer's Apprentice* have been developed (Britt &

Aglinskas, 2002). This intervention is aimed at increasing students' attention to source features such as author characteristics and intent, publication information such as date, and source type. It has been found to improve students' attention and memory for source features (Britt & Aglinskas, 2002).

Given the prevalence of digital in addition to print sources and resources, the importance of selecting between and among print and digital sources is a common task for students today (Brand-Gruwel et al., 2005; Bråten et al., 2011; Rouet, 2006). While the literature has previously conceptualized source types (e.g., textbook, newspaper) within a single medium (i.e., digital or print), this limits the task of source selection within the empirical literature. Broadening the conceptualization of the types of sources to include both print and digital sources more closely resembles the academic tasks in which students engage. Expanding investigations to examine the types of text and non-text sources available digital and in print form enhances understandings of how students select sources and resources for their use.

Further, within the categories of digital and print sources, sources can include text as well as images. The inclusion of text and pictorial sources stems from early studies on multiple source use (Wiley & Voss, 1999; Wineburg, 1991), yet these studies did not explicitly address questions of comparative use of pictorial and text sources. For example, participants in Wineburg's (1991) study of historical problem solving were provided with primary and secondary sources and were also asked to evaluate pictorial depictions of the battle in terms of accuracy. Although both pictorial and text sources were provided, the study was designed such that the information presented in the text sources was used to evaluate the pictorial images, rather than the images serving as

informational sources. Reasoning with the pictorial images was used as an outcome measure and was analyzed separately from the text processing. Other studies have integrated pictorial sources into the repository of multiple sources available to participants (Wiley & Voss, 1999). For instance, in addition to text sources, Wiley and Voss (1999) included maps as sources available within a source library. However, no comparisons were made between the types of sources available (i.e., pictorial vs. text).

Tasks and Outcomes of Multiple Source Use

Empirical findings have highlighted the importance of considering the task in relation to multiple source use processes and performance outcomes (Cerdán & Vidal-Abarca, 2008; Le Bigot & Rouet, 2007; List et al., 2013). While the MD-TRACE model depicts the importance of considering an individual's interpretation of the task (Rouet, 2006), empirical studies have focused on comparing differences in task directions. Task directions have been found to relate to the number of sources that individuals use when answering different types of questions (List et al., 2012), the time spent on reading relevant information (Cerdán & Vidal-Abarca, 2008), and the frequency of switching between sources (Cerdán & Vidal-Abarca, 2008).

Variations in task have also been associated with differences in outcomes measures (Cerdán, Vidal-Abarca, Martínez, Gilabert, & Gil, 2009; Le Bigot & Rouet, 2007). For instance, an influential study by Wiley and Voss (1999) demonstrated that subtle task differences while using multiple sources could influence students' performance on various outcome measures. When directing students to use a set of sources to develop a narrative, summary, explanation, or argument, they found that students instructed to produce an argument were more likely than students in other

conditions to combine information from multiple texts and incorporate outside information, and they were less likely to simply restate or paraphrase individual sources. There were also differences in the number of connective words and phrases. Taken together, these results suggest that even minor task differences can result in changes in students' construction of meaning within and across texts.

Recently, researchers seeking to understand the relations among tasks and the performance outcomes of multiple source use have noted the necessity for considering the type of outcome. For certain types of performance outcomes, the relation between task and multiple source use seems to play a more important role. Specifically, tasks requiring verbatim recall and recognition demonstrate less of a difference in response to task instructions than more complex tasks requiring the integration of sources and the application of source information to novel problems (Cerdán & Vidal-Abarca, 2008; Cerdán et al., 2009; Le Bigot & Rouet, 2007; Wiley & Voss, 1999). For instance, in a comparison of performance on recall and writing of essays, Cerdán and Vidal-Abarca (2008) found differences among students instructed to write essays requiring the integration of information across three texts (intertext condition) as compared to students instructed to write essays based on questions that could be answered using the texts independently (intratext condition). However, the differences only manifested on a measure of deeper learning. Specifically, the intertext condition participants outperformed the intratext condition participants on a task requiring them to apply the knowledge from the texts to a new yet related situation. These differences were not manifest on a sentence verification task that measured students' text recall.

Similar findings have been identified in other studies, where differences were observed in the essays produced, but where comprehension as measured by multiple-choice tests did not reflect differences in multiple source use task instructions (i.e., write a summary vs. write an argument). Frequently, performance has been measured according to the source of information that individuals include in essay responses (van Strien, Brand-Gruwel, & Boshuizen, 2014; Wiley & Voss, 1996). In these studies, participants' responses were coded according to whether the information was taken directly or paraphrased (i.e., borrowed), combined across sources or made into inferences and conclusions (i.e., transformed), or included from outside knowledge (i.e., added). Borrowing and adding information were regarded as a surface-level performance indicators, and transforming information was regarded as a deep-level indicator indicative of corroboration across texts and inter- and intra-text comprehension (Naumann et al., 2009; Wiley & Voss, 1999). Task condition (i.e., write a summary vs. write an argument) and student attitudes have been found to significantly impact the number of borrows, additions, and transformations that students included in their essays (Le Bigot & Rouet, 2007; von Strien et al., 2014; Wiley & Voss, 1999). Additional outcomes such as teacher grading (Britt & Aglinskas, 2002), essay length (Le Bigot & Rouet, 2007; Wiley & Voss, 1999), and the number of references to sources (Britt & Aglinskas, 2002; Le Bigot & Rouet, 2007; Naumann et al., 2009) have also been included as measures of task performance.

Given the importance of task instructions and the need for outcome measures that require a level of processing that can be captured by differences in multiple source use, the purposeful selection of a multiple source use task was critical for the current study.

Although the comparison of tasks in relation to interest, curiosity, and multiple source use provides an avenue for future research, it was not a central question of this study, and therefore holding the task constant across individuals was necessary for addressing the relations of interest. At the same time, it was important that the task reflect characteristics identified with interest and curiosity (e.g., novelty, relevance) such that participants had the potential to experience interest and curiosity while completing the task. The explanation of the task choice is described in greater detail in Chapter 3.

In addition to source characteristics, the MDM and MD-TRACE models also implicate individual characteristics such as motivation and knowledge as critical factors in the multiple source use process. However, before returning to these connections, it is necessary to summarize the individual variables of focus, namely interest and curiosity.

Curiosity

Investigations into curiosity hearken back to John Dewey's (1910) description of curiosity-inspiring instruction. In the mid 20th century, empirical investigations of curiosity began to emerge, with studies focusing on the identification and measurement of the construct (Day, 1971; Naylor, 1981; Spielberger, 1979) and its links with academic achievement (Day, 1968; Maw & Maw, 1972). Concurrent with recent changes in technology, research on curiosity as it relates to learning has increased in recent years (Kang et al., 2009; Kashdan & Yuen, 2007; Wavo, 2004). Today's technology enables students to investigate the objects of their curiosity with greater ease than previous generations. For some scholars, this has manifested in an increased emphasis on the importance of curiosity for learning (Arnone et al., 2011; Kang et al., 2009). At the same time, much of the research on curiosity has been theoretical and has been concentrated

within the literature on psychological well-being and positive psychology (e.g., Gallagher & Lopez, 2007; Kashdan & Steger, 2007). Although this approach differs from the focus on educational contexts, overarching findings and concerns remain applicable despite divergent theoretical traditions.

Conceptualizations

A systematic review of the literature identified four common themes of curiosity definitions within educational and psychometric research in the past decade (Grossnickle, 2014). These give light to an understanding of how curiosity is commonly characterized. The first theme addresses curiosity as a need for knowledge or information. Within education, curiosity as a need for knowledge has been conceptualized as a defining feature of curiosity in early empirical research (Berlyne, 1960) and later investigations (Arnone et al., 2011; Litman, 2008; Loewenstein, 1994). The gap in knowledge or information is regarded as known by the individual, who has a conscious awareness of what is not known (Litman, 2010) and may even seek out opportunities to explore knowledge gaps (Kashdan et al., 2009).

The second theme is curiosity as a motivator for and enactment of exploratory behaviors. Exploration has frequently been included within conceptualizations of curiosity to describe the enactment of behaviors to reduce knowledge gaps (Koo & Choi, 2010; Litman, Hutchins, & Russon, 2005; Litman & Speilberger, 2003). In this manner, curiosity is depicted as a motivator for action (Kashdan, 2004). Although exploration has sometimes focused on non-academic sensation-seeking and novelty-seeking (Pearson, 1970; Zuckerman, 1979), exploration has also been examined through question asking

(Peters, 1978) or the examination of online sources and resources (Arnone et al., 2011; Lowry & Johnson, 1981).

Another characterization of curiosity evident in the literature is its relation with collative variables (e.g., novelty, complexity, uncertainty). This association stems back to initial conceptualizations of the construct (Berlyne, 1960, 1978) that have centered around curiosity as arising from conditions of novelty, complexity, ambiguity, challenge, and uncertainty (Čavojová & Sollár, 2007; Kashdan et al., 2004; Kashdan & Yuen, 2007). These variables indicate the importance of disequilibria for curiosity. Specifically, curiosity is regarded as occurring more frequently under conditions where collative variables have drawn the attention of an individual to features such as novelty, uncertainty and surprise (Subbotsky, 2010). On the other hand, those who regard curiosity as a more stable trait that individuals bring with them to the environment describe a propensity for curious individuals to seek conditions of novelty, uncertainty, and surprise across situations (Kashdan et al., 2004; Kashdan & Yuen, 2010).

Finally, curiosity has been characterized by distinct patterns of emotions and arousal. For the most part, the emotions associated with curiosity tend to be positive (Gallagher & Lopez, 2007; Swan & Carmelli, 1996). However, certain conceptualizations consider potentially negative emotions associated with feelings of ignorance surrounding a need to know (Litman & Jimerson, 2004). Nonetheless, curiosity is typically depicted as an enjoyable experience, including enjoyment from learning new knowledge or information or from resolving unwanted gaps in knowledge (Litman, 2010). Along the line of positive emotions, and associated with the identification of collative variables is arousal as a component of curiosity. Within

definitions of curiosity, arousal was included through the acknowledgment of curiosity as a state of heightened awareness or attention (Litman and Jimerson, 2004). Heightened awareness and attention associated with curiosity is regarded as initiated by the presence or identification of collative variables. This conceptualization stems back to James's (1890/1950) argument for the co-occurrence of curiosity and fear in the presence of environmental features such as novelty.

Types of Curiosity

Within research investigations, curiosity is typically regarded as a multifaceted construct (Ainley, 1987; Litman & Silvia, 2006; Loewenstein, 1994; Reio et al., 2006). Perhaps the most common distinction is that of curiosity as a trait versus curiosity as a state (Arnone et al., 2011; Boyle, 1989; Reio & Callahan, 2004). This division has a clear alignment with interest in its situational and individual forms (Alexander, 2003; Schiefele, 2009), although there are differences that are considered in the discussion of differentiating interest and curiosity. In its trait form, curiosity is viewed as an enduring characteristic of individuals, which they bring with them from situation to situation (Beswick & Tallmadge, 1971; Day, 1971; Litman & Silvia, 2006). Consistent with research in personality traits, trait curiosity is believed to be a characteristic that is relatively stable within an individual (Gold & Henderson, 1990; Mascherek & Zimprich, 2012; von Stumm & Deary, 2011).

Comparatively, state curiosity is the momentary experience of curiosity expressed by the individual in response to features of the environment (Loewenstein, 1994). Much of the early research in curiosity focused on environmental factors that support the experience of state curiosity, referred to by Berlyne (1960, 1978) as collative variables.

These variables, such as novelty, complexity, surprisingness, and uncertainty, have been found to trigger curiosity for both academic (Knobloch et al., 2004; Lowry & Johnson, 1981) and non-academic tasks (Gilmore & Cuskelly, 2011; Harter & Zigler, 1974). It is important to note that trait curiosity and state curiosity have been found to be highly correlated (Boyle, 1989; Kashdan & Roberts, 2004; Reio & Callahan, 2004). Individuals who have higher levels of trait curiosity are believed to be more sensitive and receptive to situational factors triggering state curiosity, and are more likely to frequently experience the state of curiosity (Kashdan et al., 2004; Naylor, 1981). In the current study, trait curiosity was included as an a priori measure of curiosity. Post-hoc expressions of situational interest and state curiosity were captured through a retrospective interview following a multiple source use task, and the relation between trait curiosity and these post-hoc expressions were examined.

Curiosity has also been examined in terms of whether it is focused toward physical objects or the experience of sensations (i.e., perceptual curiosity), the lives of others (i.e., interpersonal curiosity), or knowledge (i.e., epistemic curiosity). This differentiation stems from Dewey's (1910) explanation of the development of curiosity from the physical to the intellectual, and James's (1890/1950) differentiation of physical and intellectual curiosity. For Dewey (1910), curiosity in children developed from curiosity about the physical world (oneself and surroundings) to social curiosity (use of language to ask questions) and ultimately to intellectual curiosity (generating problems and seeking resolution to questions of interest). Intellectual curiosity as conceived by Dewey closely aligns with conceptualizations of epistemic and academic curiosity (Litman, 2010; Vidler & Rawan, 1974).

The types of curiosity are not mutually exclusive. Rather, they are frequently conceptualized as hierarchical and nested. Of particular relevance for the present study is the relation between trait curiosity and epistemic curiosity. Specifically, epistemic curiosity is often regarded as a type of trait curiosity, with I-type and D-type further delineations of epistemic trait curiosity (Litman, 2008; Litman & Jimerson, 2004). Dividing curiosity into state and trait forms can coexist with dividing curiosity as physical, perceptual, social, and epistemic. For example, the general object of curiosity (e.g., perceptual, epistemic) has the potential to result from the interaction of person and object (i.e., state curiosity) or from a more enduring disposition or trait (i.e., trait curiosity; Naylor, 1981; Reio et al., 2006; Spielberger, 1979).

Recent decades have brought a resurgence of interest in epistemic curiosity, with the publication of several epistemic curiosity scales. Findings have suggested that epistemic curiosity is related to performance on cognitive and academic tasks (Kang et al., 2009; Lin, Wong, & McBride-Chang, 2012; Mascherek & Zimprich, 2012; Smalls et al., 2007; Wavo, 2004), as well as with attributes regarded as conducive for learning (Gilmore & Cuskelly, 2011; Neblett et al., 2006; Peters, 1978; Smalls et al., 2007). For instance, Kang and colleagues (2009) found that individuals were more likely to remember facts after a delay and were more likely to spend limited resources when learning facts about which they were more curious.

Epistemic curiosity has additionally been subdivided to reflect whether the orientation is toward gaining new knowledge or toward resolving oneself of the unknown. These types are referred to as interest-type curiosity (I-type) and deprivation-type (D-type) curiosity, respectively (Litman, 2010; Litman, Crowson, & Kolinski, 2010;

Litman & Jimerson, 2004). Interest-type curiosity is associated with positive feelings surrounding learning new information and the desire to approach disequilibrium with the anticipation of gaining knowledge (Litman, 2008, 2010). For I-type curiosity, the reward is the gain of knowledge or information. In contrast, D-type curiosity is associated with the desire to reduce uncertainty and feelings of ignorance (Litman & Jimerson, 2004). The reward for D-type curiosity comes with the reduction of tension created by feelings of not knowing and an undesirable lack of information. This is associated with negative feelings of uncertainty and concurrent feelings of relief after the knowledge gap has been resolved. Given the differential associations with lacking information, I-type curiosity has been associated positively with tolerance for ambiguity (i.e., acceptance of uncertainty), whereas D-type curiosity has been negatively associated with tolerance for ambiguity (Litman, 2010). This suggests that individuals differing in these types of curiosity may have varied relations to collative variables as proposed by Berlyne (1960).

When examining I-type and D-type curiosity in relation to the experience of curiosity as a state, Litman, Hutchins, and Russon (2005) found that when participants reported not knowing answers, I-type curiosity significantly positively predicted participants' curiosity for learning answers to trivia questions (i.e., state curiosity). However, when participants reported that the answer was on the tip of their tongue, D-type curiosity significantly positively predicted state curiosity. There is evidence that I-type and D-type curiosity are correlated, yet manifest distinctly in the experience of curiosity and stem from different motivations (Litman, 2010; Litman et al., 2005; Litman & Silvia, 2006).

In the current study, I-type and D-type curiosity were measured and examined as they related to individuals' use of multiple sources, task outcomes, and expressed interest and curiosity. As such, the term *trait curiosity* will be used predominantly throughout the document to refer to I-type and D-type curiosity in order to emphasize the comparison between trait and state curiosity in the present study. However, *epistemic curiosity* will be used when there is a need to emphasize the type of curiosity is epistemic as compared to social, perceptual, or sensation seeking.

Educational Implications

Although much of the recent research has focused on the measurement of curiosity (e.g., Kashdan et al., 2009; Litman & Jimerson, 2004; Reio et al., 2006), empirical research has examined relations between curiosity and performance in a variety of tasks relevant for education and learning (e.g., Krietler, Zigler, & Kreitler, 1984; Maw & Maw, 1972; Wavo, 2004). For one, curiosity has been examined in relation to overall academic performance, including grades and standardized tests (Day, 1968; Kashdan & Yuen, 2007; Wavo, 2004). Even though curiosity has been positively related to standardized achievement tests (Wavo, 2004) and performance on individual learning tasks (Arnone et al., 1994; Mittman & Terrell, 1964), it has not been shown to be a predictor of grades (Day, 1968). This may be due to an interaction between the individual and the environment. For example, Kashdan and Yuen (2007) found that more curious high-school students in Hong Kong received higher grades than less curious students only when studying in schools that they reported to be challenging. This provides evidence of the importance of perceived collative variables as supporting trait curiosity in educational settings.

To explicate the relation among curiosity and academic outcomes such as grades and standardized achievement tests, researchers have examined curiosity as a potential influence on learning and learning strategies (Knobloch et al., 2004; Reio & Wiswell, 2000). For example, in a study of workplace learning, curiosity positively predicted socialization-related learning, which in turn predicted performance (Reio & Wiswell, 2000). Curiosity has also been identified as a potential influence on the number of verbalizations that undergraduates make in their classrooms (Peters, 1978) and the learning strategies of first graders (Kreitler et al., 1984). Moreover, studies have shown curiosity to be positively associated with convergent thinking, (Vidler & Rawan, 1974), divergent thinking (Vidler & Karan, 1975), and the recognition of verbal absurdities (Maw & Maw, 1972).

Curiosity has a history of being used synonymously with other terms, including interest, wonder, need for cognition, and sensation seeking (Bowler, 2010; Byman, 2005; Grossnickle, 2014; Mussell, 2010; Schmitt & Lahroodi, 2008; Silvia, 2006). For those desiring to understand motivations in educational contexts, the entanglement of interest and curiosity has presented itself as particularly problematic (Grossnickle, 2014). Although their distinctiveness remains open to debate, the relations between interest and curiosity are considered. Before this can be addressed, the literature on interest is selectively summarized, with an emphasis on the text processing. Then, to provide some clarity, as well as to acknowledge overlaps and relations among interest and curiosity, potential relations among interest and curiosity are considered.

Interest

Within the educational psychology literature, interest has been described as an emotion (Silvia 2005, 2006; Silvia et al., 2009), a relation between person and object (Hidi, 2006; Krapp, 2005, 2007), and as a motivational variable integral to learning and development (Alexander, 1997; Hidi & Renninger, 2006; Krapp, 2002). Research has suggested that interest includes both cognitive and emotional components (Ainley, 2006; Ainley, Hidi et al., 2002; Hidi, 2006; Krapp, 2005; Silvia, 2006), with theories of interest differing in their focus on these attributes. Moreover, the degree to which cognitive versus emotional attributes come into play has been argued to vary according to the stage of interest development (Hidi, 2006).

Conceptualization

Interest is defined in terms of features such as knowledge of, positive feelings toward, and value for the object of interest (Hulleman, Durik, Schweigert, & Harackiewicz, 2008; Schiefele, 2009). As an emotion, interest is described as having a positive valence (Silvia, 2006). It is characterized by liking and the desire to engage with particular content (Krapp, 2002; Krapp & Prenzel, 2011) and includes absorption in the task at hand and feelings of being engrossed (Hidi, 1990, 2006). Research indicates that a balance between perceived competence and perceived complexity of the objects at hand is necessary to support interest (Silvia, 2005; Silvia et al., 2009; Silvia & Kashdan, 2009). The positive valence arises when something is perceived as moderately complex, yet comprehensible. However, in considering interest as a positive emotion (Izard, 1977; Silvia, 2006), it is important to examine its relation to the associated emotion of enjoyment, and to note that interest and enjoyment are not synonymous (Reeve, 1989).

While enjoyment relates to the perception of successful performance, interest is associated more closely with challenge and other collative variables such as complexity (Reeve, 1989; Silvia, 2005).

Theories of interest with more cognitive leanings emphasize attention as a defining feature of interest (Hidi, 2006). The experience of interest is typically described as one of sustained attention, with individuals more willing and able to direct attention to the objects of their interest (Ainley, Hidi et al., 2002; Ainley, Hillman, & Hidi, 2002). However, the way in which theoretical relations among interest and attention are manifest in observed relations among the constructs is less clear. While theories of interest indicate that attention and subsequently time-on-task should increase as a result of increased interest, empirical research has found mixed results (Graham, Tisher, Ainley, & Kennedy, 2008; Hidi, 1990, 1995). For instance, consistent with theories of interest as a means of increasing sustained attention and time-on-task, a study by Ainley, Hillman, and Hidi (2002) found that students selected to spend more time reading passages whose titles they reported to be interesting. In contrast, McDaniel, Waddill, Finstad, and Bourg (2000) examined the allocation of attention while reading passages for comprehension, and found that for interesting stories, individuals spent less time reading and had decreased secondary task reaction time indicative of decreased attention to the reading task. At the same time, participants recalled more of the passages that they reported as interesting. Studies that have reported decreased time-on-task concurrent with increased interest have hypothesized that the relation between interest and attention is such that interest focuses the direction of attention on the task, thereby requiring less time (Hidi, 1995; McDaniel et al., 2000). Based on this reasoning, reading time does not necessarily

represent an accurate measure of attention as related to interest, since interest may be important in increasing the quality of attention, which may in turn decrease the quantity.

Persistence has received more consistent support in relation to interest (Ainley, Corrigan, & Richardson, 2005; Ainley, Hidi et al., 2002). Specifically, operationalized as the reading of additional text passages when given the options to stop or continue reading, Ainley and colleagues found that individuals who reported greater interest during a task were more likely to choose to read additional text passages (Ainley et al., 2005; Ainley, Hidi et al., 2002; Ainley, Hillman et al., 2002; Graham et al., 2008). Unlike studies of attention and reading where students are given a set of texts that they are required to read (e.g., McDaniel et al., 2010), in the current study, participants selected the sources and determined the amount of time they spent on the task as a whole. This is similar to the methodology of Ainley and colleagues (e.g., Ainley, Hillman et al., 2002; Graham et al., 2008). Therefore, persistence, as determined by the number of sources selected and total time spent on the task, was analyzed in relation to students a priori and post-hoc expressions of interest and curiosity.

An additional feature of cognitive-based theories of interest is the relation between interest and knowledge. For some theories knowledge is a defining feature of interest, whereas for others it is a variable that relates to, but does not define, interest. Renninger and others (Hidi & Renninger, 2006; Renninger, 2000) have included knowledge as a critical, defining component of interest. In such cases, enduring interest is posited to require a certain level of knowledge, and to be unable to exist without requisite knowledge (Hidi & Renninger, 2006). The role of knowledge is regarded as critical in maintaining interest over time, and in developing stored value, an associated

feature of interest (Hidi, 1990; Hidi & Renninger, 2006). In this manner, value is believed to stem from an understanding of the object of interest that is sustained over time, an understanding that is only possible with the development of knowledge.

However, other theories of interest have indicated reciprocal or concurrent relations between knowledge and interest. In the Model of Domain Learning (MDL), Alexander (1997, 2003) indicated that the relation among interest and knowledge changes over the course of individuals' academic development, and varies according to whether interest is momentary (i.e., situational interest) or enduring (i.e., individual interest). The MDL accounts for the increase in knowledge and individual interest consistent with the development of expertise in a domain (Alexander et al., 1995; Alexander & Murphy, 1998). As individuals gain knowledge and experience, it is posited that their individual interest increases. Reciprocally, as individuals develop increased individual interest in a domain, they are more motivated to develop their knowledge (Alexander, 2003). As such, individual interest and domain knowledge have been found to concurrently increase from the earliest stage of acclimation to the later stages of competence and proficiency (Alexander et al., 1995). A different relation is posited to exist for situational interest and knowledge, such that as knowledge increases with competence and proficiency, the reliance on situational interest decreases (Alexander, 1997, 2003). Individuals in acclimation, even from its earliest stages may frequently experience momentary interest triggered by the environment (Alexander, 1997, 2003). Over time, with experience in a domain, this triggered interest is believed to have the potential to develop into more sustained and recurring individual interest, a development modeled by Alexander (2003)

in her Model of Domain Learning as well as Hidi and Renninger (2006) in their four-phase model of interest development.

Types of Interest

Given these defining features of interest, it is necessary to characterize two types of interest frequently depicted within the educational literature and mentioned briefly within the discussion of the MDL: individual interest and situational interest. Situational interest and individual interest are regarded as having distinct cognitive and affective components (Ainley, 2006; Hidi, 2006; Krapp, 2007). Situational interest, the momentary experience of interest triggered by environmental features and characteristics, is defined by feelings of enjoyment accompanied by momentary arousal or attention (Hidi, 1990; Schraw & Lehman, 2001). For situational interest, the environmental triggers are often described as universal, including variables such as novelty, complexity, and surprisingness, termed collative variables (Berlyne, 1960). Additional variables of situational interest have been identified, including coherence, comprehensibility, and vividness (Schiefele, 2009; Schraw & Lehman, 2001; Silvia, 2005; Silvia et al., 2009). As situational interest has a history of research in the context of reading (e.g., Asher, Hymel, & Wigfield, 1978; Shirey & Reynolds, 1988; Wade et al., 1993), many of the additional factors identified as triggering situational interest relate to text processing.

In contrast to situational interest, individual interest is an enduring disposition toward and propensity to reengage with particular content (Krapp, 2002; Silvia, 2006; Renninger, 2000). The experience of individual interest manifests many of the same characteristics as situational interest, including heightened attention (Ainley, Hidi et al., 2002; Lehman, Schraw, McCrudden, & Hartley, 2007) and enjoyment (Hidi, 2006;

Schiefele, 2009; Silvia, 2006). Accordingly, it drives decisions to participate in certain activities or tasks in a predictable way; for instance, guiding decisions about college major or choices to engage in behaviors and activities related to the subject of individual interest (Lapan, Shaughnessy, & Boggs, 1996).

Within academic contexts, the study of individual interest typically depicts individual interest at the domain level. However, in studies focusing on learning from text, the relatively stable interest in certain topics within a domain, topic interest, has been frequently examined (e.g., Alexander, Kulikowich, & Schulze, 1994; Schiefele, 1996). Topic interest is considered a type of individual interest that more narrowly specifies the content of the individual interest (Schiefele, 1996). Previous research has indicated that topic interest tends to be related to deeper-level learning, but less with surface-level learning (Schiefele, 1992, 1996). The current study examined relations between topic interest and both surface and deep indicators of task performance in order to address the relation between interest and learning in a multiple source use task.

Measures of topic interest have typically taken two forms. The first aligns with many measures of individual interest, including several dimensions regarded as central for individual interest, such as value and feeling (Boscolo & Mason, 2003; Schiefele, 1996). However, rather than asking individuals to rate agreement for the domain in general, a specific topic from the domain is selected. The second typical measure of topic interest includes a set of sub-topics within a domain, with individuals asked to report their level of interest in each of the sub-topics (Alexander & Murphy, 1998; Murphy & Alexander, 2002). This method for the measurement of topic interest was selected for the current study because it aligns with the definition of topic interest put

forth in this review. Namely, it provided an overall evaluation of participants' interest for a range of topics within a domain.

In cases of situational and individual interest, a defining feature of the interest experience is that it is directed toward specific objects or content (Hidi, 2006; Krapp, 2007). Characterizing individuals as interested necessitates a description of the object of their interest. The objects of interest are regarded as being largely specific to the individual, both in terms of enduring individual interests and in terms of momentary situational interest (Krapp, 2002). Even though situational interest is depicted in large part as resulting from environmental triggers, certain individual characteristics such as knowledge have been found to relate to the experience of situational interest (Alexander et al., 1994; Logtenberg, van Boxtel, & van Hout-Wolters, 2011; Rotgans & Schmidt, 2011). For instance, Alexander, Kulikowich, and Schulze (1994) found that topic knowledge related to reported interest for content presented in scientific texts. In light of theoretical and empirical evidence to support the person-specific nature of situational interest, research has frequently predetermined the objects of interest, such as identifying certain texts as more or less interesting (e.g., McDaniel et al., 2000; Wade et al., 1993). While such studies capitalize on the environmental triggers identified as related to situational interest, they do not allow for individual differences in the particular objects that individuals may find interesting, and report only differences in outcomes related to interest, rather than describing the interest itself.

Educational Implications

Interest is depicted as both a means and an end for education. On the one hand, it is frequently examined as a motivator for learning and academic performance (Ainley,

Hidi et al., 2002; Alao & Guthrie, 1999; McDaniel et al., 2000; Shirey & Reynolds, 1988; Rotgans & Schmidt, 2011). Interest has been found to relate to student performance for short-term academic tasks such as the comprehension of texts (Alexander et al., 1994; Murphy & Alexander, 2002; Schiefele & Krapp, 1996), understanding of course material (Rotgans & Schmidt, 2011), and strategy use (Alao & Guthrie, 1999; Alexander & Murphy, 1998). On the other hand, interest has often been described as an inherent goal of education over the past century (Dewey, 1910; James 1890/1950). From the early writings of Dewey (1910) and James (1890/1950), the goal of developing students as interested learners has prevailed as an undercurrent of education, albeit a goal not as readily apparent in today's educational systems as goals of knowledge acquisition or higher order thinking (e.g., CCSS, 2012). However, the development of interest across academic settings and the lifespan has received increasing attention in the past decades (Alexander, 2003; Hidi & Renninger, 2006; Krapp, 2002).

Potential Relations between Curiosity and Interest

Interest and curiosity are often regarded as co-occurring or as related in a directional or reciprocal manner. For instance, in some theoretical discussions, curiosity is identified as a potential cause of interest (Dewey, 1910; Schmitt & Lahroodi, 2008; Silvia, 2008). For Schmitt and Lahroodi (2008), this directional relation is linked closely to changes in one's knowledge. They suggest that curiosity increases an individual's knowledge, which can support the development of individual interests. Additionally, reciprocal connections between interest and curiosity have been proposed, with varied explanations of the bi-directional nature (Arnone et al., 2011; Engel & Randall, 2009; Hidi, 2006; Renninger, 2000). For one, interest has been regarded as supporting the

increase of knowledge that facilitates curiosity questions, which then supports the continuing development of interest (Hidi, 2006; Renninger, 2000). Arnone and colleagues (2011) put forward a similar conception when noting that, “it is curiosity’s power to both trigger and be triggered through the development and deepening of interest” (p. 186). They implicate curiosity as both a motivator for and outcome of interest.

In light of theoretical connections, only a few studies have empirically examined interest and curiosity through the inclusion of measures of each construct (Boscolo et al., 2011; Connelly, 2011; Silvia, 2005, 2008; Silvia et al., 2009). With the exception of the study by Boscolo and colleagues (2011), these studies employed Silvia’s appraisal model of interest as a means of examining the relations among interest and curiosity. For Boscolo and colleagues (2011), the focus was on the relation of topic interest and state curiosity while reading multiple types of texts. Curiosity for specific text passages (rated during reading) was significantly related to interest in the topic of the passage (rated a priori). Boscolo et al. (2011) described this as a unidirectional relation among topic interest and state curiosity.

In contrast, Silvia and others examined the relation between trait curiosity and situational interest (Connelly, 2011; Silvia 2005, 2008; Silvia et al., 2009). Trait curiosity was not related to interest in viewing abstract art or complex polygons (Silvia, 2005). Rather, a more recent study of perceived ability to understand complex pictures and poetry found perceived ability to mediate a positive relation between trait curiosity and reported situational interest in viewing art (Silvia, 2008). The same relation did not

hold for simple pictures or poetry, suggesting that reported interest and trait curiosity may relate only when the stimuli are complex.

A particular challenge for distinguishing interest and curiosity is the similar conditions and characteristics of the variables in their momentary forms, situational interest and state curiosity. For both, collative variables such as novelty and surprisingness are implicated as triggers in the environment (Berlyne, 1960; Čavojová & Sollár, 2007; Kashdan & Yuen, 2007; Schiefele, 2009). However, situational interest has been found to relate to additional environmental factors such as concreteness and vividness (Sadoski, Goetz, & Rodriguez, 2000; Schiefele, 2009). Moreover, both curiosity and interest are characterized by increased attention and persistence (Ainley, Hidi et al., 2002; Bowler, 2010; Hidi, 1995; Wade et al., 1993) as well as positive feelings (Kang et al., 2009; Litman et al., 2010; Silvia, 2006). Measures of these two variables have perpetuated the tendency to use the terms interchangeably. *Interest* frequently appears in measures of curiosity (e.g., Litman & Spielberger, 2003), *curiosity* appears in measures of interest (e.g., Silvia, 2005), and other measures assess interest and curiosity as a unitary construct (e.g., Curiosity/Interest in the World Scale: Peterson & Seligman, 2004).

For the purpose of the current study, interest and curiosity were differentiated in their enduring forms (i.e., topic interest and trait curiosity). This extended limited prior research that examined both of these constructs in the context of a single study, and allowed for topic interest and trait curiosity to be independently examined in relation to situational expressions of interest and curiosity as well as to indicators and outcomes of multiple source use. However, given the challenges noted with separating interest and

curiosity in their situational forms (i.e., situational interest and state curiosity), no attempt was made in the current study to separate post-hoc expressions of interest and curiosity. In the conceptual model, topic interest and trait curiosity were not hypothesized to be related. In theoretical models indicating relations between interest and curiosity, these relations exist between trait curiosity and situational interest (Hidi, 2006; Renninger, 2000) and individual interest and state curiosity (Arnone et al., 2011). Although interest has been postulated to relate to the development of specific individual interests (Arnone et al., 2011), this relation is regarded as taking place over time. As such, interest in one specific topic was not hypothesized to be related to trait curiosity.

Knowledge, Interest, and Curiosity

For epistemic curiosity, defined as the need or desire for knowledge, knowledge is a defining factor. In contrast, for interest, knowledge does not often appear as a definitional factor, and enters as a central characteristic only in certain theoretical perspectives (e.g., Renninger, 2000; Renninger, Ewen, & Lasher, 2002). Rather, interest and knowledge are typically regarded as two distinct constructs that are reciprocally related (Alexander, 2003). For individual interest, knowledge is identified as something that is present and increases concurrently (Alexander, 1997; Silvia, 2005). However, consistent with the MDL, situational interest exhibits a somewhat inverse relation with knowledge, indicating that with increased knowledge, the reliance on situational interest decreases (Alexander, 1997, 2003).

In contrast to the positive relation of interest and knowledge, curiosity, by definition, is marked by the absence of specific knowledge (Loewenstein, 1994). For curiosity, research has centered on the optimum levels of knowledge that stimulate

curiosity (Kang et al., 2009; Litman et al., 2005). Theoretical and empirical research has suggested that a moderate amount of knowledge is conducive to experiencing curiosity (Kang et al., 2009; Loewenstein, 1994; Schmitt & Lahroodi, 2008). If individuals are confident that they know something or are unknowledgeable about something, they are less likely to report feeling curious than if they have a moderate level of knowledge (Kang et al., 2009).

Research on levels of knowledge in relation to curiosity has been examined in the context of curiosity for trivia questions and has measured knowledge as participants' confidence in whether they know the answer to given questions (Kang et al., 2009; Litman et al., 2005). Couched in this context, reported curiosity was highest for questions where moderate levels of knowledge were reported (Kang et al., 2009). Further comparisons of I-type and D-type curiosity suggested that D-type trait curiosity produced the strongest relation to state curiosity for questions associated with moderate levels of knowledge, whereas I-type trait curiosity was linked with curiosity for questions of lower levels of knowledge (Litman et al., 2005). This suggests that when individuals have moderate levels of knowledge, operationalized as having the answer on the tip of one's tongue, there is a stronger sense that there is a gap in knowledge that needs to be resolved to avoid ignorance (Litman et al., 2005). On the other hand, feeling confident that one has limited knowledge and consequently much more to know may be more closely related to feeling curiosity as a growing and expansive opportunity for learning and exploration (Litman et al., 2005). It is important to note that these studies address a relation among knowledge and state curiosity. The relation between trait curiosity and knowledge on a specific topic has not received theoretical justification or empirical

support. As such, trait curiosity and topic knowledge are not hypothesized to be related in the current study.

While much of the research examining the relation between interest and knowledge has measured knowledge through tests, the curiosity literature has focused more on individuals' perceptions of knowledge, measuring the extent to which individuals believe they have knowledge about a given topic or question (Murphy, 1998). In the current study, the measurement of knowledge in relation to curiosity helped to facilitate understandings of whether the relations between curiosity and knowledge resemble the relation between interest and knowledge for measured rather than perceived knowledge. The current study included a measure of topic knowledge that was examined in relation to expressions of interest and curiosity. Topic knowledge was hypothesized to be positively related to topic interest, but not to trait curiosity. Therefore, no relation between topic knowledge and trait curiosity was included in the conceptual model. Further, while not distinguishing post-hoc expressions of situational interest and state curiosity, topic knowledge was regarded as having a positive relation with situational interest. Additionally, given the interactive relations between knowledge and interest identified in the literature (Alexander & Murphy, 1998; Taboada et al., 2009), the effect of an interaction between knowledge and interest on source use and outcomes measures was examined.

In addition to investigating the relations among interest, curiosity, and knowledge, the current study examined I-type and D-type trait curiosity and topic interest in relation to multiple source use processes (e.g., number and type of sources used) and products of that source use (e.g., performance on an outcome measure). This allowed for the

examination of interest and curiosity in their more enduring forms as they relate to the selection and use of multiple sources, and to the expressions of interest and curiosity articulated following the multiple source use process. These relations are depicted in Figure 1.

For the current study it was important to consider how individuals' interest, curiosity, and knowledge might affect their use of sources and outcomes of a multiple source use task. To address the third major research question of this literature review, the research relating multiple source use with interest, curiosity, and knowledge is reviewed. The role of individual characteristics within the multiple source use process is explained through the framework of multiple source use.

Interest, Curiosity, and Knowledge in Relation to Multiple Source Use

For the current study, the relations between reader characteristics and source use are a central question. Specifically, the reader characteristics of interest, curiosity, and knowledge as related to multiple source use are of primary concern and reflect the third major question addressed in this literature review. Knowledge in relation to multiple source use is summarized first. As this literature is extensive, seminal studies are summarized, followed by an overview of more current findings. Then, the theoretical and empirical findings within the multiple source use literature that position interest and curiosity as motivational variables giving rise to differences in source use are exhaustively reviewed. Finally, the interest and curiosity literatures are examined to provide an explanation for the selection of multiple source use as a task in which interest and curiosity are expected to be enacted.

Knowledge and Multiple Source Use

As expertise has been associated with increased domain knowledge and individual interest according to models of academic development such as the Model of Domain Learning (Alexander, 1997, 2003), the relation between knowledge and source selection is of particular concern for the current study. Since the early work on multiple source use comparing novices and experts in a domain, level of experience in a domain has been identified as a factor related to better understanding and integration across sources (Rouet et al., 1997; Wineburg, 1991). The MDM regards the attention of experts to source features as one reader-text interaction that helps to explain this finding (Perfetti et al., 1999). As readers are more attuned to source features they are better able to differentiate sources, providing for the creation of situation models distinct for each source and combined across documents (Strømsø & Bråten, 2009).

Similarly, in line with expert-novice differences in multiple source use (Wineburg, 1991), differences in topic and domain knowledge have been identified as contributing factors to the way in which individuals select and use sources (Gil et al., 2010; Rouet et al., 1997). Attempts have been made to parse the contribution of disciplinary knowledge from knowledge related to multiple source use for individuals nearing expertise in fields that require the frequent use of multiple sources (Rouet et al., 1997). In an examination of the comprehension and evaluation of multiple sources in the context of an historical controversy (i.e., the Panama Canal), Rouet, Farvart, Britt, and Perfetti (1997) compared history and psychology graduate students. While the history students demonstrated more history domain knowledge, topic knowledge of the history of the Panama Canal was similar across groups. Across the two groups, students did not

differ in the time or order spent reading the seven provided documents. However, the groups differentially rated the usefulness of sources and provided different types of justifications for source utility.

For instance, compared to psychology graduate students, history graduate students rated participant accounts as more useful sources. History students also provided more justifications of usefulness based on source features (e.g., author) and relation of the source to the task. Comparatively, the psychology students tended to focus their utility evaluations on the content presented in the source. In their essays based on the sources, group differences were also manifest in the claims provided and number of contextualized statements, but not in the number of source citations or corroborations.

In addition to overarching disciplinary or domain knowledge, the role of topic knowledge has been robustly examined within the multiple source use literature (e.g., Gil et al., 2010; Stadtler & Bromme, 2008; Strømsø et al., 2010). This has resulted in investigations of topic knowledge as a direct contributory factor in multiple source use processes, and frequently as a control variable to account for the relations of task (e.g., task directions; Cerdán & Vidal-Abarca, 2008) and individual (e.g., self-efficacy; Bråten et al., 2013) to multiple source use. For the current study, topic knowledge was examined with regard to its direct contributions to multiple source use.

Interest and Curiosity in Relation to Multiple Source Use

In addition to translating the concepts of text-base and situation model from single to multiple texts, the MDM and the MD-TRACE Model retain the focus of Kintsch's (1998) C-I model on the interaction among reader, task, and text, or in this case, reader, task and multiple texts (Rouet, 2006). Examinations of reader characteristics in multiple

source use have focused almost exclusively on individuals' knowledge (e.g., Wineburg, 1991) and epistemic beliefs (e.g., Bråten & Strømsø, 2010a). However, theoretical models pose motivations as important characteristics for understanding differences in source use (Rouet, 2006). Within this framework, limited empirical research on the relations between motivations and multiple source use has begun to emerge (Bråten et al., 2013; Bråten & Strømsø, 2006; Salmerón et al., 2010; Strømsø & Bråten, 2009; Strømsø et al., 2010). While multiple source use research has examined interest, to the knowledge of the author, no studies have examined curiosity as a reader characteristic related to multiple source use.

In a systematic review of motivation in relation to multimedia, hypermedia, and hypertext learning and processes, Moos and Marroquin (2010) identified interest as the most commonly researched motivation. The studies reviewed found mixed results in relation to interest and learning within these contexts. However, this emerged in part from a focus of some studies on interest in terms of seductive details, which resulted in negative relations between interesting texts and comprehension (e.g., Mayer, Griffith, Jurkowitz, & Rothman, 2008). Additionally, these studies often identified complex relations among interest and knowledge, for instance, noting that interest and comprehension were positively related only for high knowledge individuals (e.g., Salmerón, Kintsch, & Cañas, 2006). It is important to recognize that while research on multimedia, hypermedia, and hypertext has the potential for examination in multiple source contexts, most of the research identified in this review focused on interest in relation to learning from a single source (e.g., Lawless, Brown, Mills, & Mayall, 2003).

Of research investigating multiple source use and interest, only a few studies have examined measures of individual interest in relation to source use or source comprehension (Bråten & Strømsø, 2006; Strømsø & Bråten, 2009; Strømsø et al., 2010) and one examined interest as a justification for source utility (Braasch et al., 2013). In a study of Internet-based learning activities, Bråten and Strømsø (2006) identified individual interest in participants' domain of study as a positive predictor of online communication about subject content, but as unrelated to reported identification and evaluation of online sources. In a later study that examined relations among knowledge, epistemic beliefs, and multiple source use comprehension, Strømsø and Bråten (2009) utilized topic interest as a control. Although not the main focus of the study, topic interest was significantly related to comprehension. Specifically, topic interest positively correlated with comprehension of individual texts as well as across texts when measured through a sentence verification task, a finding replicated in a similar study (Strømsø et al., 2010). Finally, in an intervention study examining students' justifications for source usefulness, Braash and colleagues (2013) identified interest as a reported justification. However, it was not cited as frequently as source features as a justification, perhaps given the focus of the intervention on source features. Although topic interest was included in several other studies (Stadtler & Bromme, 2007, 2008), it was examined as a covariate to address group differences and was excluded from analysis. The current study built on these prior studies to examine interest as well as curiosity as predictors of source use, thereby examining the relations theoretically posited in the MDM and the MD-TRACE models.

Multiple Source Use as a Manifestation of Interest and Curiosity

Multiple source use was selected as the task of interest because it is believed to provide students with opportunities to engage in exploration, an indicator of both interest and curiosity (Spielberger & Starr, 1994; Lowry & Johnson, 1981). For interest, exploration of text has been examined when participants were given the choice to read additional sections of text or to quit reading. In these studies, increased interest predicted continued engagement (Ainley, Hidi et al., 2002; Ainley, Hillman et al., 2002). For curiosity, examining how it manifests within an academic task that allows for exploration and choice is of particular importance given its history of association with exploratory behaviors (Spielberger & Starr, 1994). Although it has not yet been empirically examined in relation to multiple source use, the selection and use of multiple sources provides an academic task that includes choice and exploration.

With regard to exploration, some studies of curiosity have operationalized curiosity in terms of behaviors such as inquiry (Engel & Randall, 2009; Lowry & Johnson, 1981; Subbotsky, 2010), or linked curiosity measured via self-report questionnaires to behaviors such as question asking (Peters, 1978). Additionally, a line of research into neurological and behavioral correlates of curiosity has identified curiosity as positively associated with the desire to uncover hidden answers and the willingness to expend greater resources to do so (Kang et al., 2009; Litman et al., 2005). A study by Lowry and Johnson (1981) represents the study that most directly relates to curiosity and multiple source use as a measure of exploration. In that study, students in two instructional conditions (i.e., controversy and non-controversy) were provided with choices of materials to use (e.g., text and video). Rather than separating curiosity and

exploratory behaviors, the number of selections students made and their willingness to spend free time learning more about the subject was used as the measure of curiosity. The current study built on this by including a priori measures of curiosity. Additionally, it included post-hoc reported interest and curiosity as reasons for source selection in relation to the number and types of sources selected, a measure of enactment similar to exploration studied in prior research (Lowry & Johnson, 1981).

The open-ended nature of the task used in the current study provided students with the opportunity to pursue source materials that captured their interest or curiosity. Alternatively, students had the opportunity to respond to the task and source selection in ways that were not associated with their interest or curiosity. The retrospective interview probing students' source selection was designed to identify the interest- and curiosity-related reasons for students' source selections.

Summary

This literature review identified several overarching conclusions regarding interest, curiosity, students multiple source use, and the relations between interest, curiosity, knowledge, and source use. With regard to interest and curiosity, the thoroughness of the literatures differed in the extent to which they addressed the relation to learning and academic performance. While interest has an extended history of research within education (e.g., Alexander et al., 1994; Schiefele, 1996), curiosity has recently emerged within the empirical literature as a variable important for understanding student learning (e.g., Neblett et al., 2004; Wavo, 2004). Within the research on curiosity, several themes were identified: need for knowledge, motivator for or enactment

of exploratory behaviors, relation to collative variables, and emotions and arousal (Grossnickle, 2014).

The literature on source characteristics identified a focus on certain source features over others. Characteristics such as author, publication, and categories of sources (e.g., newspaper, government report, textbook) have been examined in relation to their effect on students' source use (Braasch et al., 2009; Brem et al., 2001; Stadtler & Bromme, 2007). Moreover, studies of source use within history have focused on the use of primary sources as compared to secondary sources (Rouet et al., 1997; Wineburg, 1991). These types of source characteristics have been found to play an important role in students' source selection and use. Yet, other characteristics remain underexamined. Specifically, whether sources are digital or print/physical, have remained relatively unaddressed, and no studies have explicitly compared students' source use in digital vs. print formats.

Finally, this literature review revealed that while theoretical models of multiple source use such as the MDM and MD-TRACE models (Rouet, 2006) emphasize the importance of a variety of individual difference variables in the understanding of students' source use, empirical examinations have tended to address the role of knowledge to the exclusion of other factors. In these studies, topic and domain knowledge have been found to impact source selection and use (Gil et al., 2010; Rouet et al., 1997). In comparison, multiple source use studies have only addressed the role of interest to a limited extent (e.g., Braasch et al., 2013), and have not examined curiosity. The studies that have examined interest found interest to predict students' performance on multiple source use outcomes (Strømsø and Bråten, 2009) and source evaluations

(Braasch et al., 2013). Moreover, given exploration as a manifestation of interest and curiosity, multiple source use tasks provide an opportunity ripe for examining interest and curiosity. Taken together, theoretical and empirical evidence indicates the need for further exploration of interest and curiosity in relation to multiple source use for students at the undergraduate level. Given these findings, the current study was designed to address some of these gaps in the literature.

CHAPTER 3

METHODOLOGY

The purpose of this study was to examine: (a) differences is students' use of digital versus print sources, (b) relations among students' topic interest, trait curiosity, and topic knowledge, (c) how students' topic interest, trait curiosity, and topic knowledge relate to their source selections and performance on a multiple source use task, and (d) how students' topic interest, trait curiosity, and topic knowledge relate to their expressions of interest and curiosity. To this end, undergraduate students participated in two sessions. In session one, participants completed measures of topic knowledge, topic interest, and trait curiosity. In session two, they completed a multiple source use task in which they were instructed to construct and present a PowerPoint presentation on Alzheimer's Disease suitable for a high-school audience. To address the question of students' selection and use of multiple types of sources, participants were provided with print sources (e.g., books, journals, images) and a predetermined set of digital resources (e.g., PDFs, digital images). While completing the given task, participants' source use was videotaped with a head-mounted camera. Following the multiple source use task, a retrospective guided interview was conducted to understand participants' motivations for source selection and use. During the interview, participants were asked their rationale for selecting each of the sources and their reasons for including what they did in their presentation.

Prior to collecting data for the purposed study, three pilot studies were conducted. The first two pilot studies examined the reliability of the individual difference measures and addressed whether students enrolled in a human development course would include

an adequate amount of variability on the measures. The third pilot study was conducted to determine a suitable multiple source use task and discern the amount of time that participants took to complete the task.

Pilot Study 1

Participants

Participants in the first pilot study were 30 undergraduate students enrolled in an elective course in human development who completed the study for extra credit. The sample included 14 males (46.67%) and 16 females (53.33%). Participants were 19.03 (SD=0.89) years old on average, and all participants were native English speakers. The sample included freshman (n=11), sophomores (n=12), juniors (n=5), and seniors (n=2). Participants were 56.67% white, 16.67% Asian/Pacific Islander, 13.33% Black, 6.67% Hispanic, and 6.67% other.

Measures and Procedure

Participants completed the survey measures for part 1 of the study, including the topic interest, trait curiosity, and topic knowledge measures. These measures were completed online. As the measures are described in greater detail in the measures section for the main study, they are only be summarized briefly in this section. The topic interest measure asked individuals to rate their interest in 10 neurodevelopmental disorders on a 100-point scale from *not at all interested* to *very interested*. The possible scores for this measure ranged from 0 to 1000, with lower scores indicating lower interest. The trait curiosity measure included five items measuring interest-type (I-type) curiosity and five items measuring deprivation-type (D-type) curiosity taken from pre-existing measures

(Litman, 2008; Litman & Jimerson, 2004; Litman & Spielberger, 2003). The items for the two curiosity scales were alternated, and participants responded on a scale from 1 to 5, with possible scores for each scale ranging from 5-25.

The topic knowledge measure consisted of 10 multiple-choice items on the topic of Alzheimer's Disease developed for the purpose of this study. Each item had four response options weighted on a graduated scale from correct (4 points), to Alzheimer's incorrect or neurological disorder distractor (2 points), psychological disorder distractor (1 point), and general disorder distractor (0 points). The items were selected from material presented in the sources to be used in the study and were designed to capture a range of aspects, including symptoms, treatment, and causes of Alzheimer's Disease. A content expert reviewed the measure to determine face validity and accuracy of the questions. Based on feedback, changes to wording and response options were made prior to administering the measure to the pilot sample. The topic knowledge measure was evaluated in the pilot sample for both the binary scoring with possible scores from 0-10 and the graduated response scoring with possible scores from 0-40.

Results

Findings from the pilot study revealed that students exhibited a range of topic interest, I-type trait curiosity, D-type trait curiosity, and topic knowledge. See Table 1 for a summary of the descriptive statistics for each of the measures.

Table 1

Summary of Pilot 1 Data for Individual Difference Measures

	Possible score	**Range**	**Mean (SD)**	**Scale Reliability**
Topic interest	0-1000	32-858	494.60 (184.50)	α=0.89
I-type trait curiosity	5-25	15-25	19.93 (3.19)	α=0.70
D-type trait curiosity	5-25	10-25	17.40 (4.01)	α=0.69
Topic knowledge (binary)	0-10	4-9	5.83 (1.42)	KR_{20}=-.04
Topic knowledge (graduated response)	0-40	21-38	28.00 (4.53)	α=.06

With regard to the reliability of the measures, the topic interest, I-type trait curiosity, and D-type trait curiosity measures had acceptable reliability as measured by internal consistency. Alpha was .89 for scores on the topic interest measure, .70 for scores on the I-type curiosity measure, and .69 for scores on the D-type curiosity measure. As such, these measures were deemed appropriate and no changes were made prior to administering them in the main study. However, scores on the topic knowledge measure did not have high internal consistency for the graduated response (α=.06) scoring method and had a negative coefficient for the binary scoring method (KR_{20}=-.04) because the sum of the individual item variances was greater than the total test variance. Based on an evaluation of item statistics and item correlations, this was due in part to negative correlations between some of the items and low correlations among other items. As such, the individual items were carefully scrutinized to determine if specific items should be dropped or adjusted. The item difficulties and discrimination for the 10 items are included in Table 2, along with the percentage of participants receiving each of the scores in the graduated scoring method.

Table 2

Topic Knowledge Measure Pilot 1 Item Statistics

			Graduated response score proportion			
Item	**Difficulty**	**Discrimination**	**0**	**1**	**2**	**4**
1	.40	.16	.07	.37	.17	.40
2	.47	.42	.33	.10	.10	.47
3	.37	.10	.17	.17	.30	.37
4	.47	.28	.17	.37	.00	.47
5	.47	.42	.37	.03	.13	.47
6	.90	-.04	.00	.03	.07	.90
7	.70	.42	.00	.07	.23	.70
8	.40	.30	.03	.00	.57	.40
9	.73	.20	.03	.20	.03	.73
10	.93	.02	.00	.00	.07	.93

Note: Graduated response score proportions do not add up to 1.00 due to rounding. Discrimination was calculated as the difference in difficulty between participants scoring above the mean and below the mean based on the binary scoring method. Positive discrimination indicates that the participants performing above the mean were more likely to get an item correct and suggests that the item is functioning as expected.

Based on the calculated difficulty scores, items 6 and 10 were determined to be too easy, as at least 90% of participants correctly responded to these items. As such, these items were adjusted to increase the variability. Specifically, the content of item 6 was reworded for both the stem and response options to increase the nuance of the question content to be tested. The content of item 10 was determined to be too simple for the given sample and was replaced with a different question. Additionally, items with low response rates on one or more of the distractors were revised. For instance, the response options for item 4 were reworded to increase parallelism and for item 9 the response options were reworded to increase the difficulty of the question. In addition, given concerns with reliability of the topic knowledge measure, and it was determined

that an open-ended question would be included in the main study to increase the potential for reliably measuring topic knowledge. Despite concerns about item reliability, item-level discrimination suggested that most of the items, with the exception of items 6 and 10, were functioning as expected, such that individuals scoring above the mean were more likely to respond correctly to the items than individuals scoring below the mean. The changes to the test were made in conjunction with an expert in statistics and measurement to prepare for a second pilot study.

Pilot Study 2

The second pilot study was conducted in order to evaluate the revised knowledge measure and to analyze reliability through test-retest analysis. For knowledge tests, internal consistency can underestimate test reliability, in part because internal consistency assumes the unidimensionality of the items (Crocker & Algina, 1986). For the knowledge test, although all of the items addressed a single topic, they were designed to address different aspects of the topic. For a topic knowledge measure for Alzheimer's Disease to have content validity implies that the measure covers the breadth of the topic. Accordingly, items addressed various aspects of diseases such as causes, symptoms, and treatment, and included biophysical, genetic, and social aspects. Under these conditions, test-retest reliability was determined to provide additional information about test reliability. Therefore, a second pilot test was conducted to examine consistency in scores on the knowledge measure over time.

Participants

Participants included 45 undergraduate students (15.56% male, 84.44% female), recruited from a human development course that was assumed to have a similar sample of students compared to the target population. Participants were 20.67 (*SD*=1.30) years on average and were 88.89% native English speakers. They included sophomores (n=10), juniors (n=16), and seniors (n=19). Participants were 48.94% white, 23.40% Asian/Pacific Islander, 10.64% Hispanic, 6.38% Black, and 4.26% multiethnic or other. Given the focus on test-retest reliability, only data from participants who completed the measures at both time points are reported for this pilot study.

Measures and Procedure

Participants completed a revised version of the 10-item topic knowledge test at two time points at least 2 weeks apart. The order of the items and responses were altered from time 1 to time 2 and the measure was completed online.

Results

Participants' scores for the 10-item knowledge measure are included in Table 3.

Table 3

Pilot 2 Topic Knowledge Test at Time 1 and Time 2

		Time 1		**Time 2**	
	Possible score	**Range**	**Mean (*SD*)**	**Range**	**Mean (*SD*)**
Topic knowledge (binary)	0-10	1-9	4.40 (1.70)	2-8	4.40 (1.63)
Topic knowledge (graduated response)	0-40	9-31	20.18 (4.66)	7-28	19.93 (4.24)

The performance of participants was significantly correlated between Time 1 and Time 2 for the binary scoring method (r=.46, p<.01). However, this correlation is not as high as was desired for test-retest reliability (Crocker & Algina, 1986). However, scores for the knowledge test calculated through the graduated response scoring method were not significantly correlated (r=.22, p=.15). An examination of kappa (κ) for each of the items between T1 and T2 identified problematic items. For each item, the number of individuals who received the same score across time points was computed. The binary scoring method produced κ values that were determined to be fair to moderate (κ >.4; Shrout, 1998) for seven of the 10 items. This suggested that for most of the items, students identified the same correct or incorrect item. The reliability of the three items with low κ values (items 6, 8, and 10) were therefore scrutinized in the main study.

Pilot Study 3

The third pilot study was conducted to determine a suitable multiple source use task that would elicit variability in multiple source use behaviors and performance, and would allow participants' interest and curiosity to manifest. Further, this pilot study allowed for the refinement of task instructions to determine whether participants interpreted the task as intended. As the importance of task in source selection and use has been well documented in the multiple source use literature (Cerdán & Vidal-Abarca, 2008; Le Biog & Rouet, 2007), this pilot study was deemed critical in identifying an appropriate task for this study.

The third pilot study consisted of five participants, including four undergraduates and one graduate student. Three variations of the task were implemented (a) creating a PowerPoint presentation (n=1), (b) creating and presenting a PowerPoint presentation

(n=2), and (c) creating and presenting an outline (n=2). Only one individual was given the instructions to create a PowerPoint but was not asked to explain the slides. It was evident that insufficient information about task performance could be ascertained without participants' explanations of the points that they had included, and that many of the points were ambiguous. Accordingly, having participants talk through their slides or outline was included for the remainder of the pilot participants.

The remaining four individuals were divided between completing the PowerPoint or an outline using pencil and paper. Individuals were directed to create a presentation (or outline) on any aspect of Alzheimer's Disease that they wanted, and that they would be asked to explain their presentation or outline once they had completed it. Following completion of the task, they were asked several questions to gauge the interpretability of and their engagement with the task. When individuals were asked what they thought the task was asking them to do, they responded similarly, suggesting that they were supposed to use sources, write some words or include pictures (in the case of the PowerPoint), and then elaborate in their explanations. When I asked how they could be prompted to provide a more thorough explanation, the fourth participant suggested that I ask individuals to talk through their presentation and tell what they would say for each slide. After implementing this for the final participant, it was deemed an effective way of eliciting participant elaborations and explanations without causing undo performance anxiety.

Finally, to decide between the PowerPoint and outline, I considered participants' responses to a question regarding which of the tasks they thought would be more engaging. Specifically, they were asked whether they thought they would be more or less

engaged if they were asked to create an outline versus a PowerPoint presentation. All participants indicated that they found or would have found the PowerPoint presentation to be more engaging as a task. Consequently, creating and presenting a PowerPoint was selected as the final version of the task for the main study.

Main Study

Participants

Participants for the study were 50 undergraduates recruited from a research methods course in human development from a large mid-Atlantic university. The sample consisted of 20.0% males and 80.0% females with an average age of 20.54 years (*SD*=1.18). Participants were 6.0% freshman, 16.0% sophomores, 38.0% juniors, and 40.0% seniors, and they had an average GPA of 3.34 (*SD*=.38). Most participants (94.0%) were native English speakers. Participants were 60.0% White, 14% Hispanic, 16.0% Black, and 10.0% Asian/Pacific Islander.

Participants completed an average of 2.44 courses in developmental psychology or human development and 0.20 courses in neurophysiology or neuroscience. As participants were could also have learned about Alzheimer's Disease through personal experiences, they were asked whether they had family members with Alzheimer's Disease or experience caring for or living with individuals with Alzheimer's. Fifteen participants (30.0%) reported having a family member with Alzheimer's, and of these individuals, two reported having lived with someone with Alzheimer's and two reported living with and caring for someone with Alzheimer's. This information was collected for demographic purposes and were not analyzed in the current study.

Undergraduate students were chosen as the target population for several reasons. First, for undergraduate students, multiple source use tasks are prevalent in academic contexts (Bråten et al., 2009; Cerdán & Vidal-Abarca, 2008). In spite of this, there is evidence that students at the undergraduate level are often unsuccessful in tasks requiring multiple sources (Bråten & Strømsø, 2006; Britt & Aglinskas, 2002; Rouet, 2006). Further, there are indications that motivations such as interest play a critical role in academic performance for students at this level (Bråten et al., 2013; Salmerón et al., 2010). To address the research questions, it was necessary to include participants with a range of subject-matter knowledge, topic interest, and trait curiosity. As such, participants for this study were sampled from elective courses in which students were expected to have some interest and curiosity in human development or neuroscience. However, within these courses, the topic selected for this study, Alzheimer's Disease, was believed to hold varying degrees of interest and curiosity for participants, and to be a topic for which participants would have varying levels of knowledge.

The desired sample size was determined based on power analysis using of overarching rules of thumb (e.g., Cohen, 1992; Wilson VanVoorhis & Morgan, 2007) and the statistical program G-Power 3.1.7 (Faul, Erdfelder, Lang, & Buchner, 2007, 2009), taking pragmatic needs into account (Harris, 2001). The power analysis was based on linear regression with five predictors (i.e., I-type trait curiosity, D-type trait curiosity, topic interest, topic knowledge, and knowledge-interest interaction) since this was the most complex analysis to be conducted. The desired power for the study was set to π=.80 (Cohen, 1992) at α=.05.

For the purpose of this study, it was desirable to capture a medium (f^2=.15) to large (f^2=.35) effect (Cohen, 1992). General rules of thumb for linear regression suggest that the number of participants should exceed 50 (Wilson VanVoorhis & Morgan, 2007). Using the G-Power 3.1.7 software with π=.80 and α=.05, it was determined that a sample of 43 individuals would be needed to capture a large effect (f^2=.35) and 92 individuals would be needed to capture a medium effect (f^2=.15), a finding reiterated by Cohen (1992). Given the nature of recruiting participants to complete two sessions and the process of conducting interviews and coding video data, a sample size of 92, necessary to capture a medium effect, was deemed too large. The general recommendation of 50 (Wilson VanVoorhis & Morgan, 2007) exceeds the calculated sample size to detect a large effect. As such, the desired sample size of 50 was recruited. Based on the G-Power analysis, this sample size allowed a moderately large to large effect to be captured.

Demographics Questionnaire

Participants completed a demographic questionnaire in which they reported personal and educational background (see Appendix A). They were asked to report their age, sex, race, and native English-speaker status. Additionally, participants were asked to provide information about their year in school, major(s) and minors (if applicable), grade point average, and number of courses taken in human development or neuroscience. They were asked indicate whether they had friends or relatives with Alzheimer's Disease, or whether they have lived or cared for someone with Alzheimer's Disease. Further, participants were asked to rate the frequency with which they typically used different types of printed and digital sources when "doing research for class" on a 100-point

sliding scale. Demographic variables were collected for reporting purposes only, and they were not examined in relation to other measures.

Independent Measures

Topic Interest

Topic interest in neurological and developmental disorders was measured using a 10-item topic interest questionnaire following a similar format to those used in prior studies (e.g., Grossnickle, Dinsmore, Alexander, & List, 2009; Murphy & Alexander, 2002). All items were answered on 100-point sliding scale from *not at all interested* to *very interested*. The topic interest questionnaire contained 10 neurological and developmental disorders for which students rated their interest (see Appendix B). This measure was based on the conceptualization of topic interest put forward for use in this study in which topic interest is defined as form of individual interest that involves a relatively stable propensity for increased attention and desire to engage in response to specific topics (Schiefele, 1996). The measurement of topic interest also aligned with the theoretical conception of individual interest within the Model of Domain Learning (Murphy & Alexander, 2002), as well as other theoretical notions of interest (e.g., Schiefele, 1996). The psychometric characteristics of the questionnaire were investigated through pilot testing of the instrument with an undergraduate sample, and an acceptable level of reliability for the scores of the main study sample was achieved (α=.89).

Epistemic Trait Curiosity

Epistemic trait curiosity was measured using two scales capturing curiosity as a feeling of interest and curiosity as a feeling of deprivation. Specifically, the scales included the Epistemic Curiosity Scale (EC scale; Litman, 2008; Litman & Spielberger,

2003) and the Curiosity as a Feeling of Deprivation Scale (CFD scale; Litman, 2008; Litman & Jimerson, 2004). Each of the scales included five items (see Appendix C). Both the I-type and D-type scales were focused on curiosity for epistemic topics and were constructed as measures of trait rather than state curiosity. The EC scale aligned with I-type trait curiosity and the CFD scale aligned with D-type trait curiosity. Prior research on the factor structure of the combined EC and CFD scale items found a two factor structure to be the best fit for these items compared to alternative models (Litman, 2008). Specifically, the two factor model include the five EC scale items loading together on an I-type curiosity factor with loadings from .58-.72, and the CFD scale items loading together on a D-type curiosity factor with loadings from .55-.76 (Litman, 2008). In this previous study, the latent factors were correlated at .6, indicating that these scales measure related, yet distinct constructs (Litman, 2008).

The EC and CFD scales were selected for two main reasons. First, these scales were designed to capture epistemic trait curiosity specifically rather than trait curiosity more generally. The focus on curiosity for knowledge was of particular interest in the current study. As many existing curiosity scales include items more closely related to general curiosity (e.g., Kashdan et al., 2004; Naylor, 1981; Peterson & Seligman, 2004) and less relevant to the need or desire for knowledge or information, the content of the EC and CFD scales made them a good match for the intended purposes of the study. Second, the EC and CFD scales have well-established psychometric properties for use with undergraduate populations, including reliability (αs>.7; Litman, 2008) and validity (Litman, 2008; Litman & Jimerson, 2004; Litman & Spielberger, 2003). Scores on each

of the scales were determined to be appropriately reliable for the sample in the main study (I-type: α=.70, D-type: α=.69).

Topic Knowledge

In order to measure prior knowledge of Alzheimer's disease, participants completed a topic knowledge measure including 10 multiple-choice items (see Appendix D). The measure included items related to the physiological and neurobiological aspects of Alzheimer's disease, etiological factors, social and emotional implications, and current treatments. Questions were developed for the purpose of this study, and an expert in Alzheimer's Disease determined the accuracy of each item, representativeness of content, and appropriateness for the given sample. Distractors for each of the multiple-choice items were developed according to a graduated scoring model (Alexander, Murphy, & Kulikowich, 1998), which allows for a more nuanced discrimination of individuals' knowledge. For most items, of the four response options, there were: (a) an Alzheimer's correct answer, (b) an Alzheimer's incorrect or neurodevelopmental disease distractor, (c) a psychological disease distractor, or (d) a general non-psychological or neurodevelopmental disease distractor. For instance, in the following question, each of the level of responses is noted:

Alzheimer's Disease can be definitively diagnosed through

a. Psychological testing [Alzheimer's incorrect distractor; 2 points]
b. Behavioral observation [Psychological disorder distractor; 1 point]
c. Brain autopsy [Alzheimer's correct answer; 4 points]
d. Genetic testing [General disease distractor; 0 points]

As described in the section on pilot tests, items were revised as a result of pilot testing with undergraduate participants and through review with a measurement expert. Revision included the adjustment of response options that were not selected frequently by

participants and the adjustment of item stems and response options for questions with difficulties >.8, which indicated that most participants were responding correctly. Difficulties for current sample ranged from .18-.86 and are included in Table 4.

Given the low reliability of the measure in the pilot tests, the items were scrutinized to determine whether a subset of the items could be used to achieve sufficient reliability. Internal consistency for the 10-item measure was lower than desirable (α=.27). Items were analyzed for their impact on overall test reliability, and three items with a negative correlation to the overall test score were excluded (items 1, 5, and 10). The alpha for the revised measure was .47. Two additional items (items 6 and 10) had near-zero correlations with the total score, and were excluded to reexamine the internal consistency.

Table 4

Scores on Topic Knowledge Measure

		Graduated response score proportion			
Item	**Difficulty**	**0**	**1**	**2**	**4**
1	.34	.16	.32	.18	.34
2	.58	.16	.06	.20	.58
3	.70	.00	.12	.18	.70
4	.50	.06	.08	.36	.50
5	.24	.02	.46	.28	.24
6	.60	.30	.02	.08	.60
7	.18	.10	.04	.68	.18
8	.52	.00	.14	.34	.52
9	.86	.04	.08	.02	.86
10	.28	.22	.10	.40	.28

With the exclusion of the five items with the lowest reliability α=.61, which was determined to be acceptable for a measure of topic knowledge. The five items retained for analysis are marked in Appendix D.

Dependent Measures

Source Selection and Use

The current study identified two mediums of sources and resources that students encounter in their studies: digital and print. A variety of types of sources across print and digital mediums were provided for participants in order to understand students' source selection and use. Several factors guided source selection: (a) the number of sources, (b) variability and variety of type, (c) source relevance, (d) appropriateness for the target sample, and (e) source features.

With regard to the total number of sources provided, an adequate number of sources were desired so that participants would be able to engage in exploration related to their interest and curiosity without being overwhelmed. Too few sources would not allow for participants to select from among sources given the ease of reviewing all sources. On the other hand, too many sources could leave participants overwhelmed. Previous studies of multiple source use that have provided students with sources have ranged in number from two sources (e.g., Wolfe & Goldman, 2005) to more than 10 sources (e.g., Wineburg, 1991). Studies requiring students to read all sources typically include six to eight sources (e.g., Bråten et al., 2013; Le Bigot & Rouet, 2007; Wiley & Voss, 1999), although in his seminal study, Wineburg (1991) required students to review eight text and three pictorial sources. Based on these findings, it was determined that eight sources would be used for each presentation format (i.e., eight digital and eight print).

Second, the relevance of the sources was considered. Sources were selected if information about Alzheimer's Disease was featured prominently as the topic of the

source. While students are sometimes required to select between relevant and irrelevant information when selecting sources (e.g., List et al., 2013), the purpose of the current study was not to understand students' judgments of relevance, rather to discern their interest- and curiosity-driven motivations for source selection and the effects on task performance. As previous studies have shown that students frequently make judgments surrounding relevance (e.g., List et al., 2013), I aimed to ensure that students would find all of the sources potentially relevant for completing the academic task. However, the sources were selected to vary such that some sources focused more on brain and neurological changes of Alzheimer's Disease, others focused on current research, and yet others examined symptoms and treatment.

The third consideration was determining that the selected sources were appropriate for the sample, namely, undergraduates who potentially have some exposure to the domain of neuroscience but who have not reached more advanced levels of academic development in the domain. To ensure that the readability level of materials was suitable for undergraduates, Flesch-Kincaid grade levels (FKGL) were calculated for digital and print text sources, with the exception of textbooks and tradebooks for which the calculation of readability statistics was not feasible given the source length. Only sources that fell in the range appropriate for undergraduate samples (FKGL≤12) were considered for inclusion. Instructors teaching similar courses from which students were recruited examined the textbook, tradebook, and non-text sources for their suitability for an undergraduate sample. The final sources were all judged to be suitable for the sample.

Finally, digital and print sources were matched according to source features. Appendix E includes a brief description of each digital and print source, and Appendix F

provides a summary of the audience and tone (e.g., written for general medical/scientific audience), credibility (e.g., peer-reviewed, inclusion of scholarly references), length (e.g., single page image), and format (e.g., single graph, two-page article). The print sources were presented in their original format with a few exceptions. The maintain consistency across mediums and reduce the need to search through sources for relevant information, the encyclopedia and textbook were bookmarked, with irrelevant pages made unviewable. The graph and image were printed in color on 8.5 by 11 inch laminated paper. The digital sources were linked to an online interface that can be accessed at: drlrlresearch.weebly.com.

Performance Outcomes

Students' PowerPoint presentations and their verbal explanations of the PowerPoint presentations were scored in terms of surface-level and deep-level indicators of performance consistent with previous research (e.g., Le Bigot & Rouet, 2007; Wiley & Voss, 1996, 1999). First, participants' PowerPoint slides and explanations were coded for whether the content was *borrowed* (i.e., taken directly or paraphrased from a single source), *transformed* (i.e., a combination of material from more than one source, a conclusion or inference based on one or more sources), or *added* (i.e., containing novel information that could not be inferred from the sources). Material that was borrowed or added was considered a surface indicator of source use, while transformed material was a deep indicator (Le Bigot & Rouet, 2007; Naumann et al., 2009; van Strien et al., 2014; Wiley & Voss, 1999). The specific source of the information (e.g., digital newspaper, print encyclopedia) was also identified in order to allow for comparisons across source

types (Britt & Aglinskas, 2002). A detailed coding scheme with examples is described in the section on coding task performance in this chapter and is provided as Appendix G.

Additional surface indicators included the number of words (Le Bigot & Rouet, 2007; Wiley & Voss, 1999). This was examined for the number of words in the PowerPoint, and the additional words included in the spoken explanation beyond the number written in the PowerPoint (n_{spoken}-n_{PPT}). Similarly, whether at least one image was included and the total number of images was examined as a surface indicator. In terms of additional deep-level indicators, the presentations were coded for integration, including the number of sources used in the response and the number of switches between sources (Gil et al., 2010). Further, students' sourcing was analyzed by counting the number of different general and specific references participants included (Britt & Aglinskas, 2002; Naumann et al., 2009). References included specific in-text citations, sources included in a reference list, reference to the resources sheet (e.g., Desk Source 1), naming an authors, or mentioning that information had come from a specific source or the readings generally.

Separating the performance indicators into surface- and deep-level was done to maintain consistency with previous research in multiple source use (Le Bigot & Rouet, 2007; Wiley & Voss, 1996, 1999). However, it is critical to note that the separation between surface and deep performance is not as clearly delineated as the present study suggests. Specifically, there may be times when and participants for whom deep-level indicators are applied in a superficial way (Alexander et al., 2010). This separation is acknowledged as a delimitation of the present study.

Procedure

Participants were recruited from human development courses at the University of Maryland and were offered extra credit for participation. The study took place in two sessions. The first session was completed online prior to participants coming in person for session two. The first session lasted approximately 30 minutes and the second approximately one hour. In the online session participants completed consent forms. Consenting participants completed the demographics questionnaire, topic interest questionnaire, trait curiosity questionnaires, and topic knowledge measure. In the second session participants were seated at a workstation with a computer with Internet access loaded with a marked webpage of digital sources (see Figure 2), books, journal articles, and charts (see Figure 3).

Participants received the following written instructions:

> You have been asked to create a 3- to 5-slide PowerPoint presentation on Alzheimer's disease that you could deliver to a high-school health class. You may choose to deal with one or more aspects of Alzheimer's disease you believe are suitable for a presentation to a high-school audience. Once you are finished I will ask you to talk through your presentation. You may use any of the available resources at this workstation to develop your presentation (i.e., books, charts, online resources, print articles). Please stay within the resources or links provided.

The instruction to create the presentation for a high-school health class was designed to provide a meaningful task that would enable participants to pursue multiple avenues of interest. As health classes can cover preventative, diagnostic, treatment, and care for specific disorders, this was deemed to provide a number of subtopics related to Alzheimer's Disease that participants could pursue. Participants were directed to a pre-loaded PowerPoint template in which to create their presentation. Providing a template

was done to encourage participants to focus on the content rather than the design of their presentation. As participants completed their presentation, their screen was recorded using Camtasia screen-capture software. This provided a real-time video of participants' computer screens, recording their use of digital sources as well as their construction of the presentation.

Figure 2. Screenshot of the online interface.

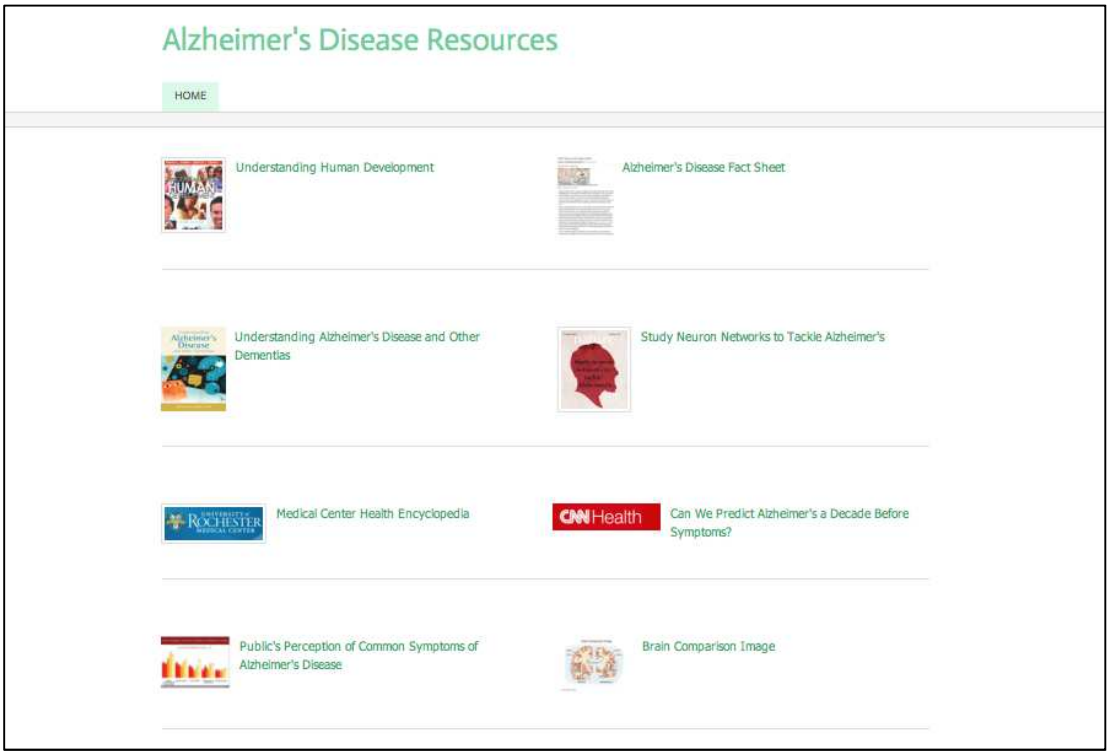


Figure 3. Participant workstation.

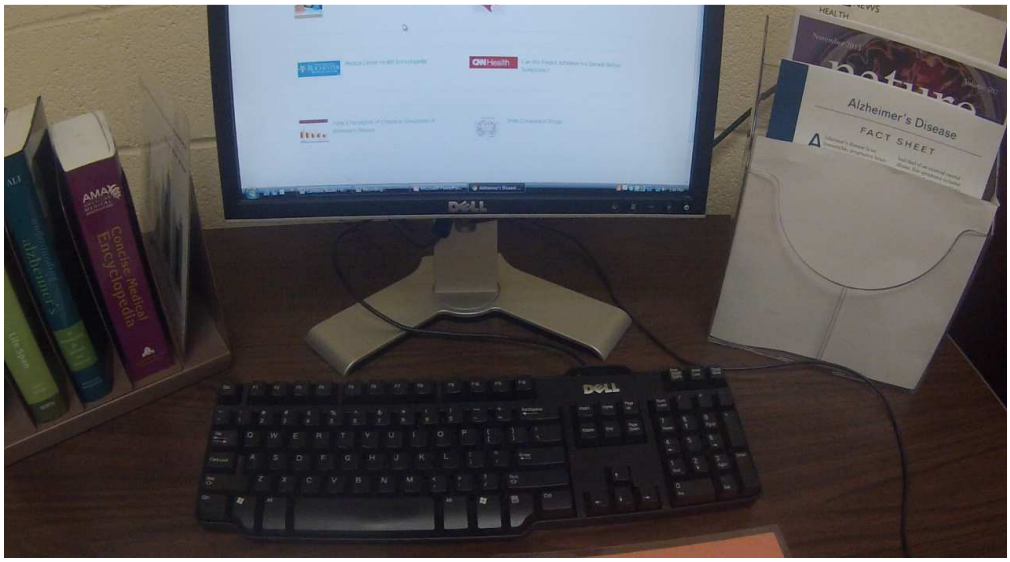


Figure 4. GoPro camera.

Additionally, participants were fitted with a GoPro camera on their head in order to record the books, models, and other physical sources they used (see Figure 4). The GoPro camera captured the direction in which participants were facing (e.g., textbook page, PowerPoint) and allowed for the coding of the direction of visual attention as well as behaviors (e.g., typing, scrolling). The video recordings from the GoPro were used for analysis, with the Camtasia screen capture recordings serving to clarify as needed.

Following the completion of the task, a guided retrospective interview was conducted in order to assess participants' retrospective expressions of their interest and curiosity during the task. The sources remained available for participants to review as they answered questions about source selection, source use, and construction of the Powerpoint. Additionally, while participants completed the task, I remotely watched a live video feed from the GoPro camera to identify the sources that they used. First, participants were asked to talk through their presentation in detail. Then, for each individual source, participants were asked the following questions: (a) Why did you choose to look at or use this source? and, (b) How did you use this source? These questions were intended to provide participants with the opportunity to describe interest- or curiosity-driven reasons for source selection as well as non-motivational reasons for source selection.

Participants were directed to one source at a time. If they used the source on multiple occasions, they were only asked once about the source. Participants were given the opportunity to look at any of the sources they used in order to recall their justifications and use. After participants were asked about the use of each source, they were then asked to explain why they included what they did in their PowerPoint. Finally,

participants were asked questions designed to reveal their level of interest or curiosity in the task more generally, including “Now that you’ve done this task, would you want to learn more or read more about Alzheimer’s Disease or some aspect of this topic?” and “Are there particular aspects of the topic or the sources that drew you in?” Follow up questions asked participants whether this task was similar to what they typically do in their courses and how what they did was similar or different from what they would have done if this was assigned for a class. The complete interview protocol is included as Appendix H. Interviews were transcribed verbatim for coding. Only the questions related to justifications for source selection, source use, or material included in presentations were coded for instances of interest or curiosity.

Coding Print and Digital Source Use

From the GoPro head camera recordings source use was coded according to (a) source selection and (b) source use.

Source Selection

Source selections consisted of whether students clicked on or picked up a particular source, whereas source use included indicators of how students used each source. Source selection was a binary indicator. Therefore, students received a code for whether they selected each of the 16 available sources, as well as a score for the total number of sources selected. This was calculated as a total with possible values from 0 to 16. Source selection was operationalized for print sources as whether students removed the source completely from the bookshelf or rack where it was positioned and had some of the content of the source in view. In the case of sources in which the content was obscured by a cover (i.e., textbook, trade book, encyclopedia), the source was counted as

selected only if the cover was opened. Digital source selection was operationalized as whether the link for a source was clicked on and some of the content of the source was in view. If students did not wait for a source to load before closing it or only viewed the cover page in the case of the sources with a cover page (i.e., textbook, tradebook), the source was not counted as selected.

To establish interrater agreement for source selections, 10% of the videos (n=5) were coded by two raters. The videos were divided into thirds (i.e., beginning, middle, end) to include a full representation of source selection across the task. Following training, 10 video segments or 10% of each third, whichever was larger, was coded by the author and a second rater for whether or not each source was selected. Perfect agreement was 95.0%. Discrepancies were resolved and I coded the remainder of the videos for source selection.

Source Use Processes

Source use processes were coded according to what individuals were viewing and acting on during the source use task, and for the length of time any given viewing or acting took place. This coding was conducted in a two-phase process. During the first phase, videos were coded at a fine-grained level that applied a new code any time the object in view (e.g., source, PowerPoint) or action (e.g., typing, putting source back on shelf) changed. These codes ranged in length from one second to several minutes. The second phase involved aggregating source codes from phase 1 to identify overarching source use processes (e.g., switching between sources, switching between source and PowerPoint).

In phase 1, videos were coded according to what was in view and what action the participant was engaging in at that time. The unit of time for codes was not fixed. Rather a new code was applied when there was a change in either what was being viewed or the action. Changes in what was being viewed resulted immediately in a new code for any change lasting at least one second. Changes in action were coded according to a three-second rule such that a new action code was not applied until a participant had engaged in the new action for at least three seconds. For instance, if a participant was typing while viewing the PowerPoint, the code for typing was applied until the participant had stopped typing for three seconds. This three second decision rule accounted for slight disruptions in participant actions (e.g., glancing to the side or stretching), while identifying the main action in which participants were engaged. Based on these decision rules, videos were divided into units, and each unit received a view code and an action code. The end of the video was marked at the point at which the participant took off the camera, stood up, or signaled completion (e.g., thumbs up).

Given that digital and print source use has not been analyzed in the existing literature, a coding scheme for phase 1 was developed for the purpose of this study. Development of the coding scheme followed an iterative process until the coding scheme reached saturation and at any given time participants' views and actions could be accounted for with a code if the views and actions were repeated across multiple participants. The coding scheme was developed on 25% of the videos before being applied to all participants' videos. The videos used for developing the coding scheme were recoded as necessary to include additional codes created during the iterative process. A complete coding scheme is provided as Appendix I.

View codes. View codes included separate codes for each of the sources, as well as for the PowerPoint, directions, reference list, online homepage, scanning of print sources, and various combinations of these objects. When a single print or digital source was in the center of the camera view, the view code was applied for this source. For example, if a participant set the printed fact sheet on the desk and the camera was pointed at the source with no other sources or other objects (e.g., reference list) in view, then the view code of PFS for printed fact sheet was applied. Similarly, if a participant clicked on the link for the digital encyclopedia and faced the camera toward the computer screen where this source was open, the view code of OE[1] was applied (for digital encyclopedia).

If the source was not the only object in focus, caution was taken when applying the view code for a single source. Certain indicators were used as evidence that an individual source was the focus of attention. For one, if participants used their finger to point at or follow along with a source, the view code for that single source was applied. For example, if the printed news article was placed in view on the desk next to the directions sheet, but the participant used a finger to underline the words in the news article, then the view code of PN for printed news was applied. Second, proximity to the camera was considered. For instance, if the printed journal article was held by the participant in front of the computer screen where an opened source was visible from around the sides of the printed journal article, a view code of PJ for printed journal article

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[1] Digital sources were given codes of "O" for *online* rather than "D" for *digital* because the sources were initially conceived as being online sources. However, given that some of the sources were scanned from print sources into a digital format, the term digital was determined to be more accurate and is therefore used throughout the document to describe sources available on the computer.

was applied given the proximity of the printed journal article to the camera and the obstruction of the digital source.

When multiple print sources were set out next to each other in view, with one clearly in the center of the camera's field and the other turned to the side or obscured, the view code was applied for the source in the center. In cases where there was less clarity in the source in the center of view and multiple sources were in view, a view code of MUL for multiple sources was applied, unless there was additional evidence that a specific source and only that source was receiving visual attention. For instance, if the participant typed information into the PowerPoint presentation that was relevant only to one source, then the view code for that specific source was applied. An identical method was used for coding viewing of the PowerPoint, directions sheet, reference list, and online homepage, as well as typed or handwritten notes for the participants who chose to include these. Similarly, the view code of SP for scanning print sources was applied when participants were looking to the right or left of the computer screen with the spines of the sources or the magazine rack in view, but without any additional indicators (e.g., pointing) of the specific source to which they were attending.

Combination view codes were applied when a single source or object could not be identified as what the participant was viewing. When participants had a source and the PowerPoint in view, they received a view code of OPC (online/PowerPoint combination) if the source was digital and PPC (print/PowerPoint combination) if the source was print. For digital sources the code of OPC was applied when the size of the screens for the PowerPoint and a source were adjusted so that both were simultaneously in view. For print sources, PPC was applied if a portion of the screen with the Powerpoint and a

portion of the print source were in view, or if the participant was quickly scanning back and forth between the PowerPoint and a print source.

An analogous view code was applied if the directions or reference list was in view in addition to the PowerPoint (DRP) or if notes were in view in addition to the PowerPoint (NPC). When more than one source was in view, a view code for multiple sources was applied (MUL). This could include multiple print, multiple digital, or a combination of print and digital. Similarly, if notes were in view in addition to a source a code for notes-source combination (NSC) was applied. Finally, codes of other were applied for viewing objects unrelated to the study, such as a cellphone, looking up at the ceiling, or viewing a webpage outside of the provided source links. The code of other was also applied when participants were adjusting the fit of the camera during the study.

Action codes. Action codes were applied to describe what participants were doing while they were viewing a given source, PowerPoint, or object. An action code of typing (TYPE) was applied when participants were typing into the PowerPoint presentation or notes page. This code could be applied when the participant was viewing the PowerPoint, any source or combination of sources, notes, or PowerPoint and any combination of sources. This included actions related to composing the PowerPoint, including adding or deleting text, copying and pasting text in the PowerPoint, and moving or rearranging text. Indicators of the TYPE code included changes in the text on the screen or notes page as well as the movement or sound of the participants' fingers on the keyboard. When the size or color of the text or textbox was changed, or the PowerPoint background was changed, an action code of FORM (format) was applied.

When a picture was inserted and formatted, or the participant was scrolling through and selecting clip art, an action code for picture formatting (PIC) was applied.

When viewing the PowerPoint or any combination and there were no text, formatting, or picture changes, the action was coded as stationary (STAT). This included remaining on a single slide, scrolling through the slides, or clicking on a different slide. For print and digital sources, a stationary code (STAT) was applied when the participant remained on a single page or flipped or scrolled through the pages at a pace that words or visuals could be read or comprehended. When participants quickly flipped through the pages of a print source or rapidly scrolled through the digital source at a pace that was not conducive to making meaning of words or images, an action code for scanning (SCAN) was applied. Additionally, two print-specific and one digital-specific action codes were included. For print sources, when participants were placing a source back on the shelf or rack, an action code of CLOSE was applied. Additionally, given that participants could touch a print source without removing it from the shelf to view the content, a print-specific code of TOUCH was applied to acknowledge that they were attending the source without selecting it. For digital sources, the text or images could be resized (e.g., enlarged) or reformatted (e.g., rotated 90 degrees). These actions were coded as RESIZE.

Interrater agreement for view codes and action codes was established on 10% of the videos (n=5). The videos were separated into the time units and the videos were divided into thirds (i.e., beginning, middle, end) to include a full representation of source processes across the task. Following training, 10 or 10% of the units, whichever was larger, for each third were coded by myself and a second rater for what individuals were viewing and doing at each time. A high level of reliability was achieved for the view

codes (κ=.79; 80.13% perfect agreement) and the action codes (κ=.80; 82.69% perfect agreement). Discrepancies were resolved through discussion and I coded the remainder of the videos.

Aggregation of action and view codes. In phase 2, the individual codes were aggregated in order to determine the length of time individuals spent viewing the source in conjunction with composing or creating their presentation (referred to as *compositional source use*), and viewing only the source (referred to as *focused source use*). To do this, units from phase 1 were grouped into sets of units. For each participant, the first source used was identified from the view codes from phase 1. After the first instance of viewing the source, the immediately subsequent codes for viewing that source, the PowerPoint, notes, or combination codes that included that source were coded as *compositional source use* for the first source. All action codes were included in the compositional source use coding. Subsequent units were coded as related to the first source until a unit was reached that included viewing a different source or viewing something other than the original source, PowerPoint, or notes. For example, this included viewing the homepage, scanning print sources, and codes for *other* such as looking around the room. Following cessation of codes related to the first source, the next unit coded from phase 1 as viewing a source (either the same as the first source or a different source) started the second aggregated coding set. Subsequent codes were identified as related to a particular source in the same manner as for the first source. This procedure was followed for all of the codes from phase 1. See Figure 5 for a sample section of phase 1 and 2 codes for Participant 34. Column I summarizes compositional source use.

Figure 5. Sample phase 1 and phase 2 coding in Excel.

	A	C	D	E	F	G	H	I	K
1	Time	TimeMin	ViewCode	ActionCode	Notes	Partial	Source	Compositional	Focused
2	0:23	0.10	HP	Stat					
3	0:29	0.03	RD	Stat					
4	0:31	0.07	HP	Stat					
5	0:35	0.17	RD	Stat					
6	0:45	3.58	OFS	Stat			OFS	3.58	3.58
7	4:20	0.13	HP	Stat					
8	4:28	0.85	ON	Stat			ON	1.12	0.85
9	5:19	0.13	PPT	Stat					
10	5:27	0.12	PPT	Type					
11	5:34	0.02	PPT	Stat					
12	5:35	0.48	PB	Stat			PB	0.70	0.48
13	6:04	0.22	PPT	Stat					
14	6:17	0.08	SP	Stat	Looking to left of computer screen				
15	6:22	0.25	DIR	Stat					
16	6:37	0.10	PPT	Stat					
17	6:43	2.98	PFS	Stat			PFS	3.68	3.19
18	9:42	0.08	PPT	Stat					
19	9:47	0.07	PPT	Type					
20	9:51	0.23	SPC	Type	PFS	0.117			
21	10:05	0.10	PPT	Stat					
22	10:11	0.18	SPC	Type	PFS	0.092			
23	10:22	0.03	PPT	Stat					
24	10:24	0.05	ON	Stat			ON	0.05	0.05

The final PowerPoint view code was not coded as related to a specific source if the action was STAT because most participants looked through all of their slides at the end of the task, perhaps as a means of double checking or rehearsing the entire content of their presentation. Compositional source use time was calculated for each aggregated set of codes related to a source, and compositional source use time was summed separately for each of the 16 possible sources. This accounted for participants' use of the same source multiple times throughout task completion.

After compositional source use was calculated, the length of time spent viewing only the source was extracted from each coding set. Time spent viewing only the PowerPoint or notes was excluded from this calculation. For combination PowerPoint and source use view codes, and combination source codes (MUL), the length of time spent was divided by the number of items in view. For instance, if the participant was

viewing the PowerPoint and the encyclopedia for 10 seconds, 5 seconds was included in the *focused source use* calculated for the encyclopedia. Additionally, only view codes that were accompanied by action codes of STAT or TYPE were included in calculations of focused source use. Action codes related to SCAN, TOUCH, CLOSE, and RESIZE were excluded from counts of focused source use because they did not suggest that participants were engaged with the content of the source, rather that they were moving through the source, adjusting the source, or had not yet picked up the source. In figure 5, column K depicts focused source use.

Coding Post-Hoc Expressions of Interest and Curiosity

Given the challenges of separating interest and curiosity in their momentary forms of situational interest and state curiosity (Grossnickle, 2014; Kashdan, 2004), no distinctions between interest and curiosity were made when coding the interview data. As such, the expressions are referred to as *interest/curiosity*. Only the interview questions regarding reasons for source selection and use, and creation of the PowerPoint presentation were included. These questions did not prompt participations to think about motivational reasons for source selection and use, and therefore these expressions were considered unprompted.

The interview proceeded in a back-and-forth manner between the interviewer and the participants. The unit of analysis for coding was the participant's response to an interview question. Given that expressions of interest/curiosity sometimes extended across several lines, this unit of analyses was deemed more useful than a further parsing of the data into idea units. Each response unit was first coded for whether or not it contained any expressions of interest/curiosity. Consistent with prior studies, response

units were identified as reflective of interest or curiosity if they directly included the words “interest” or “curiosity” or an iteration of either of these terms (e.g., Braasch et al., 2013). Additionally, response units that reflected characteristics of the definitions of interest and curiosity put forward in Chapter 1, were regarded as indicative of interest/curiosity.

Specifically, explanations noting a disposition toward or propensity to reengage with particular content, or the desire to foster such dispositions in the audience of the presentation, were regarded as indicative of interest/curiosity (Hidi & Renninger, 2006; Schiefele, 2009). Consistent with the definition of academic curiosity as a need for knowledge, information, or exploration of academic environments (Kang et al., 2009; Litman, 2010; Litman & Silvia, 2006), the need or desire for knowledge or information was regarded as indicative of interest/curiosity. This included wanting to see, learn, know, or find out something during the course of the task. It did not include wanting to do something or wanting to add something to the presentation. Additionally, consistent with curiosity and interest as having catch and hold mechanisms (Hidi & Renninger, 2006), statements where participants noted that something caught their attention was regarded as indicative of interest/curiosity. Although participants frequently talked about “liking” a particular source or content, these comments were not coded as interest/curiosity. Given the general nature of this type of comment, it could not be discerned whether this was interest or whether this simply reflected enjoyment, which has been identified as similar, but not synonymous with interest (Reeve, 1989). The coding scheme is presented as Appendix J. Following training, a second rater independently

coded 14.3% of the interviews for whether or not each response unit included expressed interest/curiosity. Perfect agreement was 94.87%.

Then, all units identified as containing an expression of interest/curiosity were categorized according to the target of the interest/curiosity. Each unit could receive multiple codes if it contained more than one target of interest/curiosity. Development of a coding scheme was based on bottom-up analysis of the data, with a focus on themes relevant for understanding interest/curiosity within the context of the conceptual model tested in this study. Additional codes were added until the coding scheme reached saturation. The following three categories were identified: (a) *interest/curiosity for content*, (b) *interest/curiosity for source features*, and (c) *interest/curiosity of the audience*. A small number of expressions (n=5) could not be classified into one of these categories because they did not include sufficient information as to the target of interest/curiosity. For instance, Participant 45 said, "I wanted to look at this." It was unclear from the transcript whether she wanted to look at the content or the type of source. These expressions were classified as *other*, and were included in the overall total number of expressions. Additionally, expressions that included multiple targets of interest/curiosity could be coded into more than one category.

Interest/curiosity for content included expressions related to the material contained within sources or the desire to learn about or retrieve the information contained within a source. This manifested in several ways. First, this could include references to finding particular information within a source to be interesting/curious. This included the general content topics and specific details, as well as the content of images within the source. For example, Participant 16 identified her interest/curiosity in the fact that

Alzheimer's can only be definitively diagnosed through an autopsy, suggesting interest/curiosity about a specific fact contained in the source. Participants also reported that they were interested in or curious about certain content more generally while completing the task. For example, Participant 34 noted that she "wanted to know…if there was a cause." Second, interest/curiosity in the content included participants' desires to see something that was not currently visible to them, such as picking up the graph to "see what was on the graph," or wanting to check out all of the sources because "I was curious to see what each one had to offer" (Participant 35). Additionally, the title served to provide some information about whether the content in the source would be interesting. For example, Participant 32 said, "I just saw the BBC headline and was curious what it was about."

The second category, *interest/curiosity for source features* included expressions that mentioned the type of source or the features of a source. For instance, Participant 18 noted that "the picture [on the cover] kind of drew me to that" and Participant 9 stated that the print sources "immediately caught my eye." Others were more specific about interest/curiosity in the particular source. For example, Participant 45 justified selecting the BBC news article because, "I listen to BBC news sometimes, so I felt like, you know, I have some interest in it." Features that were visible prior to selecting the source, such as the image on the cover, were coded as interest/curiosity for source features. In contrast, images contained within the source were regarded as the content of the source and were therefore coded as interest/curiosity for content.

The third category was *interest/curiosity of the audience.* This category included expressions where participants reported (a) sensitivity to what the audience of their

presentation would find interesting/curious, or (b) a desire to increase the interest/curiosity of the audience. This was done in two main ways. First, some participants described the content that the audience might consider interesting/curious. For example, Participant 1 noted that: "people are really interested in knowing how [Alzheimer's] affects them." In explaining how she used the information from the news article, Participant 2 said, "to make them think more about if they're interested in it." In this comment, she indicated a desire to increase future interest/curiosity of her audience. Second, participants focused on the type of information presented, such as statistics or visuals. For instance, Participant 25 justified using images "to make it interesting."

A second coder served to establish interrater agreement on 14.3% of the transcripts. After acceptable reliability was achieved (κ=.83, 87.50% perfect agreement), disagreements were resolved through discussion and the author coded the remainder of the transcripts.

Coding Task Performance

The PowerPoint presentations were coded according to the degree to which the information contained in the presentation was borrowed, added, or transformed (see Appendix G). Transformed information was further divided according to whether the transformation occurred within a source or across more than one source. This coding scheme was based on prior research and theories of multiple source use (Le Bigot & Rouet, 2007; van Strien et al., 2014; Wiley & Voss, 1996). It aligns with theories of multiple source use that suggest that multiple source use requires the inclusion of intratext and intertext information (Perfetti et al., 1999). Therefore, participants' PowerPoint presentations were expected to include information contained within a single

source (i.e., borrowed and within source transformations) as well as information combined across multiple sources (i.e., multiple source transformations). Additionally, given the alignment of theories of multiple source use with Kintsch's (1998) construction integration model, it was anticipated that students would include information at both the text-base and situation model levels. Specifically, information that was borrowed was considered to be at the text-base level, and information that was transformed within or across sources was considered to be at the situation model level. Although it was not anticipated that all students would include information at both levels, these levels were expected to be present across the range of participant presentations.

The PowerPoint slides and the verbal presentation of the PowerPoint were coded in conjunction. First, the PowerPoint presentations were compared with the transcripts of participants' explanations to identify statements that were not included in the PowerPoint. In order to be counted as a novel statement, the verbalized statement needed to include more than a simple restating or rephrasing of what was typed in the PowerPoint. It was included if it presented a new idea or elaborated on the PowerPoint content. The presentation was then broken into units based on the natural separation of units indicative of PowerPoint presentations (i.e., bullets). Each bullet was coded as a unit. If the bullet contained multiple sentences separated by sentence ending punctuation (e.g., period, question mark), then these were separated into multiple units. The novel statements in the verbal explanation were broken into units at the level of a sentence or phrase. Units that were spoken to the researcher were not included in the coding. These include statements justifying what was included in the presentation (e.g., "just to give them an idea of why that disease matters to the current population"). Additionally, when

participants summarized what they were going to present next or said something to transition between ideas, these units were coded as *transitional summaries.* These included units describing what was going to be stated next, such as, “so we’re going to learn about Alzheimer’s Disease.” The title of each slide was coded as a transitional summary unit. These were not included in the analysis. Participants’ PowerPoints and verbal presentations contained an average of 29.25 (*SD*=9.63) units, ranging from 13-65 units.

Presentations were coded using triangulated information from the PowerPoint, transcript of the verbal explanation, and the GoPro videos of source use. As needed, the interview transcript and Camtasia videos of source use were used to supplement the coding in order to correctly identify the source of the information. In conjunction with the PowerPoint and transcript of the explanation, the GoPro videos served as the main source of information. They were followed in chronological order to determine at what point during source use participants developed each bullet point of their presentation.

Units were coded as *borrowed* if they directly copied or paraphrased information presented within a single source. This information could come from a single sentence or multiple sentences in the source, but did not require the participant to make any inferences or to reconceptualize the information in any way. Borrowed information frequently included slight modifications to the text, such as substituting synonymous words or omitting words in a sentence. When the images or the graphs were included in the presentation, this was categorized as borrowing. This included copying and pasting digital images into the PowerPoint or physically holding up the print image during the verbal explanation. In verbal explanations of images, the explanation of the image was

considered borrowed if it only included information directly available in the image without requiring any inferences. For example, the printed graph was a bar graph that included the Alzheimer's death rates for males, females, and total individuals of different ethnicities. It was coded as borrowed if the participant stated that the average death rate was 25, as this value was clearly visible from a single bar on the graph. However, it was not be considered borrowed if the participant made the conclusion that across all ethnicities, females were more likely than males to have Alzheimer's, since the participant had to aggregate multiple pieces of evidence to reach this conclusion.

When participants created a sequence of multiple phrases or words from the text that did not change the basic meaning of the text or go beyond the words as presented in the text this was also considered borrowing. For example, the printed fact sheet included a paragraph on the neurological markers of Alzheimer's Disease. Specifically, it states:

> After [the patient] died, [Alois Alzheimer] examined her brain and found many abnormal clumps (now called amyloid plaques) and tangled bundles of fibers (now called neurofibrillary tangles). Plaques and tangles in the brain are two of the main features of Alzheimer's disease. The third is the loss of connections between nerve cells (neurons) in the brain.

From this information, one participant wrote a bullet point stating, "three features of Alzheimer's are amyloid plaques, neurofibrillary tangles, and loss of connections between cells." In this example, the participant did not change the information in any way, and combined it in the same way in which it was stated in the source (i.e., the source explicitly stated that there are three main features, so the participant did not need to make this inference).

Units were coded as *transformed* if the participant made conclusions or inferences across one or more of the sources. Transformations went beyond repeating or rephrasing the information as presented in the text or image. Rather, transformations required making an inference or combining material in novel ways. This could occur within a source (*within source transformation*) or by combining material across sources (*multiple source transformation*). Within source transformations involved either making an inference or combining information from within the source that was not originally reported as related. For instance, one participant inferred from the printed journal article that Alzheimer's is "diagnosed using MRI which shows the loss of brain cells associated with the disease." Although there were statements within the journal referring to the use of MRI as a diagnostic tool, the participant went beyond this information to draw a conclusion about how this was used. To be considered a transformation, combining information within a source needed to go beyond connecting things already listed as related within the text. For instance, in her verbal explanation one participant stated, "it also helps to test different clinical trials or interventions, because since the disease is irreversible, any information they learn…can help over time." All of this information was included within the printed fact sheet, but it was not included together. Although she was summarizing information about clinical trials, the participant made the connection that these trials were important due to the irreversible nature of the disease, a point that was stated earlier in the text.

For images, units were coded as transformed if they involved the interpretation of the image. For instance, when describing the online image of a side by side comparison of an Alzheimer's and non-Alzheimer's brain, one participant said: "You can see that

there's a significant difference in impairment in the brain and in the center ventricle and with the sulcus and gyrus. Everything kind of like shrinks or deteriorates away." Both of these sentences were coded as within source transformations because the participant had to interpret these changes. However, if the participant read about the shrinking of the brain in Alzheimer's and then applied this to the image, the second sentence in this example would have been coded as a multiple source transformation.

Multiple source transformations were similar to within source transformations, although they involved the combination of related pieces of information from different sources. For example, one participant typed in her Powerpoint: "Most common cause of dementia (deterioration of mental functions)." She used information from the online encyclopedia to compose the first part of this bullet point, and used the online fact sheet to provide the information in parentheses. Additionally, some participants initially typed information into their PowerPoint from a single source, but then revised the information when encountering a second source. For instance, one participant used the printed textbook to note that Alzheimer's is "a brain disease that leads to memory impairment." Then, at a later point during the task, he encountered information in the printed fact sheet that indicated that Alzheimer's also affects thinking capabilities. He then revised his bullet point to state that it is "a brain disease that leads to memory impairment and loss of thinking capabilities." Since this information was combined across more than one source, it was regarded as a multiple source transformation.

Units were coded as *added* when they did not come from any of the sources accessed or when the information could not be inferred from any of the sources viewed by the participant. Added information was regarded as originating with participants'

prior knowledge or experiences; however, unlike transformations, prior knowledge was not used to assist in the formation of inferences, rather it allowed the participant to provide additional information. Particular consideration was given to the specific sources each participant accessed, and to the specific pages or parts of the source that they viewed. If the information contained in a participant's presentation was available in one of the sources, it was considered borrowed if the participant viewed that source, but was considered added if the participant did not view the source with that information. For example, if a participant viewed the page in the print tradebook or the online fact sheet containing information about exercise as a potential treatment for Alzheimer's disease, the information would be counted as borrowed. However, if the participant did not view this page or any other page in any of the sources containing information about exercise as treatment, then the inclusion of a similar statement would be counted as added given that the participant included this information based on prior knowledge. Additions could also refer to information specific to the participant, such as "my grandmother has Alzheimer's" or to the general idea of what their audience might experience, such as, "I know that some of you may have an aunt, uncle, or grandparent who suffers from Alzheimer's."

Units that were borrowed or transformed were also coded for the specific source where the information came from (borrowed) or what source(s) led to the inference or conclusion that was drawn (transformed). The number of times that participants switched sources in their presentation was tallied. A second coder served to establish interrater agreement on 10% of the presentations. An acceptable reliability was achieved for whether information was borrowed, added, or transformed (κ=.72, 78.79% perfect

agreement) and for the specific source used for borrows and transformations (κ=.92, 92.11% perfect agreement). Disagreements were then resolved through discussion and the author coded the remainder of the presentations.

Summary

The current study was designed to address several major gaps in the multiple source use and interest and curiosity literatures. First, it addressed the relations among students' interest, curiosity, knowledge, and multiple source use when they were provided with the opportunity to engage with print and digital sources. In this way, it built on prior literature examining differences in source use by source type and characteristics, to explicitly compare students' use of print and digital sources to complete an open-ended task. The current study provided students with a common open-ended academic task, creating a PowerPoint presentation, in order to examine their multiple source use processes and to compare the processes to the outcomes of the task. Although multiple source use theories have posited a relation between motivational variables and multiple source use, this relation has been under examined with regard to interest and unexamined with regard to curiosity. Moreover, as limited studies have examined interest and curiosity by including measures of both constructs in relation to processes and performance on academic tasks, the present study addressed this gap. Moreover, interest and curiosity were examined in both enduring forms (i.e., topic interest and trait curiosity) and situational forms (i.e., situational interest and state curiosity) to explicate relations between these motivation constructs. The examination of topic knowledge allowed for the investigation of knowledge in relation to multiple source use, as well as the relation among knowledge and expressions of interest and curiosity.

CHAPTER 4

RESULTS: MULTIPLE SOURCE SELECTION, USE, AND OUTCOMES

Within the framework of multiple source use models (Britt et al., 1999; Perfetti et al., 1999; Rouet, 2006), this study compared students' selection and use of multiple types of print and digital sources. Further, it examined how source selections and use related to knowledge, interest, curiosity, and task performance. This chapter summarizes the results of students' source selection, source use, and task performance, and the relations between these variables. Specifically, this chapter presents the results for the following two research questions:

1. How many, what types of sources (e.g., textbook and image), in what mediums (i.e., digital and print/physical), and for what length of time do students use different types of sources when completing an academic multiple source use task?
2. How are students' source selections and use related to their performance on an academic task?

For research question 1, descriptive results for source selection and use are summarized by source medium (i.e., print, digital) and source type (e.g., newspaper, textbook). Chi-square analyses, *t*-tests, and ANOVAs were used to assess differences by source type across print and digital sources. For research question 2, descriptive analyses related to surface and deep indicators of performance are summarized. Then, results from correlation analyses are presented to determine the degree to which source selection and use related to surface and deep indicators of performance. Finally, the degree to which students incorporated information from print compared to digital mediums into their presentations is summarized, and *t*-tests are presented to compare differences by

medium. For all statistical tests, alpha was set at .05 with corrections for increased experiment-wise error made as applicable.

Research Question 1

How many, what types of sources (e.g., textbook and image), in what mediums (i.e., digital and print/physical), and for what length of time do students use different types of sources when completing an academic multiple source use task?

To address the first research question, the video recordings were coded for what participants were viewing (e.g., print news article, PowerPoint) and their actions (e.g., typing, scanning; see Chapter 3 and Appendix I for a complete description). Videos were coded for whether each of the 16 sources were selected or viewed, whether they were used in composing the PowerPoint, and the length of time each of the sources was used. Additionally, the number of times participants switched between sources was examined as an indicator of source selection use. See Table 5 for a summary of the source selection and use variables.

First, *t*-tests were used to examine whether the number of sources selected differed for print and digital sources. Then, chi-square analyses were used to examine whether there were differences by source type (e.g., newspaper, textbook) in terms of whether the sources were selected and used in print, digital, both, or neither medium. Next, descriptive statistics were calculated for time spent on: (a) overall source use, (b) print source use, (c) digital source use, and (d) use per source, as well as (e) the number and proportion of source switches. Differences across source medium and type were calculated through the use of ANOVAs and *t*-tests. Finally, correlations were calculated to address relations between print and digital source use indicators.

Source Selection

Students selected a total of 7.06 (*SD*=3.71) sources on average, ranging from 1-14 of the 16 available sources. This included an average selection of 3.18 (*SD*=2.25) print sources and 3.88 (*SD*=2.24) digital sources. There were no statistically significant differences in the total number of print or digital sources that students selected, $t(49)=1.96$, p=.06. Rather, there was a significant positive correlation between the number of print sources and the number digital sources that students selected ($r=.37$, $p=.009$), indicating that participants who used more print sources were also more likely to use more digital sources. Further, 78.26% of participants used at least one print source and 89.13% of participants used at least one digital source.

The total number of participants selecting each of the 16 sources (8 print and 8 digital) is presented in Table 6. Given that participants were able to use print and digital versions of each source type, the frequencies for digital source use and print source use were dependent. Therefore, the McNemar $\chi 2$ test, which is designed to compare frequencies across dependent groups (Fay, 2014; McNemar, 1947), was conducted to compare whether there were differences in the frequency digital compared to print sources were selected for each source type. This allowed for an examination of differences in selecting each of the other source types (e.g., textbook) across medium.

Table 5

Summary of Source Selection and Use Variables

		Separation of Data	
	Description	**By Medium**	**By Source**
Source Selection			
Total Sources Selected	Count of the number of sources used; possible range from 0-16	Possible range from 0-8 for each print and digital	Possible score of 0 or 1 for each of 16 sources
Source Use			
Total Compositional Source Use	Minutes spent viewing a source, working on PowerPoint immediately following source viewing, or switching between viewing PowerPoint and source	Time for print and digital sources calculated separately	Time calculated for each source separately
Per Source Compositional Source Use	Total compositional source use divided by total sources selected; Average time spent composing with all selected sources	Average time for print and digital sources calculated separately	Average time calculated for each source separately
Total Focused Source Use	Minutes spent viewing a source	Time for print and digital sources calculated separately	Time calculated for each source separately
Per Source Focused Source Use	Total focused source use divided by Total sources selected; Average time spent composing with all selected sources	Average time for print and digital sources calculated separately	Average time calculated separately for each source
Source Selection and Use			
Total Source Switches	Total number of times switched between sources	n/a	n/a
Proportional Source Switches	Total source switches divided by Total sources selected	n/a	n/a

Table 6

Comparison of Source Selection by Medium

	Frequency Source Selected				
	Print	**Digital**	**McNemar $\chi 2$**	***p*-value**	**Favored Medium**
Textbook*	7	17	4.50	.02	Digital
Tradebook*	22	31	3.05	.04	Digital
Journal Article*	24	12	6.05	.007	Print
Newspaper	17	16	0	.50	--
Encyclopedia entry*	7	19	6.05	.007	Digital
Fact Sheet*	40	47	2.77	.05	Digital
Graph	24	25	0	.50	--
Image*	18	27	3.76	.03	Digital

Note: N=50; *df*=1, *p*-values based on 1-tailed test; *$p \leq .05$.

Significant differences were identified in six of the eight types of sources, and revealed a general preference for digital sources. Specifically, participants were more likely to access the textbook, tradebook, encyclopedia entry, fact sheet, and image in the digital format. In contrast, they were more likely to access the journal in the print as compared to the digital format.

Source selections were further broken down to characterize relations among source type and source medium for students' source selections. For each source type, source selection was separated according to the number of individuals who used only the print version of the source, only the digital version of the source, both the print and digital versions, or neither version. Table 7 provides a complete breakdown of source selection by source type and source medium. Standardized residuals >|1| were examined for indications of the categories that were overrepresented (residuals >1) or underrepresented (residuals < -1).

Table 7

Frequency of Source Selection by Source Type and Medium

	Digital Only	**Print Only**	**Both**	**Neither**
Textbook	14	4^{-}	3^{-}	29^{+}
Tradebook	15^{+}	6	16	13^{-}
Journal Article	4^{-}	16^{+}	8^{-}	22
Newspaper	9	10^{+}	7^{-}	24^{+}
Encyclopedia entry	16^{+}	4^{-}	3^{-}	27^{+}
Fact Sheet	10	3^{-}	37^{+}	0^{-}
Graph	9	8	16	17
Image	13	4^{-}	14	19

Note: N=50; superscripts represent standardized residuals that are >1 (designated by "+") or <-1 (designated by "-").

An omnibus chi-square test of independence indicated that source type and medium were significantly related [$\chi 2$=127.10, *df*=21, *p*<.01], suggesting that selection of source type is not independent of medium. A further examination of the standardized residuals indicated patterns that differed from the values expected given the data for all source types except the graph. For the textbook, participants were unlikely to access this type of source in either medium, and fewer than expected accessed it in print or in both mediums. Similarly, for the newspaper, comparatively few participants accessed this source compared to other source types, and if they did so they were more likely to access it only in print. In contrast, for the fact sheet, all participants accessed it in at least one medium, and more participants than expected accessed it in both mediums. The tradebook was also accessed by most participants and favored in the digital medium. For the encyclopedia entry, participants were more likely to access it digitally or not at all. Comparatively, for the journal article, participants preferred the print format, and were

more likely to access it in this medium and less likely than expected to access it digital or in both formats. Finally, the image was particularly unlikely to be accessed only in print.

Source Use

Source use was calculated in terms of the amount of time participants spent (a) viewing a source and composing in the PowerPoint presentation directly following source viewing (i.e., *compositional source use*), (b) viewing a source in a focused way (i.e., *focused source use*), and (c) the number of times participants switched between sources during the task (i.e., *source switches*). Time was calculated in minutes. The data for participants with incomplete source use data due to video recording errors (N=7) were excluded from this analysis. These data were assumed to be missing at random given that they were due to technical errors with the camera (e.g., freezing of the video resulting in loss of data) that were deemed to be unrelated to participants.

Time was calculated for compositional and focused source use in two ways. First, time was calculated only for individuals who used each source, as designated by having a time greater than zero for compositional source use. These data addressed the question: If participants used a source, what was the average amount of time they spent engaged in compositional and focused source use? Table 8 summarizes time spent on compositional source use and Table 9 summarizes time spent on focused source use for participants who used each source for any time >0 minutes. It is important to note that some of the focused source use times are zero because participants may have used a source in ways that were included in compositional source use but were not included in focused source use (e.g., scanning a source).

Table 8

Time Spent on Compositional Source Use by Source Type and Medium for Participants Using Each Source

	Compositional Source Use					
	Print			**Digital**		
	N	**Range**	**Average (*SD*)**	**N**	**Range**	**Average (*SD*)**
Textbook	7	.15-25.09	8.10 (9.98)	15	.23-11.12	2.79 (3.36)
Book	20	.27-29.90	7.11 (8.36)	27	.15-28.08	4.54 (7.12)
Journal Article	23	.03-2.80	.86 (.79)	9	.13-4.46	1.57 (1.62)
Newspaper	18	.02-9.44	1.70 (2.45)	12	.12-13.60	2.85 (3.93)
Encyclopedia	6	.29-16.90	5.90-5.94	13	.08-9.52	2.54 (2.96)
Fact Sheet	35	.08-46.75	16.51 (10.08)	40	.56-26.97	7.14 (6.13)
Graph	20	.07-2.10	.48 (.51)	21	.05-4.17	1.15 (1.28)
Image	14	.07-2.40	.59 (.78)	23	.13-3.63	1.38 (.39)
Total	36	2.12-61.17	24.45 (12.09)	41	.56-37.92	14.32 (8.88)
Average per source	36	2.12-39.70	8.57 (8.04)	41	.56-18.47	4.38 (3.61)

Note: Only times >0 for compositional source use were included in the calculations; time is reported in minutes.

Table 9

Time Spent on Focused Source Use by Source Type and Medium for Participants Using Each Source

	Focused Source Use					
	Print			**Digital**		
	N	**Range**	**Average (*SD*)**	**N**	**Range**	**Average (*SD*)**
Textbook	7	0-8.39	3.34 (3.22)	15	0-5.23	1.27 (1.55)
Book	20	.22-20.33	4.62 (5.35)	27	0-15.77	2.52 (3.90)
Journal Article	23	0-2.40	.66 (.70)	9	0-3.46	.84 (1.07)
Newspaper	18	0-5.57	.94 (1.39)	12	.06-8.85	1.57 (2.47)
Encyclopedia	6	.12-5.98	2.70 (2.31)	13	0-3.60	1.16 (1.24)
Fact Sheet	35	0-24.47	9.42 (6.08)	40	.56-13.03	3.52 (2.72)
Graph	20	.05-1.33	.38 (.38)	21	.05-1.58	.38 (.36)
Image	14	.05-.81	.25 (.27)	23	.05-1.82	.41 (.39)
Total	36	1.22-38.98	14.02 (7.67)	41	.56-18.93	6.99 (4.50)
Average per source	36	1.22-24.47	4.95 (4.86)	41	.41-8.35	2.15 (1.79)

Note: Only times >0 were included in the calculations; time is reported in minutes.

For the sources selected, the average time participants spent on compositional source use was 24.45 (*SD*=12.09) minutes for print sources and 14.32 (*SD*=8.88) minutes for digital sources. In terms of focused source use for the sources participants selected, they spent an average of 14.02 (*SD*=7.67) minutes using print sources and 6.99 (*SD*=4.50) minutes using digital sources.

Second, time was calculated across all participants, including times equal to 0 (see Table 10). For example, print compositional source use was calculated as:

$$\frac{\sum Print\ Compositional\ Source\ Use}{Total\ Number\ of\ Print\ Sources\ Selected}$$

Per source time could only be calculated for individuals who used at least one source in the medium under consideration. This was because when calculating print sources, participants who did not use any print sources had a value of zero as the denominator. Therefore, print and digital per source use is reported only for participants who selected at least one source in each of the respective mediums.

Including zero values, the time participants spent on compositional source use averaged 20.47 (*SD*=14.33) minutes for print sources and 13.66 (*SD*=9.19) minutes for digital sources. The 36 participants who used at least one print source spent an average of 8.57 (*SD*=8.04) minutes on per print source compositional source use. In comparison, the 41 participants who used at least one digital source spent an average of 4.38 (*SD*=3.61) minutes on per digital source compositional source use. For focused source use including zero times, participants spent an average of 11.74 (*SD*=8.74) minutes using print sources and 6.66 (*SD*=4.63) minutes using digital sources. The 36 participants who used at least one print source spent an average of 4.95 (*SD*=4.86) minutes on per print

source focused source use. In comparison, the 41 participants who used at least one digital source spent an average of 2.15 minutes (*SD*=1.79) on per source digital focused source use.

Table 10

Time Spent on Source Use by Source Type and Medium Including Zero Values

	Compositional Source Use		**Focused Source Use**	
	Print	**Digital**	**Print**	**Digital**
Textbook	1.32 (4.84)	.97 (2.36)	.54 (1.74)	.44 (1.09)
Book	3.31 (6.67)	2.85 (6.02)	2.15 (4.29)	1.58 (3.31)
Journal Article	.46 (.72)	.33 (.96)	.35 (.61)	.18 (.58)
Newspaper	.71 (1.77)	.79 (2.39)	.39 (1.00)	.44 (1.45)
Encyclopedia	.82 (2.91)	.77 (1.97)	.38 (1.24)	.35 (.85)
Fact Sheet	13.43 (11.16)	6.65 (6.19)	7.67 (6.61)	3.28 (2.77)
Graph	.22 (.42)	.56 (1.06)	.18 (.32)	.18 (.31)
Image	.19 (.52)	.74 (.98)	.08 (.19)	.22 (.35)
Total	20.47 (14.33)	13.66 (9.19)	11.74 (8.74)	6.66 (4.63)

Note: N=43; time presented in minutes; all times, including times of 0, were included in the calculations.

A 2 (source medium) by 8 (source type) within subjects ANOVA was conducted based on all values, including zero values. For compositional source use, there were significant main effects for source medium [$F(1, 42)=5.37$, $p=.025$, $\varepsilon^2=.11$] and source type [$F(7, 36)=29.19$, $p<.001$, $\varepsilon^2=.85$]. Follow up *t*-tests were conducted to examine differences across medium for each source type. Holm's (1979) method to correct for increased experiment-wise error resulting from multiple tests was applied. Holm's method uses a sequential Bonferroni procedure in which the calculated *p*-values are ordered from smallest to largest and are sequentially compared to newly calculated critical values. This procedure has been determined to be more powerful than the standard Bonferroni procedure and more appropriate when there are more than five tests

(Bender & Lange, 2001). Specifically, the new critical values are calculated as $\frac{\propto}{n-i-1}$, where *n* is the number of tests and *i* is the order of the *p*-value from lowest (*i*=1) to highest ($i=i_n$). For instance, given the eight comparisons, the cut-off value for alpha for the first *p*-value was .05/8, or .0063 and the second was .05/7 or .0071. For compositional source use, participants spent significantly longer using the print as compared to the digital fact sheet, $t(42)=-3.61$, $p=.001$, but significantly longer using the digital as compared to the print image, $t(42)=3.42$, $p=.001$. For focused source use, there were significant main effects for source medium [$F(1, 42)=9.29$, $p=.004$, $\varepsilon^2=.18$] and source type [$F(7, 294)=57.99$, $p<.001$, $\varepsilon^2=.82$]. Follow up tests accounting for Holm's sequential Bonferroni correction found that participants spent significantly longer using the print as compared to the digital fact sheet, $t(42)=-3.00$, $p=.005$.

Additionally, in order to examine relations among print and digital source use, bivariate correlations were calculated among total source use and per source use for print and digital sources. The results for compositional source use are presented in Table 11 and the results for focused source use are presented in Table 12. Total compositional source use values were calculated based on the 43 participants with complete data. Per source calculations were based on 34 participants who used at least one of each print and digital sources.

Time spent engaged in CSU for print and digital sources was inversely related. Digital CSU was negatively correlated with print CSU ($r=-.31$, $p=.04$) and per source print CSU ($r=-.39$, $p=.02$). These results suggest that participants who engaged in more compositional source use with digital sources spent less time using print sources. Next, bivariate correlations for focused source use were calculated. These are presented in

Table 12. Results for focused source use were similar to compositional source use. Specifically, digital FSU was negatively related to print per source FSU (r=-.34, p=.004), indicating that individuals who engaged in longer focused source use with digital sources spent less time in focused use per source with print sources.

Table 11

Bivariate Correlations Between Compositional Source Use Indicators

	1	2	3
1. Print CSU Total	1		
2. Print Per source CSU	.55***	1	
3. Digital CSU Total	-.31*	-.39*	1
4. Digital per source CSU	-.29	-.06	.54***

Note: N=34 for per source categories and N=43 for all other; *p≤.05; **p≤.01; ***p≤.001; CSU=Compositional Source Use.

Table 12

Bivariate Correlations Between Focused Source Use Indicators

	1	2	3
1. Print FSU Total	1		
2. Print Per source FSU	.56***	1	
3. Digital FSU Total	-.26	-.34*	1
4. Digital per source FSU	-.29	.009	.59***

Note: N=34 for per source categories and N=43 for all other; *p≤.05; **p≤.01; ***p≤.001; FSU=Focused Source Use.

Relations Between Source Selection and Use

To gain a more holistic understanding of how students engaged in the multiple source use task, relations between source selection and use were examined. Of interest as an indicator related to both source selection and use was the number of times participants switched between sources. While completing the task participants switched between sources an average of 17.32 times (SD=14.60) ranging from 1 to 75 switches. Given that

the number of switches might be contingent upon the number of sources selected, a proportional value was calculated by dividing the number of switches by the total number of sources selected. The average number of switches per source was 2.43 (*SD*=1.34). Proportional source switches were determined to be more informative than total switches for examining relations among source selections and use because it was not contingent upon the number of sources selected.

Bivariate correlations among source selection, source switches, compositional source use, and focused source use were calculated for print sources (Table 13) and digital sources (Table 14). Students who selected more sources tended to spend more time total engaged in using those sources, but spent less time working with each source individually. Specifically, for print and digital sources, the total number of sources selected within the medium was positively related to total CSU (print: r=.51, p<.001; digital: r=.43, p<.001) and total FSU (print: r=.45, p=.002; digital: r=.38, p=.01), indicating that participants who selected more sources were more likely to spend more time working with sources. In contrast, there was a negative relation between time spent per source on CSU (print: r=-.53, p<.001; digital: r=-.38, p=.02) and FSU (print: r=-.51, p<.001; digital: r=-.38, p=.02), indicating that individuals who used more sources spent less time on average per source.

The proportion of source switches was not significantly related to either the number sources selected for print (r=.12, p=.42) or digital sources (r=.22, p=.16). However, the proportion of source switches was significantly related to indicators of total source use. Specifically, for print sources, total compositional and focused source use were positively related to the proportion of source switches (compositional: r=.35, p=.02;

focused: r=.42, p=.02). For digital sources, total focused source use was positively related to the proportion of source switches (r=.34, p=.03). This suggested that individuals engaged in source use for a longer time spent more time moving back and forth between sources.

Table 13

Bivariate Correlations Between Indicators of Print Source Selections and Use

	1	2	3	4	5
1. Total Print Selected	1				
2. Proportion Source Switches	.12	1			
3. Print CSU Total	.51***	.35*	1		
4. Print Per source CSU	-.53**	.14	.55***	1	
5. Print FSU Total	.45**	.42**	.95***	.52***	1
6. Print Per source FSU	-.52***	.19	.53***	.99***	.56***

Note: N=50 for source selection; N=44 for source switches; N=43 for total use; N=36 for per source use; *p≤.05; **p≤.01; ***p≤.001; CSU=Compositional Source Use; FSU=Focused Source Use.

Table 14

Bivariate Correlations Between Indicators of Digital Source Selections and Use

	1	2	3	4	5
1. Total Digital Sources Selected	1				
2. Proportion Source Switches	.22	1			
3. Digital CSU Total	.43**	.27	1		
4. Per source Digital CSU	-.38*	-.14	.54**	1	
5. Digital FSU Total	.38**	.34*	.94**	.51**	1
6. Per source Digital FSU	-.38*	-.14	.51**	.95**	.59**

Note: N=50 for source selection; N=44 for source switches; N=43 for total use; N=41 for per source use; *p≤.05; **p≤.01; ***p≤.001; CSU=Compositional Source Use; FSU=Focused Source Use.

Research Question 2

How are students' source selections and use related to their performance on an academic task?

To address the second research question, students' PowerPoint presentations and verbal explanations were scored in terms of surface-level and deep-level indicators of performance. Then, the relations among performance indicators were calculated. Next, the relations between indicators of task performance and indicators of source selection and use as described in the results for research question 1 were calculated. Finally, task performance was compared across digital and print source use, and the inclusion of digital and print sources in the presentation.

Overview of Task Performance

Surface-level indicators included: the number of words in the PowerPoint and explanation; whether images were included; and the amount of borrowed and added information. The number of words in the explanation was calculated as the difference between the total number of words in the explanation and the number of words in the PowerPoint. Deep-level indicators included how many references or citations were included, source integration (i.e., number of sources incorporated in the PowerPoint and the number of switches between sources), and the amount of transformed information. Average scores on each of the performance indicators are summarized in Table 15.

Table 15

Summary of Performance Indicators

	Type of Indicator	**N**	**Range**	**Mean(*SD*)**
PowerPoint Word Count	Surface	50	67-632	222.98 (105.88)
Explanation Word Count	Surface	50	206-1407	522.88 (255.93)
References	Deep	50	0-9	1.00 (1.75)
Images	Surface	50	0-9	1.04 (1.55)
Transformed Information	Deep	48	0-15	4.79 (3.70)
Borrowed Information	Surface	48	6-46	20.83 (7.81)
Added Information	Surface	48	0-15	3.63 (4.07)
Number of Sources Incorporated	Deep	48	0-9	3.68 (2.01)
Number of Source Switches	Deep	48	0-17	5.85 (3.85)

Data were available for all 50 participants for the PowerPoint word count, explanation word count, and the number of references and images. Due to technical difficulties with the video camera, the information in presentations for two individuals could not be classified according to the degree to which information was transformed, borrowed, or added, or the number of sources and source switches in their presentations. The average proportion of borrowed information was .73 (*SD*=.18). Added information (*M*=.12, *SD*=.12) and transformed information (*M*=.16, *SD*=.11) made up relatively small proportions of the presentation.

First, bivariate correlations were calculated to examine the relations between surface-level indicators (see Table 16) and deep-level indicators (see Table 17). For surface indicators, there was a significant positive relation between the number of words in the explanation and the amount of borrowed information (r=.29, p=.04) and added information (r=.70, p<.001). The amount of borrowed information was also related to the number of words in the PowerPoint (r=.36, p=.01). For deep indicators, the number of

source switches was positively related to the number of sources incorporated (r=.84, p<.001) and the amount of transformed information (r=.44, p=.002).

Table 16

Bivariate Correlations Between Surface-Level Indicators

	1	2	3	4	5
1. PowerPoint Word Count	1				
2. Explanation Word Count	-.19	1			
3. Images	-.12	.12	1		
4. Borrowed Information	.36**	.29*	-.10	1	
5. Added Information	-.20	.70***	.05	-.14	1

Note: N=50 for word counts and images; N=48 for borrowed and added information; correlations between images and other indicators were calculated as point biserial correlations; all other correlations were calculated as Pearson product moment correlations; *p≤.05; **p≤.01; ***p≤.001.

Table 17

Bivariate Correlations Between Deep-Level Indicators

	1	2	3	4
1. References	1			
2. Transformed Information	-.18	1		
3. Number of Sources Incorporated	.24	.26	1	
4. Source Switches	.11	.44**	.84***	1

Note: N=50 for references; N=48 for other indicators; *p≤.05; **p≤.01; ***p≤.001.

Further, the theoretical model predicted that surface and deep indicators of performance would be related. First, a canonical correlation was calculated in order to determine whether the set of surface indicators was significantly related to the set of deep indicators. For the set of five surface and four deep indicators, four sets of canonical variates were estimated; however, only the first pair was significant (Wilk's lambda=.39, p=.005), which explained 76.63% of the variance of the relation between the sets of indicators. The canonical correlation for this pair of variates was R_C=.70, with an effect

size of R_C^2=.49, suggesting that there was a moderately strong relation between the sets of surface and deep indicators.

Additionally, follow-up correlations between surface- and deep-level performance indicators were calculated to explicate the individual relations (see Table 18). Holms' (1979) method was used to adjust for increased experiment-wise error. Given that there were five correlations for each deep indicator, the adjusted cut-off values for the lowest to highest p-values were .01, .013, .017, .025, and .05.

Table 18

Bivariate Correlations Between Surface-Level and Deep-Level Performance Indicators

	Surface Indicators				
Deep Indicators	**PowerPoint Word Count**	**Explanation Word Count**	**Images**	**Borrowed Information**	**Added Information**
References	.23	-.07	.16	-.02	-.16
Transformed Information	.08	.58***	.11	-.10	.53***
Number of Sources	.04	.10	.58***	-.02	.04
Number Source Switches	.04	.18	.50***	.01	.08

Note: N=48; correlations between images and other indicators were calculated as point biserial correlations; all other correlations were calculated as Pearson product moment correlations; ***$p \leq .001$.

The number of words in participants' explanations was positively correlated with the amount of transformed information in the presentation (r=.58, p<.001). The inclusion of images was positively correlated with the number of sources incorporated (r=.58, p<.001) and the number of times participants switched between sources in their presentation (r=.50, p<.001). There was also a positive relation between the amount of

added information and the amount of transformed information (r=.53, p<.001). Borrowed information was not significantly related to any of the deep-level indicators.

Task Performance in Relation to Multiple Source Use

Bivariate correlations were calculated to examine the degree to which performance indicators were related to source selection and use (surface: see Table 19; deep: see Table 20). For surface indicators, students who spent more time engaging with print sources included significantly more words in their PowerPoint presentations and included more borrowed information. Specifically, PowerPoint word count was positively related to total print CSU (r=.54, p<.001), total print FSU (r=.44, p=.003), per source print CSU (r=.50, p=.002), and per source print FSU (r=.48, p=.003). The amount of borrowed information was significantly positively related to total time spent on print FSU (r=.31, p=.04), but not with total digital FSU (r=-.09, p=.59).

Source selection and use was also related to the inclusion of an image. Whether participants included at least one image was positively related to the number of print sources selected (r=.38, p=.006) and the number of digital sources selected (r=.68, p<.001). However, including an image was negatively related to per source print CSU (r=-.39, p=.02) and digital per source CSU (r=-.34, p=.03). The number of sources selected was related to each of the deep-level performance indicators in at least one source medium. The number of references was positively related to the number of print (r=.83, p<.001) and digital sources (r=.83, p<.001). Similarly, the number of source switches was positively related to the total number of print sources selected (r=.50, p<.001) and digital sources selected (r=.62, p<.001). Additionally, the number of sources used was positively related to total source selection (r=.59, p<.001) and print source

selection (r=.75, p<.001). The amount of transformed information was also positively related to the number of print sources selected (r=.31, p=.03).

In terms of compositional and focused source use, students who spent more time engaged with print sources and less time with digital sources used a greater number of sources in the creation of their presentation. The number of sources used in the presentation was significantly positively related to the total time spent on print CSU (r=.63, p<.001) and print FSU (r=.59, p<.001), but was negatively related to the time spent per digital source (r=-.33, p=.04). However, switching between sources exhibited an opposite pattern. The number of source switches was positively related to the total time spent on digital CSU (r=.35, p=.02). The number of source switches was negatively related to per source print CSU (r=-.48, p=.003), per source print FSU (r=-.46, p=.005), and per source digital FSU (r=-.33, p=.04).

Source Use and Task Performance Across Mediums

The number of sources incorporated in the presentation, borrowed information, and transformed information were separated according to whether they originated from print or digital sources. For the purpose of this comparison, the transformations only included within source transformations that could be attributed to a specific source and did include across source transformations. Transformations across multiple sources were not included. These performance indicators were compared across mediums using paired samples t-tests (see Table 21). Although there were no differences in the overall selection of print and digital sources (see research question 1), students tended to use more digital sources in composing their PowerPoint presentations [t(47)=-3.30, p=.002].

However, transformed information was more likely to come from print sources than digital sources ($t(47)=2.38$, $p=.02$).

Next, the degree to which students incorporated the sources they selected to view was examined across print and digital sources for each source type (see Table 22 and Figure 6). This addressed the question of: To what degree were the print and digital sources that students viewed incorporated into their presentations? Although students more frequently selected the digital versions of the textbook and the tradebook, a greater proportion incorporated print versions of these sources into their presentations (textbook: $z=3.52$, $p<.001$; tradebook: $z=1.96$, $p=.05$). Compared to the print versions, a larger proportion of students who viewed the digital sources incorporated them into their presentations for the journal article ($z=-2.30$, $p=.02$), graph ($z=-4.08$, $p<.001$), and image ($z=-6.17$, $p<.001$). For the graph and the image, only a few (n=3) students incorporated the printed versions into their presentations.

Table 19

Bivariate Correlations for Surface-Level Indicators and Source Selections and Use

	N	PowerPoint Word Count	Explanation Word Count	Images	Borrowed Information	Added Information
Sources Selected						
Print	50	.20	.20	.38**	.12	.10
Digital	50	-.13	.17	.68***	-.09	.10
Compositional Source Use						
Print Total	43	.54***	.17	.01	.34*	.07
Digital Total	43	-.005	-.27	.21	-.13	-.11
Print per Source	36	.50**	-.04	-.39*	.26	-.06
Digital per Source	41	-.01	-.24	-.34*	.10	-.16
Focused Source Use						
Print Total	43	.44**	.13	.04	.31*	.04
Digital Total	43	<.001	-.26	.27	-.09	-.15
Print per Source	36	.48**	-.06	-.28	.24	-.08
Digital per Source	41	-.006	-.25	-.15	.11	-.18

Note: Correlations between images and other indicators were calculated as point biserial correlations; all other correlations were calculated as Pearson product moment correlations; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Table 20

Bivariate Correlations for Deep-Level Indicators and Source Selections and Use

	N	References	Transformed Information	Number of Sources Used	Number of Source Switches
Sources Selected					
Print	50	.83***	.31*	.75***	.50***
Digital	50	.83***	.14	.22	.62***
Compositional Source Use					
Print Total	43	.04	.27	.63***	.11
Digital Total	43	-.004	-.03	-.07	.35*
Print per Source	36	-.25	-.06	-.21	-.48**
Digital per Source	41	-.07	-.22	-.27	-.28
Focused Source Use					
Print Total	43	.01	.26	.59***	.15
Digital Total	43	-.09	-.07	-.11	.29
Print per Source	36	-.24	-.05	-.21	-.46**
Digital per Source	41	-.16	-.24	-.33*	-.33*

Note: *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Table 21

Comparison of the Origin of Performance Indicators across Print and Digital Sources

	Print Average	**Digital Average**	***t***	***p***	**Favored Medium**
Sources Incorporated	1.52 (*SD*=1.07)	2.31 (*SD*=1.43)	-3.30	.002	Digital
Borrowed Information	12.25 (*SD*=10.03)	8.31 (*SD*=7.00)	1.77	.08	--
Transformed Information	2.44 (*SD*=3.05)	1.33 (*SD*=1.34)	2.38	.02	Print

Note: N=48.

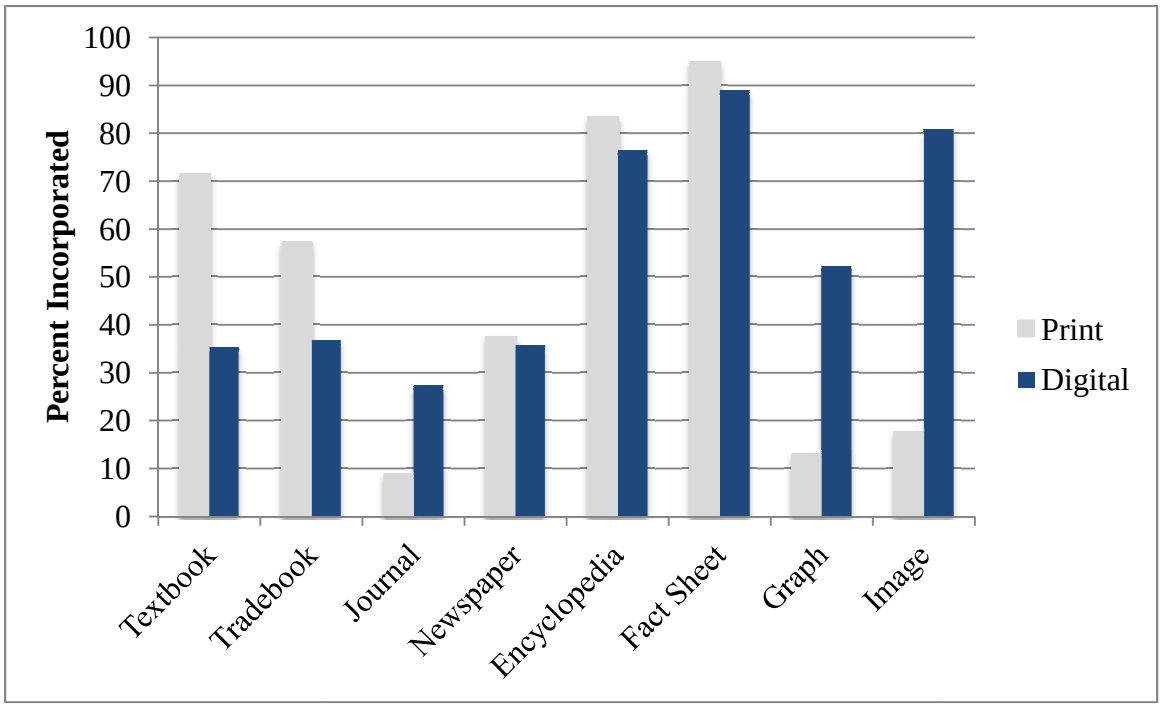
Table 22

Frequency and Proportion of Sources Incorporated in the Presentation Compared to Sources Selected

	Print			**Digital**			**Comparison of Proportion Incorporated**		
	Frequency Selected	**Frequency Incorporated**	**Proportion Incorporated**	**Frequency Selected**	**Frequency Incorporated**	**Proportion Incorporated**	***z***	***p***	**Favored Medium**
Textbook	7	5	0.71	17	6	0.35	3.52	<.001	Print
Tradebook	21	12	0.57	30	11	0.37	1.96	.05	Print
Journal Article	23	2	0.09	11	3	0.27	-2.30	.02	Digital
Newspaper	16	6	0.38	14	5	0.36	.20	.84	--
Encyclopedia	6	5	0.83	17	13	0.76	.85	.40	--
Fact Sheet	38	36	0.95	45	40	0.89	1.08	.28	--
Graph	23	3	0.13	23	12	0.52	-4.08	<.001	Digital
Image	17	3	0.18	26	21	0.81	-6.17	<.001	Digital

Note: N=48. Based only on participants with data for source incorporation.

Figure 6. Percentage of print and digital sources selected by participants that were incorporated into the presentation.



CHAPTER 5

RESULTS: INDIVIDUAL DIFFERENCE VARIABLES AND MULTIPLE SOURCE USE

This chapter addresses the degree to which individual differences in motivational and cognitive variables interplay in multiple source use processes and performance, as implicated in models of multiple source use (Perfetti et al, 1999; Rouet, 2006). Specifically, the individual differences investigated were interest, curiosity, and knowledge. First, this chapter summarizes the degree to which interest and curiosity were expressed a priori, as individual difference variables, and as post-hoc expressions related to the multiple source use task. In doing so, relations among interest and curiosity were examined. Topic knowledge was also included to examine its relation to a priori and post-hoc expressions of interest and curiosity. To this end, the following research questions were addressed:

3. What are the relations among students' topic interest, trait curiosity, and topic knowledge?
4. How are students' topic interest, trait curiosity, and topic knowledge related to their post-hoc expressions of interest and curiosity?

The second goal of this chapter is to examine the degree to which interest and curiosity were enacted during multiple source use. That is, to what degree were interest, curiosity, and knowledge related to source selection, source use, and task performance in the context of a multiple source use task? To this end, research questions 5 and 6 were addressed:

5. To what extent are students' source selections and use related to their topic interest, trait curiosity, topic knowledge, and their post-hoc expressions of interest and curiosity?
6. How are students' topic interest, trait curiosity, topic knowledge, and their post-hoc expressions of interest and curiosity related to their performance on an academic task?

To address these questions, descriptive data for a priori topic interest, trait curiosity, and topic knowledge are summarized. Bivariate correlations were calculated to examine the extent to which these individual difference variables were related (research question 3). Then, the post-hoc expressions of interest/curiosity identified in the interview data are presented. Post-hoc expressions of interest/curiosity are presented descriptively by theme, including the frequency of expressions and their interrelations. The frequency of post-hoc expressions of interest/curiosity was then correlated with topic knowledge, topic interest, and trait curiosity (research question 4). Next, multiple linear regression analyses were used to examine the degree to which topic knowledge, topic interest, and trait curiosity predicted multiple source selection and use (research question 5) and task performance (research question 6).

Research Question 3

What are the relations among students' topic interest, trait curiosity, and topic knowledge?

This research question was addressed by examining the correlation coefficients between each of the variables for the 50 participants in the main portion of the study. Prior to analyzing the relations among the variables, descriptive statistics for the

individual difference measures (i.e., topic interest, I-type curiosity, D-type curiosity, and topic knowledge) were calculated (see Table 23). Scores on the individual difference measures supported findings from the pilot studies that students in the sample exhibited a wide range of interest and knowledge about Alzheimer's disease, and had variance in trait curiosity. To address the research question, bivariate correlations were calculated between the variables (see Table 24).

Table 23

Summary of Individual Difference Measures

	Possible Score	**Range**	**Mean (*SD*)**
Topic knowledge	0-20	3-18	12.36 (3.70)
Topic interest	0-1000	29-1000	480.80 (223.25)
I-type trait curiosity	5-25	13-25	18.58 (3.07)
D-type trait curiosity	5-25	7-25	16.16 (3.34)

Note: Topic knowledge was calculated using graduated response scoring.

Table 24

Bivariate Correlations Between Individual Difference Variables

	1	2	3
1. Topic Interest	1		
2. I-type Curiosity	.27*	1	
3. D-type Curiosity	.27	.45***	1
4. Topic Knowledge	.23	.001	.04

Note: *p≤.05; ***p≤.001

Consistent with previous literature (Litman, 2010; Litman et al., 2005; Litman & Silvia, 2006), a significant positive relation was identified between I-type curiosity and D-type curiosity (r=.45, p<.001). The strength of this relation is similar to previous research, which has identified correlations in student samples ranging from .48 (Litman, 2010) to .70 (Litman et al., 2005). Consistent with expectations, topic knowledge was

not significantly associated with either type of curiosity. However, despite findings in the literature supporting positive relations among topic knowledge and topic interest (Alexander et al., 1995; Garner & Gillingham, 1991), no significant relation was identified in the present study. In contrast to prior literature that provided no theoretical justifications for a relation between topic interest and curiosity, a significant positive relation was identified between topic interest and I-type curiosity (r=.27, p=.05). D-type curiosity had a similar relation to topic interest (r=.27, p=.06), although due to rounding this was not significant at $\alpha \leq .05$.

Research Question 4

How are students' topic interest, trait curiosity, and topic knowledge related to their post-hoc expressions of interest and curiosity?

Prior to analyzing the correlations between individual difference variables and post-hoc expressions of interest/curiosity, descriptive analyses of the post-hoc expressions are summarized. One participant was missing a complete interview due to time constraints. Therefore, the data for post-hoc expressions of interest/curiosity were based on 49 participants with complete interviews. The average number of post-hoc expressions were 2.28 (SD=2.38), and 40 participants (81.60%) had at least one expression of interest/curiosity. As described in Chapter 3 and Appendix J, post-hoc expressions of interest/curiosity were divided into categories based on the focus of the interest/curiosity. Three overarching themes emerged: interest/curiosity (a) in the content, (b) in the source features, and (c) for the audience of the presentation. The means and proportion for each of the three categories of interest/curiosity expressions is presented as Table 25.

Table 25

Summary of Post-Hoc Expressions of Interest/Curiosity

	Average	**Range**	**Percent with at least one expression**
Content	1.59 (*SD*=1.66)	0-7	75.51
Source Features	.22 (*SD*=.59)	0-3	16.33
Audience	.41 (*SD*=.76)	0-4	30.61
Overall	2.28 (*SD*=2.38)	0-12	81.60

Note: N=49.

Interest/Curiosity for Content

During the retrospective interviews 75.51% of participants (N=37) mentioned at least one instance of interest/curiosity in the content. For example, when asked why she chose to look at the digital graph [*Public's perception of Common Symptoms of Alzheimer's Disease*], Participant 2 said, "I just wanted to see how the public views it; views the whole idea of Alzheimer's." She demonstrated interest/curiosity for the content presented within the source. Interest or curiosity in the content did not necessarily manifest in the likelihood that participants would incorporate the source into their presentation. For instance, Participant 31 noted that "it was kind of interesting that they were trying to use visual or retina whatever to help predict [Alzheimer's], but I didn't think I really needed to include it in my article because it's not official yet." Similarly, when asked about reasons for selecting the digital graph, Participant 7 noted, "I thought it was interesting. It didn't have anything to do with my presentation necessarily but it was just interesting to look at."

Other participants described interest or curiosity related to more specific details of the content. This manifested either in terms of finding content that sparked interest or curiosity, or in terms of identifying something that one was interested in or curious to

know and then seeking content to address that interest/curiosity. Speaking about what she noticed in the content, Participant 8 said, "I thought it was interesting that [the printed graph] looked at the instances of which sex has Alzheimer's and thought it was interesting how it was mostly females, because in the beginning I thought it would be males for some reason." In this, she notes that her interest arose from a discrepancy between her prior expectations and the presented content. Similarly, when explaining her rationale for including content related to diagnosing Alzheimer's in her presentation, Participant 16 said:

> I thought it was interesting that it can't be definitively diagnosed until an autopsy, but the fact there are possible measures they use now to kind of diagnose it as much as they can I thought was interesting and important because, I mean, it's strange they have no way of knowing until you're dead but the fact they can figure out close enough, like, oh yeah, this is probably Alzheimer's.

Other participants reported identifying something of interest/curiosity and then seeking information about that content. Alternatively, some participants reported finding a source interesting/curious because it included information related to an initial interest/curiosity. For example, Participant 9 reported including information about treatment in his presentation because he "thought it would be interesting how doctors diagnose the disease and prescribe medications for the disease." Participant 34 reported that the printed book was interesting because of its relation to her prior interests. She noted that "it had more causes I was interested in, like gender."

The titles of sources also provided information related to content that some participants reported as a source of their interest or curiosity. Participant 15 noted several instances where titles were important. When selecting the printed article [*Alzheimer's Breakthrough Hailed as a 'Turning Point'*], she noted that the "headline caught my eye."

Similarly, regarding the digital journal [*Study Neuron Networks to Tackle Alzheimer's*], she stated that she accessed this source because "the title was interesting." She further explained that the interest in the title was because "I already mentioned neurons…I thought it would shed more light." Here, she described its relation to information she had already included in her presentation. For others, the title generated a question about the content that they sought to answer using the source. Participant 20, when describing why she looked at the digital graph, *The Public's Perception of Common Symptoms*, said, "this was just kind of more curiosity, I was kind of wondering what people did think of the common symptoms."

Additionally, some participants noted an interest or curiosity to uncover hidden content. Rather than expressing a specific interest in learning about the content, they reported a desire to look at or open something because they wanted to know what was there. When asked why she selected to look at the printed picture, Participant 7 indicated: "I couldn't see what it was so I picked it up to see what it was." Similar sentiments were reported for digital content, such as Participant 13 who noted that she looked at the digital graph because she "just wanted to see what the graph was." Other participants reported similar desires to pick up the printed graph or image in order to see what was printed on them. When justifying her reasons for picking up the printed image, Participant 10 said, "I was just kind of curious to see what it was." Upon identifying the content, her curiosity continued. She noted, "and then I looked at it and it reminded me of my anatomy class with all the neurons and everything so I was just curious." For Participant 10, what was originally a desire to observe the unknown became curiosity for the content contained within the source. For other participants, this general interest or

curiosity to know what was contained in each source served as the rationale for selecting more sources, and for selecting a large number of sources. For instance, Participant 35 said, “I guess I was curious to see what each one had to offer.”

Interest/Curiosity for Source Features

Compared to 75.51% of participants who expressed interest/curiosity in the content, only 16.33% of participants (N=8) described interest/curiosity related to the features of a given source. Typically, this interest or curiosity led participants to select the source because it caught their attention. For instance, Participant 18 noted that “the picture kind of drew me to that, and I was just going to see what was inside.” Although the participant later acknowledged that she did not use the information in the source in her presentation, she selected the source based on a triggered interest or curiosity. Participant 19 expressed a similar response, stating about the print fact sheet that, “it just caught my eye initially because it’s a fact sheet.”

Interest/Curiosity of the Audience

Finally, 30.61% of participants (N=15) noted that they made decisions about the sources they selected or the content of their presentation because they thought it would increase the level of interest or curiosity for the audience of their presentation. There were two main ways that participants reflected on creating their presentation to spark interest or curiosity for the audience. The first was the general types of information (e.g., statistics, visuals) presented. For example, Participant 15 explained her use of an image in the PowerPoint. She said that she included it “on the first slide, kind of like bang, here it is kind of thing, and hopefully it would spark curiosity about what it is.” Additionally, for Participant 25, including images was noted as important for making the presentation

interesting. He noted that he included images "to make it interesting." He further elaborated: "if you have a slide completely, only of words, at some point it's going to look boring, no matter how interesting the topic is, so…I threw in pictures to balance it out, the information, and make it a little bit fun." In contrast to Participant 15 who included a picture of the brain to stimulate curiosity for the topic, Participant 25 was focused on including pictures more generally as a way of increasing general interest. Similarly, when Participant 9 explained why she included what she did in the presentation, she noted that she included "something to keep their interest, just like a statistics slide, like facts and interesting stuff."

The second way participants referred to increasing audience interest or curiosity was through deciding to focus on specific content. For example, when Participant 1 was asked why he chose the digital news article [*Can We Predict Alzheimer's a Decade Before Symptoms?*], he explained that "people are really interested in knowing how it affects them." Similarly, Participant 21 said, "I really wanted [to talk about] what Alzheimer's was, because I think it's big to start out with that because a lot of people could be wondering what it really is." This suggested that the participants were taking the interest and curiosity of their audience into account when deciding what material to include in their presentations.

Relations Between A Priori and Post-Hoc Expressions

Correlations were inspected for general patterns between individual difference variables and overall expressions of interest/curiosity. There were no significant relations between interest/curiosity expressions and topic knowledge (r=-.02, p=.89), topic interest (r=.24, p=.10), I-type curiosity (r=.20, p=.16), or D-type curiosity (r=.14, p=.34).

Research Question 5

To what extent are students' source selections and use related to their topic interest, trait curiosity, topic knowledge, and their post-hoc expressions of interest/curiosity?

The fifth research question was examined in two parts. First, the relation among individual difference variables (i.e., knowledge, interest, curiosity) and source selection and use was addressed through correlation and multiple regression analyses. Second, the relation between post-hoc expressions of interest/curiosity and indicators of source selection and use was addressed through correlation analyses.

Individual Difference Variables and Multiple Source Selection and Use

To address the first part of the question, a series of bivariate correlation and multiple regression analyses were conducted. Specifically topic knowledge, topic interest, I-type trait curiosity, and D-type trait curiosity scores were correlated with indicators of source selection and use. Source selection and use indictors were calculated for total selection and use as well as separately for print and digital sources. Then, topic knowledge, topic interest, I-type curiosity, D-type curiosity, and a knowledge-interest interaction were analyzed as predictors for each of the indicators of source selection and use through multiple regression analyses.

For all regression analyses, simultaneous multiple regression was determined to be the preferred analysis for several reasons. First, given that research on multiple source use suggests that cognitive and motivational variables influence the source use process (Rouet, 2006; Wineburg, 1991), multiple regression was desired for its potential to use a set of predictor variables to explain an outcome. Second, multiple regression is a flexible framework that addresses the independent and collective effects of more than one

predictive factor in explaining an outcome (Cohen, Cohen, Aiken, & West, 2003). For understanding the role of individual differences in multiple source use within the framework of MD-TRACE model (Rouet, 2006), the relative impact of cognitive and motivational variables was of particular interest. Additionally, given the paucity of research that includes studies of both interest and curiosity (Grossnickle, 2014), the degree to which interest and curiosity serve as independent predictors for source selection and use was of importance, and could be addressed through multiple regression.

Simultaneous multiple regression was chosen over other types of regression because there was no theoretical rationale for dividing the individual difference variables into separate sets (Cohen et al., 2003). Theoretical models of multiple source use (Perfetti et al., 1999; Rouet, 2006) forward that cognitive and motivational variables play a role in source selection and use. However, these theories do not prioritize certain individual differences over others (Rouet, 2006). In fact, research on academic development suggests that there is a complex relation between cognitive and motivational variables, and that they should be considered in conjunction (Alexander, 2003; Linnenbrink-Garcia et al., 2012). This complex relation was further enabled within multiple regression through the inclusion of interaction terms. Specifically, given evidence of the complex relation between knowledge and interest (Alexander & Murphy, 2002; Hidi & Renninger, 2006; Toboada et al., 2009), an interaction term for knowledge and interest was added to the model.

Prior to conducting regression analyses, data were examined for evidence of multicolinearity and to ensure that the assumptions for multiple linear regression were met. First, multicolinearity was assessed via bivariate correlations among the predictor

variables (Cohen et al., 2003). As noted in the analysis for research question 2, there was a significant correlation between I-type and D-type curiosity (*r*=.45) and between I-type curiosity and topic interest (*r*=.27). To determine whether this presented an issue for multicolinearity, tolerance ($1\text{-}R_k^2$) was examined for values less than .10 (Cohen et al., 2003). For all regression analyses, tolerance for each of the predictor variables remained greater than .10, indicating that multicolinearity was not an issue and that all of the individual difference variables could be included as predictors in the model.

When considering deviations to the required assumptions, namely normality, linearity, and homogeneity of variance, it was important to carefully weigh evidence prior to making adjustments within the data such as deleting outliers or transforming the data (Cohen et al., 2003). To examine normality of the residuals, Q-Q plots of the standardized residuals were examined for the presence of linearity. For all of the variables except for topic knowledge, the Q-Q plots provided strong evidence of normality. Topic knowledge suggested the possible presence of a non-linear function at the extreme scores. Although logistic transformation was considered to alleviate this issue, such a transformation would make the results difficult to interpret. Given that a cursory examination of the relations between the transformed prior knowledge scores with other variables produced results that followed similar trends to the original scores, the original scores were retained. Next, to examine linearity, a plot of the unstandardized residuals across all predicted values was examined. Residuals between -2 and +2 centered around a mean of y=0 indicate linearity (Cohen et al., 2003). For all of the regression analyses, strong evidence of linearity was supported. Then, to examine whether the assumption for homogeneity of variance was met, a plot of *e* by $\hat{Y}$ was

examined for whether the residuals averaged around y=0 (Cohen et al., 2003). In all cases, there was evidence that the homogeneity of variance assumption was met.

Additionally, data were screened for outliers in terms of discrepancy, leverage, and influence (Belsley, Kuh, & Welsch, 2004). Discrepancy was examined by calculating studentized residuals. A cutoff value of ±2 is commonly suggested for the identification of discrepant values (Cohen et al., 2003). However, this value has been found to identify approximately 5% of the data as discrepant, which was undesirable given the relatively small sample size. As such, the ±2 cutoff value was not regarded as absolute. Only slight deviations were observed greater than +2 and less than -2, and it was desirable to retain these cases since they did not represent extreme values. For leverage, values that were greater than 3 times the average were carefully examined (Belsley et al., 2004). These were individuals with extreme scores on the individual difference variables. Leverage values that exceeded this threshold were further examined for whether there was a large gap in the leverage value for these cases as compared to others (Cohen et al., 2003). In doing so, the purpose was to identify a limited number of cases with potentially substantial leverage, but to do so with caution (Cohen et al., 2003). Given that the cases with leverage values three times the average did not appear upon visual inspection to have a large gap from other values, and given that the purpose of the study was to examine the role of individual difference variables across a range of values, these individuals were retained. Finally, to examine influence, values for Cook's D were examined (Cook, 1977). Values for D>1 are regarded as potentially influential (Stevens, 1984). In the present study, all values of D were <1.

Review of the studentized residuals suggested that Participant 38 might have been an outlier with regard to total compositional and focused source use, and print compositional and focused source use. Specifically, this participant had above average values on each of these indices. The data were examined for errors in the research procedure, measurement, calculation, and data recording, as well as participant fatigue and inattention (Cohen et al., 2003; Stevens, 1984). Inspection of the numerical data as well as the video recording provided no evidence that any of these reasons explained the extreme values for this participant. Given the interest in variability within the sample of students, it was not desirable to delete cases. However, in order to examine whether removing Participant 38 from the sample affected the results of the analyses, the regressions were run twice, first with Participant 38 retained in the data set, and then when deleting Participant 38 from the data set. For all regression analyses, excluding Participant 38 did not result in any changes in whether results were significant, and only slight differences in beta values were observed. Moreover, removal of Participant 38 resulted in additional potential outlying cases—a problem that often occurs with the removal of data points (Cohen et al., 2003). Therefore, the decision was made to retain Participant 38 in the data set.

Zero-order (bivariate) correlations and regression analyses were examined separately for print and digital sources (see Table 26). Topic knowledge was positively related to the number of digital sources selected (r=.27, p=.05), indicating that students with greater topic knowledge selected more digital sources. However, topic knowledge was negatively related to the time spent per source engaged in compositional source use with digital sources (r=-.46, p=.002) and in focused source use with digital sources (r=-

.49, p=.001). This indicated that individuals who were less knowledgeable about the topic spent more time using digital sources, and individuals who were more knowledgeable about the topic spent less time using digital sources. No other bivariate correlations between individual difference variables and indicators of print or digital source selection or use were significant. Regression analyses were only examined for criterion variables with at least one significant relation to a predictor variable (i.e., digital source selection, per source digital compositional and focused source use).

The individual difference variables were then examined as predictors of source selection and use for print and digital sources. The omnibus multiple linear regression analysis for individual differences as indicators of digital source selection was not significant (see Table 27). The models were significant for predicting digital compositional per source use [$F(5, 35)=8.59$, $p<.01$, $R^2=.55$, *adj* $R^2=.48$] and digital focused per source use [$F(5, 35)=7.46$, $p<.001$, $R^2=.52$, *adj* $R^2=.45$].

Table 26

Bivariate Correlations Between Individual Difference Variables and Source Selection and Use Separated by Print and Digital Sources

	N	**Topic Knowledge**	**Topic Interest**	**I-type Trait Curiosity**	**D-type Trait Curiosity**
Print Sources Selected	50	.20	.23	.09	.17
Print CSU Total	43	.18	.12	.22	.27
Print CSU Per Source	36	.07	-.11	.09	.08
Print FSU Total	43	.15	.01	.15	.16
Print FSU Per Source	36	.06	-.14	.07	.07
Digital Sources Selected	50	.27*	.01	.07	-.09
Digital CSU Total	43	-.08	-.002	-.08	-.13
Digital CSU Per Source	41	-.46**	-.19	-.26	-.16
Digital FSU Total	43	-.11	-.001	-.09	-.10
Digital FSU Per Source	41	-.49**	-.18	-.24	-.13

Note: *p≤.05; **;p≤.01; CSU=Compositional Source Use; FSU=Focused Source Use

Table 27

Beta Coefficients for Individual Difference Factors as Predictors of Digital Source Selections

	Selection of Digital Sources
Intercept (β_0)	-.98
Topic Knowledge	.36
I-type Trait Curiosity	.005
D-type Trait Curiosity	.09
Topic Interest	-.06
Knowledge-Interest Interaction	<.01
F	1.31
p	.28
R^2	.13

Note: Beta coefficients are unstandardized.

Table 28

Individual Difference Factors as Predictors of Time Spent Using Digital Sources

	Per Source Compositional Use	Per Source Focused Use
Intercept	28.05	13.15
Topic Knowledge	-1.35**	-.64**
Topic Interest	-.03**	-.01**
I-type Trait Curiosity	-.12	-.07
D-type Trait Curiosity	-.30*	-.12
Knowledge-Interest Interaction	.002*	.001**
F	8.59	7.46
p	p<.01	p<.001
R^2	.55	.52

Note: Beta coefficients are unstandardized.

For digital compositional source use, predictors explained 55.09% of the overall variance. Within the model, topic knowledge [β =-1.35, t(39)=-5.96, p<.001], topic interest [β =-.03, t(39)=-4.43, p<.001], D-type trait curiosity [β =-.30, t(39)=-2.02, p=05], and the knowledge-interest interaction [β =.002, t(39)=4.68, p<.001] were significant predictors of students' per source digital compositional source use. The part and partial correlations presented in Table 29 indicate evidence of suppression (Tzelgov & Henik, 1991). Suppression occurs when the predictors are positively correlated with other predictors, but the predictors are negatively correlated with the criterion variable. Specifically, in terms of the main effects, topic knowledge, topic interest, and D-type curiosity were positively correlated with each other, but negatively predicted the amount of time students spent per source composing with digital sources. Therefore, when accounting for the variance from each of the other predictors, there were strong negative relations of compositional source use per digital source with topic knowledge

($r_{Y(TK.TI.IC.DC)}$=-.68) and topic interest ($r_{Y(TI.TK.IC.DC)}$=-.50), and a moderate negative relation to D-type curiosity ($r_{Y(DC.TK.TI.IC)}$=-.23).

For per source digital focused source use, predictors explained 51.66% of the overall variance. Within the model, topic knowledge (β =-.64, t(39)=-5.51, p<.001), topic interest (β =-.01, t(39)=-3.87, p<.001), and the knowledge-interest interaction (β =.001, t(39)=4.11, p<.001) were significant predictors of students' per source digital focused source use (see Table 30).

Table 29

Individual Difference Factors as Predictors of Digital Compositional Use Per Source

						Correlations		
	β	***SE(B)***	***β****	***t***	***p***	**Zero-order**	**Partial**	**Part**
Topic Knowledge	-1.35	.23	-1.43	-5.96	<.001	-.46	-.71	-.68
Topic Interest	-.03	.006	-1.83	-4.43	<.001	-.19	-.60	-.50
I-type Curiosity	-.12	.16	-.10	-.76	.45	-.26	-.13	-.09
D-type Curiosity	-.30	.15	-.28	-2.02	.05	-.16	-.32	-.23
Knowledge-Interest Interaction	.002	<.001	2.37	4.68	<.001	-.22	.62	.53

Table 30

Individual Difference Factors as Predictors of Digital Focused Use Per Source

						Correlations		
	β	***SE(B)***	***β****	***t***	***p***	**Zero-order**	**Partial**	**Part**
Topic Knowledge	-.64	.12	-1.38	-5.51	<.001	-.49	-.68	-.65
Topic Interest	-.01	.003	-1.66	-3.87	<.001	-.18	-.55	-.46
I-type Curiosity	-.07	.08	-.11	-.79	.43	-.24	-.13	-.09
D-type Curiosity	-.12	.08	-.23	-1.58	.12	-.13	-.26	-.19
Knowledge-Interest Interaction	.001	<.001	2.16	4.11	<.001	-.23	.57	.48

However, in addition to main effects, there was a significant interaction between knowledge and interest for per source digital CSU and per source digital FSU. Figure 7 depicts the relation between knowledge and time spent on per source digital compositional source use for low and moderate levels of interest, with I-type and D-type curiosity held constant. High interest is not depicted in this graph because the estimated values were negative for certain levels of knowledge. For individuals with low and moderate interest, the amount of time spent engaged in per source digital compositional source use was highest at low levels of knowledge, and lowest at high levels of knowledge. However, the slope was steeper for low interest individuals, indicating that time spent per source on digital CSU was more related to topic knowledge than for individuals with moderate interest.

Similar to digital per source compositional source use, topic knowledge and topic interest negatively predicted time spent in per source in focused source use. In other words, individuals with high knowledge and high interest spent less time engaged per source with digital sources. Neither I-type nor D-type curiosity were significant predictors in the model. As with compositional source use, there was evidence of suppression due to the positive relation between knowledge and interest, and the negative relation between each of these predictor variables and time spent per source on digital focused source use. Additionally, there was a significant interaction between knowledge and interest, which is depicted in Figure 8. For low and moderate levels of interest, there was a negative relation between knowledge and time spent per source on digital focused source use. As with compositional source use, this relation was stronger for low interest individuals. However, for high interest individuals, there was a positive relation between

knowledge and time spent on per source digital source use. The model depicted individuals with low knowledge and high interest as spending relatively limited time per digital source. Comparatively, individuals with high knowledge and high interest were estimated to spend more time per digital source than individuals with low or moderate interest.

Figure 7. Interaction of knowledge and interest on per source digital compositional source use across low and moderate levels of interest with I-type and D-type curiosity held constant.

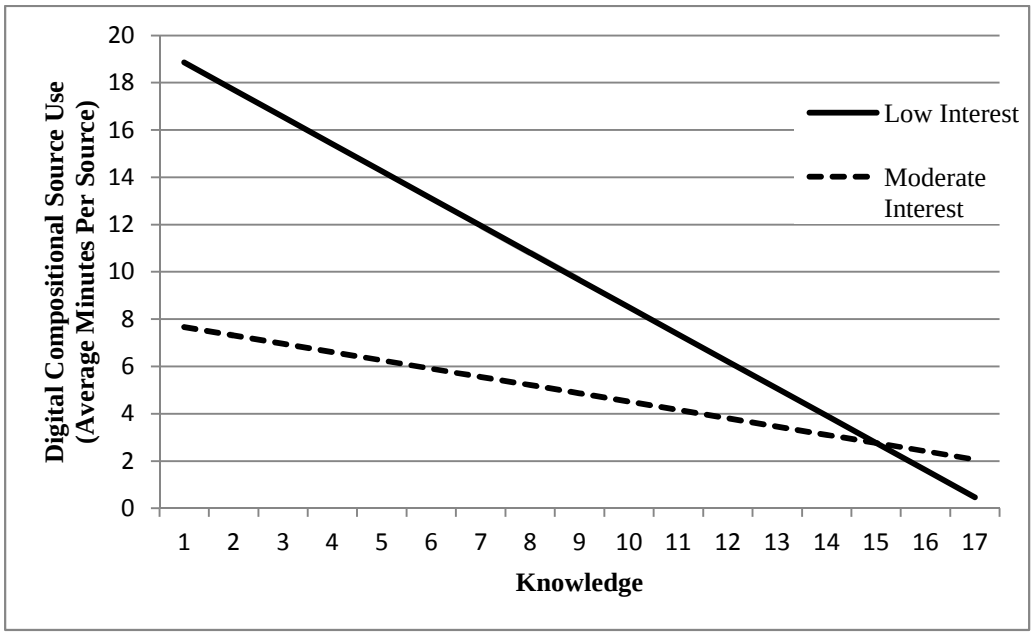
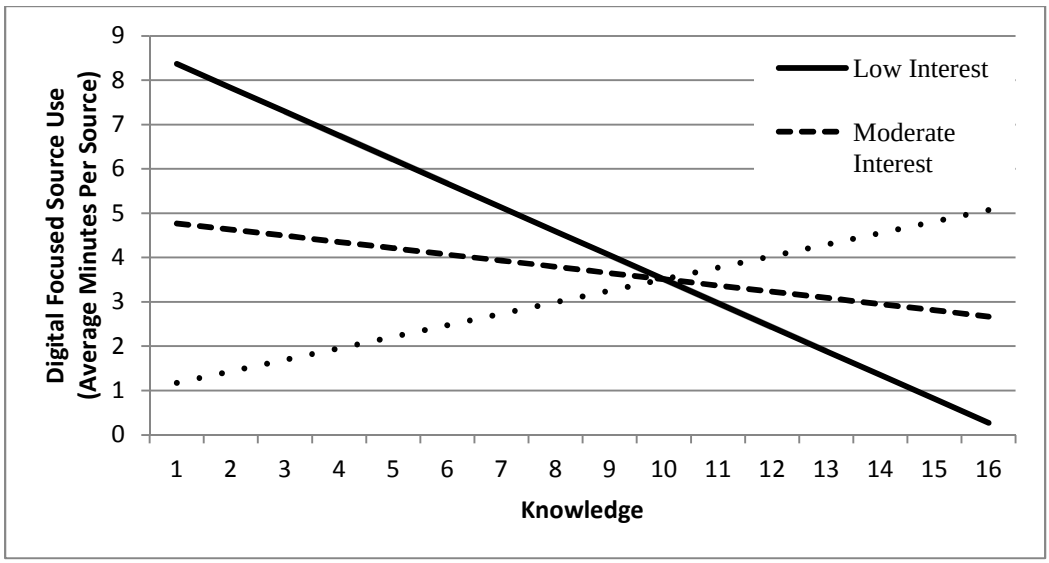


Figure 8. Interaction of knowledge and interest on per source digital focused source use with I-type and D-type curiosity held constant.



Post-Hoc Expressions and Multiple Source Selection and Use

Next, the relation between post-hoc interest/curiosity expressions and source selections were examined separately for digital and print sources (see Table 31). Correlations were calculated based on the total number of expressions. Given the reciprocal nature between source selection and use and post-hoc expressions, correlation analyses were used rather than regression analyses. Results indicated that students who reported more total interest/curiosity expressions spent less time per source on digital compositional source use (r=-.56, p<.001) and less time per source on digital focused source use (r=-.49, p=.001). There were no significant relations between total interest/curiosity expressions and any of the print source use indicators.

Table 31

Bivariate Correlations Between Post-Hoc Expressions of Interest/Curiosity and Print vs. Digital Source Selection and Use

	N	**Total Interest/Curiosity Expressions**
Selection of Print Sources	49	.04
Print CSU Total	42	.10
Print CSU Per Source	35	-.004
Print FSU Total	42	.09
Print FSU Per Source	35	-.008
Selection of Digital Sources	49	.17
Digital CSU Total	42	-.18
Digital CSU Per Source	40	-.56**
Digital FSU Total	43	-.13
Digital FSU Per Source	40	-.49**

Note: *p≤.05; **p≤.01; CSU=Compositional Source Use; FSU=Focused Source Use

Research Question 6

How are students' topic interest, trait curiosity, topic knowledge, and their post-hoc expressions of interest and curiosity related to their performance on an academic task?

Research question 6 was examined in two parts. First, the correlations and regressions between the individual difference variables and task performance were calculated. This enabled examination of the degree to which topic interest, trait curiosity, and topic knowledge were related to and predictive of surface- and deep-level performance indicators. Second, correlations were calculated between the frequency of interest/curiosity expressions and performance indictors to examine the reciprocal relation between reports of interest/curiosity experienced during the task and task performance.

A Priori Indicators and Task Performance

Of the individual difference variables, only topic knowledge was significantly related to task performance (see Table 32). Specifically, topic knowledge was positively related to whether participants included an image (ρ=.35, p=.01) and the number of times participants switched between sources in their presentation (r=.35, p=.02). Regression analyses were then conducted for the indicators with a significant relation to at least one individual difference variable; that is, images and source switches. These indicators were regressed on topic interest, trait curiosity, topic knowledge, and a knowledge-interest interaction in a simultaneous multiple regression. A logistic regression was conducted for whether or not an image was included (Table 33). For number of source switches, a linear regression was conducted (Table 34).

Table 32

Bivariate Correlations Between Performance and Individual Difference Variables

	Topic Knowledge	**Topic Interest**	**I-type Curiosity**	**D-type Curiosity**
Surface Indicators				
PowerPoint word Count	.08	-.07	.16	.18
Explanation Word Count	.23	-.18	-.05	.06
Images	.35**	.15	-.04	-.11
Borrowed Information	.05	-.20	.07	.10
Added Information	.21	.04	.01	.03
Deep indicators				
References	.12	-.04	-.11	-.04
Sources Integrated	.13	.16	-.07	-.01
Source Switches	.35*	-.11	-.13	-.13
Transformed Information	.21	-.12	-.01	.27

Note: Correlations between images and other indicators were calculated as point biserial correlations; N=50; *p≤.05; **p≤.01.

Table 33

Individual Difference Factors as Predictors of Inclusion of an Image

	β	***SE(B)***	***Exp(B)***	***Wald***	***p***
Topic Knowledge	.28	.23	1.32	1.50	.22
Topic Interest	.003	.006	1.00	.32	.57
I-type Trait Curiosity	-.006	.12	1.00	.003	.96
D-type Trait Curiosity	-.10	.12	.91	.68	.41
Knowledge-Interest Interaction	<.001	<.001	1.00	.12	.72

Table 34

Individual Difference Factors as Predictors of Number of Presentation Source Switches

						Correlations		
	β	***SE(B)***	***β****	***t***	***p***	**Zero-order**	**Partial**	**Part**
Topic Knowledge	.75	.32	.71	2.36	.02	.35	.34	.33
Topic Interest	.007	.009	.43	.86	.39	-.11	.13	.12
I-type Trait Curiosity	-.12	.21	-.09	-.57	.57	-.13	-.09	-.08
D-type Trait Curiosity	.008	.20	.007	.04	.97	-.13	.007	.006
Knowledge-Interest Interaction	-.001	.001	-.76	-1.23	.22	.02	-.19	-.17

When all individual difference variables were simultaneously entered into a logistic regression to predict the inclusion of an image, the overall model was not significant (χ^2=8.25, *df*=5, *p*=.14, $R^2_{Nagelkerke}$=.20) and there were no significant predictors. Similarly, the overall model predicting source switches was not significant [*F*(5, 42)=2.06, *p*=.09, R^2=.20, *adj.* R^2=.10]. However, topic knowledge was still a significant predictor [β =.75, *t*(46)=2.36, *p*=.02]. When accounting for the variance associated with interest and curiosity, the part correlation between topic knowledge and the number of source switches was .33. This suggests that even when accounting for motivation, increases in topic knowledge was still related to increases in the number of source switches in the presentation.

Post-Hoc Expressions and Task Performance

Finally, given the theorized reciprocal nature of post-hoc expressions of interest and curiosity and performance, total post-hoc expressions of interest and curiosity were correlated with each of the surface-level and deep-level indicators (see Table 35). Inclusion of an image was the only performance indicator significantly related to expressions of interest/curiosity (ρ=.37, *p*=.008).

Table 35

Bivariate Correlations Between Post-hoc Expressions of Interest/Curiosity and Performance Indicators

	Total Interest/Curiosity Expressions
Surface Indicators	
PowerPoint word Count	-.16
Explanation Word Count	.13
Images	.37**
Borrowed Information	-.17
Added Information	.08
Deep indicators	
References	.10
Sources Integrated	.20
Source Switches	.08
Transformed Information	.03

Note: N=49; ***p*<.01.

CHAPTER 6

CONCLUSION AND DISCUSSION

Theoretical and empirical research has suggested that individual and source characteristics shape students' engagement with multiple sources (Perfetti et al., 1999; Rouet, 2006). Yet, the multiple source use literature has been fairly limited in the specific characteristics that have been studied. Researchers have considered individual differences in knowledge and experience with domains (Gil et al., 2010; Stadtler & Bromme, 2008; Wineburg, 1991) and have focused on source characteristics such as source type and trustworthiness (Brem et al., 2001; Naumann et al., 2009). Other individual characteristics such as motivation have been examined to a more limited extent (Braasch et al., 2013; Bråten & Strømsø, 2006; Strømsø & Bråten, 2009). However, within this limited literature certain motivations (e.g., interest) have been emphasized over other relevant constructs (e.g., curiosity). The lack of research on curiosity within multiple source use has persisted despite evidence that curiosity may be particularly important for shaping academic behavior in technology-rich environments and during information search (Arnone et al., 2011; Zhao et al., 2011). Further, although source type has been identified as a source characteristic deserving of attention in the literature (Bråten et al., 2009; Strømsø et al., 2013), studies of multiple source use have constrained source use to the use of print or digital mediums rather than examine how students use different types of sources across mediums.

The present study sought to address the limited research related to the role of interest and curiosity in multiple source use across print and digital mediums. Further, this study aimed to extend previous empirical and theoretical research on the

interrelations between interest and curiosity (Grossnickle, 2014; Hidi, 2006; Renninger, 2000; Schmitt & Lahroodi, 2008). In doing so, this study examined how students used both print and digital sources of varying types when they had the ability to select among sources. Understanding how students select sources stands in contrast to prior research that has required students to use all sources (e.g., Bråten & Strømsø, 2006; Britt et al., 2009). Within these overarching aims, the present study also sought to extend research on the role of prior knowledge in relation to multiple source use, interest, and curiosity. Moreover, this study addressed previous research that has been inconsistent in measuring the outcomes of multiple source use (e.g., Bråten & Strømsø, 2003). As such, the present study tasked students with the creation of a PowerPoint presentation and then measured their performance on that specific task.

This chapter examines key findings related to the six major research questions explicated in Chapters 4 and 5. The key findings are addressed through the examination of five central themes that cut across the research questions. Specifically, this chapter summarizes how students navigated within the landscape of digital and print sources, and the importance of considering source medium in relation to source type. Moreover, it examines the extent to which knowledge and motivations influenced and were influenced by students' engagement in a multiple source use task. Based on key findings, the implications, limitations, delimitations, future directions, and conclusions are discussed.

Key Findings

Based on the results of the present study, four major themes emerged. These were: (a) multiple source use as management versus integration, (b) interaction of source

type and medium, (c) the role of individual differences in multiple source use, and (d) the experience of interest and curiosity.

Multiple Source Use as Management versus Integration

Engagement with multiple sources is a challenging task, even for undergraduates who may be expected to identify, select, and use multiple sources throughout their coursework (Bråten et al., 2013; Cerdán & Vidal-Abarca, 2008). Previous research has suggested that students tend to limit their use to single sources, even when tasks imply that multiple sources are necessary for integration and corroboration (Graham & Metaxes, 2003). For undergraduates, limited engagement with multiple sources may take the form of *information management* rather than *knowledge building* (Alexander, 2012; Scardamalia & Bereiter, 1987). Information management refers to the short-term recall and surface-level manipulation of information (Alexander, 2012; Alexander & the Disciplined Reading and Learning Research Laboratory, 2012). Students engaging in information management do so for the purpose of succeeding in the task at hand, with limited concern for or desire to gain lasting knowledge or conceptual change (Alexander, 2012). In contrast, knowledge building requires effortful engagement in order to develop deep understanding (Scardamalia & Bereiter, 1987). While there is some evidence of knowledge building in the present study, students' multiple source use and task performance suggested that students were frequently engaging in information management. Evidence of students' engagement in knowledge building is presented prior to considering evidence of their engagement with information management.

In the present study, students spent a substantial amount of time working with multiple sources. Even though their performance was ungraded, students spent an

average of 37.34 minutes working on the task, and several students produced explanations for their presentations that exceeded 1000 words, or approximately the length of a 3-page essay. This high level of engagement was accompanied by the selection of a substantial proportion of the available sources and by switching between sources with relative frequency. Of the 16 available sources, students selected more than seven sources on average. Compared to previous studies that have limited multiple source use to six or eight sources (Bråten et al., 2013; Le Bigot & Rouet, 2007; Wiley & Voss, 1999), more than 25% of students in the present study selected ten or more sources.

Additionally, students switched sources an average of 17.32 times, making an average of 2-3 switches per source. Students' source selection behaviors resembled patterns of source navigation presented in models of multiple source use (Rouet, 2006). Students typically spent time with one source and used information from that source, before deciding to switch to another source. After selecting the next source students either used this source to incorporate information into their PowerPoint or selected a different source, presumably to meet their information needs (Rouet, 2006). This pattern repeated for the average of seven sources and 17 switches that students made during the task. This suggested that students were making numerous iterations through the steps of the MD-TRACE (Rouet, 2006). By selecting multiple sources and spending a sufficient amount of time engaging with them, students had the potential to use the multiple sources for collaboration and corroboration (Graham & Metaxes, 2003).

Using multiple sources has been found to support information corroboration (Voss & Wiley, 1997; Wiley & Voss, 1996). Although the number of sources selected and the total time on task suggested that students were actively engaged in using multiple

sources, other evidence suggested that students in the present study infrequently exhibited the types of behaviors manifest by those well versed in a domain (Wineburg, 1991). Perhaps most striking was the prevalent use of the fact sheets. The use of the fact sheets was concerning both in the degree that students selected this source type and the frequency that they integrated it into their presentation. Notably, all participants selected to use a fact sheet in at least one medium, and 74% used both the print and digital fact sheet.

Preference for the fact sheets was also clear in the time that students spent using these sources. Considering the averages for participants who selected each given source, time spent using the printed fact sheet was more than two times the second longest time for a print source (i.e., the print textbook), and time spent using the digital fact sheet was 1.5 times the second longest time for a digital source (i.e., the digital tradebook). These selection and use behaviors translated into the prevalence of material from the fact sheets in students' presentations. Of participants selecting the fact sheets, 95% incorporated at least some information from the digital fact sheet in their presentation and 89% incorporated the print fact sheet. In the retrospective interviews, students noted the desirability of this source in relation to the task at hand, frequently noting that they selected the fact sheets because they were looking for facts or simple information. For example, Participant 31 said:

> I think [the fact sheet] was the most [desirable], it wasn't, like versus the textbook ones that were really long and filled with words, this was kind of simple and to the point. And when I was making my Powerpoint I wanted it to be simple. So this one was kind of easy to read and easier to understand than when I looked at the [book] that was like…really, really long, and I just, it was like 200 pages, so I didn't want to go through all that.

Although students chose to view a fairly substantial number of sources, they spent limited time on most sources and integrated fewer into their presentation. Despite the average of seven sources viewed, material from only half of these sources was ultimately included in their presentations. A similar pattern was identified for the frequency of switching between sources. Although patterns of source selection indicated that students were moving back and forth between sources with relative frequency, this did not translate into a similar level of integration in their PowerPoint presentations. In fact, task performance suggested that the majority of participants' presentations constituted material borrowed from the sources, with only 16% of material transformed within or across sources. Further, participants engaged in an average of three source switches during their search for every one source switch in their presentation. The average number of switches in the presentation was 5.85, which corresponds roughly to switching sources once for every one of the five PowerPoint slides created.

Although students who selected more sources spent a greater amount of time using sources and switched more frequently between sources, the selection of more sources was negatively related to time spent per source. That is, the engagement with a larger number of sources corresponded with a brief amount of time spent on each source. Students seemed to move quickly between sources and often paused their search with the fact sheet—where most time was spent—to really develop their presentation.

Interaction of Source Type and Medium

Results of the present study suggested that how students engage with multiple sources across print and digital formats may differ considerably from how students engage multiple sources within a single medium. Yet, research on multiple source use

has focused on the degree to which source selection and use differs across source types within a single medium (Anmarkrud et al., in press; Bråten et al., 2009; Strømsø et al., 2013). As a whole, the literature on multiple source use has examined both print (e.g., Braasch et al., 2013; Wineburg, 1991) and digital sources (e.g., Naumann et al., 2009; Stadtler & Bromme, 2007; Wiley & Voss, 1999). However, to the knowledge of the author, no studies of multiple source use have included a combination of both print and digital sources. This lack of research exists despite conflicting ideas regarding the degree to which students engage with digital compared to print sources. On the one hand, students report using both print and digital sources for completing academic tasks (Purcell et al., 2013). On the other, the prevalence of the term *digital natives* (e.g., Prensky, 2013; Thomas, 2011), and the increased engagement of today's students with digital compared to print media (Rideout, Foehr, & Roberts, 2010) suggests the importance of examining student behavior across print and digital mediums. Accordingly, understanding the selection and use of print and digital sources was a gap in the literature that the present study sought to address.

Although research and popular culture would consider these students digital natives (Prensky, 2001, 2011), students in the present study did not exhibit differences in their overall frequency of selecting print as compared to digital sources. Students who selected more sources in one medium also tended to select more sources in the other medium, suggesting a more general tendency toward selecting more sources (or not) rather than a preference for a particular medium. However, there were certain trends within source type that indicated a preference for digital sources. In fact, for five of the eight source types (i.e., textbook, tradebook, encyclopedia, fact sheet, image) students

more frequently selected the digital version of the source. Additionally, students incorporated more digital than print sources into their presentations and spent more time using the digital compared to the print image.

Yet, the present study suggests that these digital natives still engage with print sources, even to the extent of preferring to use print sources. Indeed, certain preferences for and deeper engagement with print sources was evident among these students. For one, the peer-reviewed journal article was selected more frequently in print than digitally. Additionally, perhaps one of the most notable findings of the study was that despite certain preferences for digital compared to print sources students spent almost twice as long working with print sources. Focused source use with print sources averaged more than 14 minutes, compared to less than seven minutes for digital sources. When broken down by source type, this difference was perhaps driven by the increased time spent using the print as compared to digital fact sheet. In task performance, the tendency to engage more deeply with print sources was translated into a greater number of within source transformations from print as compared to digital sources.

Differential patterns of source selection and source integration across medium also highlight the importance of examining source type across print and digital formats. Specifically, preferences for selecting and using sources in a particular medium did not necessarily extend to the tendency to incorporate sources from this medium into the presentation. There were some overall tendencies to select digital sources more frequently and to spend more time with print sources. However, the extent that sources were integrated in the presentation differed by source type. Differences in source integration were particularly prevalent for the image and graph. For instance, despite

selecting the print and digital graphs at similar rates, there was a large disparity in the degree to which students incorporated the graph of each medium into their presentations. In fact, only 13% of those who selected the print graph incorporated it into the presentation compared to 52% students who selected the digital graph. In contrast, participants demonstrated a clear preference for selecting the printed journal article (23 print vs. 11 digital). Yet, when deciding what to include in their presentation a similarly limited number of students actually included information from a journal article in either the print or digital form (2 print vs. 3 digital).

Further, with each medium, selecting and using sources was positively related to the number of borrows and transformations. For example, using more digital sources and spending more time on digital source use was associated with including more borrowed and transformed information from digital sources. Across mediums, there were negative relations between source selection and use in one medium (e.g., digital) and the amount of borrows and transformations from the other medium (e.g., print). This may suggest that using sources in one format takes away time from using sources in the other. For instance, spending time using digital sources is done at the exclusion of print sources. Overall, these results demonstrate an interconnectedness of medium and source type, and suggest that students are sensitive not only to source type, which has been examined in prior studies (Stadtler & Bromme, 2008; Strømsø et al., 2013), but also to the medium in which they were choosing these sources.

Role of Individual Differences in Multiple Source Use

One of the major aims of the current study was to extend previous research on multiple source use to examine the role of motivation in multiple source use processes

and performance. The multiple source use literature suggests that motivation may be particularly important for multiple source use due to the increased demands of source corroboration and integration (Bråten et al., 2011). Similarly, models of multiple source use indicate the potential role for motivational factors in addition to cognitive factors to impact the various stages of multiple source use (Perfetti et al., 1999; Rouet, 2006). From the motivational literature, interest and curiosity were selected for examination in the present study because prior research has linked them to factors important for multiple source use. Specifically, interest and curiosity have been identified as particularly relevant for engagement in technology-rich environments (Bowler, 2010; Dickey, 2011) and have been associated with exploration and persistence (Ainley, Hidi et al., 2002; Lowry & Johnson, 1981; Subbotsky, 2010). Yet, results from the present study identified limited relations between motivation and multiple source use. With certain exceptions, students for the most part were able to persevere in this task regardless of interest or curiosity.

Rather, topic knowledge frequently served as a stronger predictor. As an individual difference factor, topic knowledge is well established in the multiple source use literature as influential (Gil et al., 2010; Stadtler & Bromme, 2008; Strømsø et al., 2010). In the current study, individual difference factors were related to source selection and use for digital sources, but not for print. Specifically, topic knowledge and motivation negatively related to digital source use and accounted for approximately 50% of the variance in digital per source use. Compared to prior research that has found positive relations between knowledge and source use indicators (Gil et al.,2010; Stadtler & Bromme, 2008; Wineburg, 1991), the relation between topic knowledge and source

use in the present study was negative. This means that individuals with more knowledge spent less time engaging in digital source use. A similar pattern was identified for motivational factors. For example, topic knowledge, topic interest, and D-type curiosity negatively predicted per source digital compositional source use; a similar pattern was identified for focused source use.

In this sense, it was not only the more knowledgeable but also the more motivated students who spent less time using digital sources. This finding stands contrary to previous research on multiple source use as well as the text processing literature more generally, which strongly supports a positive relation between knowledge and performance (Fox, 2009; Rouet et al., 1997; Wineburg, 1991). This finding can be understood in terms of how participants with varying levels of knowledge and interest were selecting sources and allocating their time using sources in different mediums. For the MD-TRACE, source use is an iterative, decision-making process in which individuals must decide when to they need additional sources to meet the demands of the task (Rouet, 2006). Tasks vary in the degree to which they require students to use additional sources, and there is evidence that greater competence does not simply equate to selecting a greater number of sources (Grossnickle, Alexander, & List, 2014). However, in the present study, knowledge was positively related to the overall number of sources and number of digital sources selected. More knowledgeable students tended to select a larger number of sources, and therefore, the time spent per source decreased as they divided their time across more sources. In contrast, less knowledgeable students selected fewer digital sources, which increased the calculated time spent per source. For example, Participant 33 relied on a single digital source, the digital fact sheet, and spent 8.47

minutes engaged in focused source use with that source. Participant 24 spent an average of 8.17 minutes per digital source in focused use. She spent .57 minutes with the online fact sheet before switching to the online book to spend 15.77 minutes in focused source use to complete the task.

However, selecting more sources was not the only explanation for why knowledge and interest were negatively related to digital per source use. Rather, there were differences in how participants of varied levels of knowledge and interest were spending their time across digital and print mediums. To better understand this relation, separate linear regressions were run to predict focused source use for print and digital sources (see Tables 36 and 37). In addition to topic knowledge, individual interest, I-type and D-type curiosity, and the knowledge-interest interaction, the number of sources selected was also included as a predictor. The overall model was significant for digital focused source use [$F(6, 34)=7.67$, $p<.01$, $R^2=.58$, *adj* $R^2=.50$] and for print focused source use [$F(6, 29)=5.01$, $p=.001$, $R^2=.51$, *adj* $R^2=.41$]. However, different patterns between knowledge and source use emerged for print and digital sources when controlling for the total number of sources selected. Specifically, consistent with the findings reported in Chapter 4, topic knowledge was significantly negatively correlated with time spent per source on digital focused source use. In contrast, topic knowledge significantly positively predicted time spent per print source on focused source use. This analysis suggests that when controlling for the number of sources used, more knowledgeable students allocate more time for each print as compared to each digital source. Students with less knowledge and motivation may be selecting the path of least

resistance, which in the case of creating a digital presentation, was the use of digital sources that provided for quickly scanning and copying material.

Table 36

Predictors of Digital Focused Use Per Source

						Correlations		
	β	***SE(B)***	***β****	***t***	***p***	**Zero-order**	**Partial**	**Part**
Topic Knowledge	-.55	.12	-1.19	-4.73	<.001	-.49	-.63	-.53
Topic Interest	-.01	.003	-1.50	-3.62	.001	-.18	-.53	-.40
I-type Curiosity	-.07	.078	-.12	-.88	.39	-.24	-.15	-.10
D-type Curiosity	-.10	.074	-.18	-1.31	.20	-.13	-.22	-.15
Knowledge-Interest Interaction	.001	<.001	1.97	3.89	<.001	-.23	.56	.43
Number of Sources Selected	-.14	.07	-.27	-2.18	.04	-.50	-.35	-.24

Table 37

Predictors of Print Focused Use Per Source

						Correlations		
	β	***SE(B)***	***β****	***t***	***p***	**Zero-order**	**Partial**	**Part**
Topic Knowledge	1.21	.47	.86	2.57	.02	.06	.43	.33
Topic Interest	.02	.01	.84	1.47	.15	-.14	.26	.19
I-type Curiosity	.14	.26	.09	.55	.59	.07	.10	.07
D-type Curiosity	.31	.23	.23	1.36	.18	.07	.25	.18
Knowledge-Interest Interaction	-.002	.001	-1.35	-1.92	.07	-.12	-.34	-.25
Number of Sources Selected	-.96	.19	-.67	-4.93	<.001	-.59	-.68	-.64

Consistent with prior research, there were important interactions between the individual difference factors (Linnenbrink-Garcia et al., 2012; Toboada et al., 2009). Indeed, some of the counterintuitive relation between knowledge, interest, and digital source use seemed due to an interaction between knowledge and interest. Specifically,

for per source digital compositional and focused source use, the relation between knowledge and source use differed across levels of interest. For individuals with low interest, the relation between topic knowledge and time spent per digital source was negative. However, for individuals with high knowledge, the relation between topic knowledge and time spent per digital source was positive. For low interest individuals, when a low level of motivation was paired with a high level of knowledge, they did not spend much time per source to complete the task. Perhaps this was because their knowledge satisfied much of the requirement, and their low level of interest made it undesirable to engage. For highly interested individuals, the positive relation between knowledge and time on task mirrors previous research (Strømsø & Bråten, 2009; Wineburg, 1991).

Individual differences had limited power to explain performance on the multiple source use task. Only two of the indicators, one surface (i.e., the inclusion of an image) and one deep (i.e., source switches), were predicted by knowledge, interest, or curiosity. Specifically, inclusion of at least one image was positively related to topic knowledge and to post-hoc expressions of interest/curiosity for content and source features; more knowledgeable participants were more likely to include an image. Perhaps this was due in part to the complexity of the images provided and the need to have background knowledge in order to be able to explain the image as a part of the presentation. In terms of post-hoc interest/curiosity, it is possible that individuals found the image more interesting, so the decision to include the image evoked interest or curiosity. Alternatively, individuals with a greater propensity to experience interest or curiosity may have sought out images because this type of source was deemed interesting or

curious. In terms of deep-level performance indicators, topic knowledge was positively related to the proportion of switches made per source during the task. That is, more knowledgeable participants switched more frequently between sources when creating their presentation. However, this positive relation did not hold for the number of source switches included in the PowerPoint presentation.

The Experience of Interest and Curiosity during Multiple Source Use

Prior research has frequently focused solely on interest and curiosity as individual difference factors (i.e., individual interest and trait curiosity). Moreover, when interest and curiosity have been examined in their more momentary forms (i.e., situational interest, state curiosity), the focus of the interest or curiosity has typically either been specified by the researcher or examined as a global rating (Ainley, Hidi et al., 2002; McDaniel et al., 2000; Kang et al., 2009). For example, research on state curiosity has asked participants to provide ratings of curiosity for a series of trivia questions selected by the researcher (Kang et al., 2009; Litman et al., 2005), and research on situational interest has asked participants to rate how interested they feel at certain points while reading a text (Ainley, Hidi et al., 2002). This research has provided informative insights into the degree to which individuals find varied situations or probes interesting, and has identified specific factors (e.g., surprise, novelty) related to interest and curiosity. However, the specific part of a task that participants find interesting or curious, and the degree to which interest or curiosity serve as motivational factor for decision making during a multiple source use task have been underexamined.

The present study sought to create a task that would have the potential for participants to experience interest or curiosity through the use of varied types of materials

for participants to feel interested in or curious about. Through post hoc interviews, three different targets of interest/curiosity were identified: interest/curiosity in the content, source features, and for the audience. Of these, participants were most likely to express interest/curiosity for the content contained within sources or to express interest or curiosity in the content more generally. Indeed, more than three quarters of participants expressed content-related interest/curiosity. Interest/curiosity for the audience was expressed by approximately 30% of participants, and a smaller number of participants (16%) expressed interest or curiosity in relation to the specific features of sources.

In addition to the frequency of having at least one expression of interest/curiosity (81.6% of participants), follow up interview questions suggested that most participants were interested/curious at least to some degree. Participants frequently expressed that they were interested in the task and that their level of interest or curiosity tended to stay stable or increase during the task. Some participants even reported that they were surprised to find themselves interested because they thought this was going to be a boring task. The degree to which participants explored the sources and the time spent engaging with the task provides some indication of interest or curiosity, although more research is needed to directly assess whether intrinsic motivation or other factors such as performance orientated goals led participants to engage to a high degree despite the lack of external incentives for performance.

Finally, it is worth noting that I-type and D-type curiosity were positively related, yet had a certain unique capacity as predictors of multiple source use and post-hoc interest/curiosity. The positive relation between these forms of trait curiosity has been well-established in the literature, and the present study identified a similar relation to

previous studies (Litman, 2010; Litman et al., 2005; Litman & Silvia, 2006). Further, consistent with prior studies that have examined the degree to which I-type and D-type curiosity are differentially related to outcome variables, in the present study they also differed in the degree to which they served as predictors for multiple source use and the experience of interest/curiosity.

Implications for Theory, Research, and Practice

Given these key findings and considering the relevant literature, certain implications for theory, research, and practice emerged. Implications for theory and research are discussed first, focusing on theoretical models of multiple source use, research on interest and curiosity, and the relations between these literatures. Methodological implications are also discussed. Then, potential implications of this research for educators are examined. These includes the need to aid students in using sources that support building inter- and intra-text models and the potential for capitalizing on the varied targets of students' interest and curiosity during multiple source use tasks.

Implications for Theory and Research

Findings from the present study support the need for models of multiple source use and empirical research to consider source medium in addition to source type. This extends previous research that has established source type and source characteristics (e.g., trustworthiness, author credentials) as influential in multiple source use (Braasch et al., 2013; Brem et al., 2001). Although prior research has examined both print and digital sources in separate studies (e.g., Naumann et al., 2009; Britt & Aglinskas, 2002), findings from the present study highlight the importance of examining print and digital source use within the context of the same study. Indeed, source use may look different when

students use sources in a single medium compared to when they use sources both digitally and in print. Moreover, it is important to examine the impact of source medium as it plays out not only in the selection and use of sources, but also in task performance. In the present study preferences in medium for source selection did not always correspond to preferences in the application of these sources to the task.

Additionally, the inclusion of visual as well as text sources provided valuable information regarding how students engage with a diverse number of sources. Prior studies on multiple source use have infrequently included images as sources. Moreover, when images have been included, comparisons across source types have not been examined (Wiley & Voss, 1999), or pictures have been included as part of the outcome measure rather than as a resource (Wineburg, 1991). In the present study, engagement with the image and graph were particularly varied across medium. Therefore, the inclusion of images in addition to the availability of sources in varied mediums was important for theoretical and empirical research on multiple source use.

Although models of multiple source use generally indicate that individual differences influence the source use process and task performance (Rouet, 2006), these models may benefit from more specific explanations of these relations. For instance, when provided with both print and digital sources, the relation of individual difference variables to task processing and performance may differ across source medium compared to source use in a single medium. The surprising negative relation between topic knowledge, topic interest, and D-type curiosity with digital source use counters previous research that suggests that knowledge and motivation increases engagement (Perfetti et al., 1999; Strømsø & Bråten, 2009). Thus, there is a need to understand persistence and

attention related to motivation as necessarily dependent upon the broader context and the available resources provided. Indeed, rather than increasing persistence or time on task, increased knowledge and motivation may allow students to engage with sources in a more expeditious or superficial manner as a means of verifying what is already known. This returns to questions of whether interest increases or decreases attention to and persistence with sources (Graham et al., 2008; Hidi, 1990, 1995; McDaniel et al., 2000). It suggests that that the specific nature of the task and the sources provided might be one means for further understanding this complex issue.

Examining the specific outcome measure for which participants are instructed to use multiple sources is also important for understanding how students integrate multiple sources to complete academic tasks. Although there were certain contradictions within the sources, the available sources served mostly as complementary rather than contradictory. Within this task, the development of text-base and situation models may depend on source medium. Significantly more transformations were made with print compared to digital sources. The present study was able to identify these connections because the multiple source use task was also used as the outcome measure. Although understanding incidental learning of source information or developing intratext and intertext models is important, the present study suggests that using the multiple source use task for the outcome measure provided valuable information about how students used different types of sources across mediums.

Despite research indicating that curiosity may be particularly relevant for understanding students' academic exploration within information-rich environments (Arnone et al., 2011; Bowler, 2010; Koo & Choi, 2010; Lowry & Johnson, 1981), the

present study indicated that curiosity was limited as a predictor of source selection, source use, and task performance. Further, D-type curiosity emerged as a negative predictor of digital source use, indicating that for this type of task, within technology-rich environments greater curiosity was associated with spending less time using digital sources. Similar to multiple source use research, which highlights how tasks change behavior and performance, it may be important for the curiosity literature to temper arguments related to the role of curiosity in academic exploration. Rather than providing global statements of the importance of curiosity for online information search, more specific characteristics of the tasks may be important to consider when understanding curiosity in relation to academic performance. The large number of sources and open-ended nature of the task in the present study was believed to provide ample opportunities for students to engage in information-seeking behaviors indicative of curiosity. Yet, students seemed to engage in such behaviors regardless of reported curiosity. This may have been because students did not perceive the task to include the conditions supporting curiosity (e.g., ambiguity, uncertainty; Berlyne, 1960; Kashdan et al., 2009). Additionally, consistent with the previous literature, the current study assessed curiosity as a trait. It may be important for future research to examine whether topic-specific curiosity is present and whether measuring curiosity at the level of topics rather than as a personality variable might be more informative for understanding academic performance.

Further, for certain groups of students, interest and curiosity in their stable forms may be related. This suggests that researchers should more carefully examine the interrelations between interest and curiosity. Additionally, differential relations to processing and performance suggest the need for studies of interest and curiosity to

include multiple indicators of performance. Moreover, the present study provided further evidence for the importance of examining cognitive and motivational variables in conjunction. Specifically, the interaction between interest and knowledge provided insights into how students use digital sources.

The present study built on previous methodologies to examine multiple source use across mediums. Specifically, two aspects of the multiple source use task methodology provide a means for future researchers to examine multiple source use with a combination of print and digital sources. First, the use of a head camera to capture source use across mediums was novel. Participants were generally comfortable wearing the camera. It served as a large grain means of eye tracking, and enabled observations of the general focus of students' source use with a single camera. Since the camera was attached to the participants' head, discerning the specific focus of participants' attention was more manageable than through the triangulation of data from multiple cameras. Although eye tracking would have provided a more specific account of what participants are viewing at any given time, certain challenges with eye tracking (e.g., designed for viewing digital items, challenges with calibrating) supported an alternative technology. Additionally, the streaming function of the GoPro camera allowed for the researcher to make notes of participants' actions as they completed the task, and to tailor the interviews based on these observations.

Second, the present study involved the development of a coding scheme to capture source selection and use in digital and print formats. Previous research has only focused on sources in a single medium and has often required participants to view all sources rather than to select from between an array of available sources (Bråten &

Strømsø, 2006; Bråten et al., 2009; Britt et al., 1999). Therefore, no coding scheme was available to meet the needs of the present study. The separation of coding into viewing and action provides a flexible framework for applying this coding scheme to studies with different numbers and types of sources. Moreover, the codes can be aggregated at various levels, as well as examined on an individual level. Although the focus of the present study was on larger grain analyses such as time spent using sources, data coded in this way have the potential to be broken down into more specific actions associated with different sources.

Implications for Practice

Although there were certain indicators that suggested students were engaging in thorough ways with multiple sources, other indicators suggested that they were doing so only superficially. Perhaps the most concerning were the proportion of borrowed information, the limited degree to which students incorporated the sources they selected into their presentation, and the relative infrequency of switching between sources in the presentation. The reliance on borrowed information is concerning for educators who want their students to develop lasting knowledge related to the material. Based on the findings in this study, there are several suggested means by which educators can increase engagement within and across sources.

For one, educators could capitalize on the different targets of interest expressed in the interviews. Students reported a number of different ways in which the content of the sources, source features, and the audience for their task served to motivate them. In addition to interest or curiosity in specific content, a number of students reported more general interest/curiosity to know what was contained within a source. Although

interest/curiosity for source features has not been established in the literature as a common source of interest or curiosity, it could be a potential avenue for educators seeking to capitalize on student motivation. Yet, research on seductive details suggests that simply including features of interest that do not support conceptual understandings can reduce text comprehension (Lehman et al., 2007; Mayer et al., 2008). Therefore, care should be taken when attempting to modify the content in order to increase interest or curiosity. Rather, given that more than 80% of participants expressed at least one target of interest related to the task, effort could be taken to capitalize on such pre-existing interest or curiosity.

Second, students engaged with print sources when they were readily available, and they often did so with indicators suggesting deeper-level engagement (e.g., time spent on source use, inclusion of transformations). Yet, in academic coursework, students are frequently not provided specific sources for research assignments such as creating a PowerPoint presentation. In the follow up interviews, participants made comments that the print sources were readily available to them for this task, but noted that this would not be the case in their everyday academic tasks. When asked what they would have done differently if they were assigned this for a class, some participants noted that they would not have had the printed resources available and would have therefore focused on sources that they could access electronically. These sentiments aligned with the demographic questionnaire, where participants responded that they were more likely to use digital as compared to print sources when completing academic assignments (see Table 38). This suggests that there is a need for educators to support

students in their identification of print sources, given that this step in the source use process may be deemed difficult and undesirable by many students.

Table 38

Average Reported Use of Print and Online Materials When Doing Research For Class

	Print	**Online**	***t***	***p***
Books	34.56 (*SD*=28.84)	60.89 (*SD*=35.70)	-4.10	<.001
Articles	35.93 (*SD*=31.00)	88.80 (*SD*=17.84)	-9.96	<.001
Images or Diagrams	31.32 (*SD*=30.32)	73.05 (*SD*=26.41)	-8.11	<.001

Note: Mean print and online use reported on a 100 point line (0=*very infrequently*, 100=*very frequently*); paired samples *t*-test with *n*=45 for books and articles and *n*=44 for images and diagrams.

Limitations, Delimitations, and Future Directions

Finally, limitations and delimitations of the current study are considered, along with future directions that arose from these limitations and delimitations. The discussion centers around six central aspects: (a) generalizability, (b) challenges related to the large grain and descriptive metrics of source use, (c) challenges related to assessing interest and curiosity, (d) separation of surface- and deep-level performance indicators, (e) inability to discern the uniqueness of interest and curiosity, and (f) the video recording method.

Generalizability

In the present study, there are certain concerns related to the generalizability of the task and the generalizability of the sample. The task was constrained in order to address specific research questions; however, in doing so, the task may not have reflected the typical practices of undergraduate students. For instance, in order to compare the likelihood of selecting and using sources in each medium, the ease at which these sources

could be accessed was held constant. Although students might prefer digital sources for the ease of access in their typical academic work (see Table 38), in the present study total source selection did not differ across source medium, although there were some differences within source types. Rather than relying on digital sources in the present study students may have used print sources more frequently because they were pre-selected and as easily available as the digital sources. Students were not required to go to the library, nor were they required to do an online search for digital sources. Providing print sources and a library of digital sources may not have reflected the typical research-based tasks that undergraduate students complete for academic courses. Despite this delimitation, the inclusion of multiple print and digital sources was more comparable to participants' typical academic assignments given that it did not require students to read all sources and provided them with the freedom to select from among a large number of sources across mediums.

Additionally, given the interest of the present study on direct comparisons between print and digital sources of various types, it was necessary to include only source types that were available in both formats. This meant that more traditional digital formats such as websites or videos could not be included in the present study. As such, the present study provided findings related to a limited number of source types. Future research should examine a greater variety of source types across mediums, and examine the degree to which ease of access to sources influences multiple source use. In doing so, future research could aid in understanding why students reported relatively infrequent use of print sources in their typical academic research, yet spent more time with and frequently relied on print sources more in creating their presentations in the present study.

Another concern for task generalizability is the degree to which creating a PowerPoint presentation is a typical task for undergraduate students. Given that research has identified the task as particularly important for guiding multiple source use (Cerdán & Vidal-Abarca, 2008; Le Bigot & Rouet, 2007), the specific task of creating a PowerPoint presentation was a necessary delimitation. The PowerPoint presentation was selected over other tasks such as writing an essay or completing a recall measure because it was determined in the pilot studies to have the potential to be more interesting for participants. When completing the task, participants did not appear to have difficulty with creating a PowerPoint. The only point at which I needed to provide some guidance was pasting images from the digital source library on to a slide. Even then, most participants who attempted this were able to do so without any support. Moreover, when asked during the post-hoc interview, "how typical was this of a task you might receive in an academic class," most participants reported that they frequently had to create PowerPoint presentations for their classes. At the same time, there could be significant variability in terms of participants' experience with this task, and so future research should consider a measure of task familiarity as a potential control variable.

The generalizability of the sample was also a limitation. Students self-selected to participate from the recruited research methods courses for extra credit. Of 90 enrolled recruited students, 50 agreed to participate in the present study. These students may have been differentially motivated for participation. For instance, low-performing students who wanted to improve their grade might have participated more frequently compared to students who were satisfied with their current grade in the course. Moreover, the focus of the present study on internal motivations such as interest and curiosity contrasted with the

external motivator of participating in exchange for points for a class. Although the extra credit was not contingent upon performance in the research study, this is still a potential limitation given the focus of the study on motivation.

Focus on Large Grain and Descriptive Metrics of Source Use

Next, it is important to note that this study focused on larger grain and descriptive metrics of source selection and use. Due to the descriptive nature of this study and consequently large number of concurrent analyses, there was the potential for increased Type I error rate. Efforts to address this concern included conducting omnibus tests and adjusting critical values using a sequential Bonferroni procedure (Holm, 1979). At the same time, the results should be interpreted with caution given the large number of significance tests conducted in the present study.

The descriptive focus of the study was on larger grain metrics of source selection and use. Source codes were aggregated to provide a summary of source use, and estimates of the total time that participants spent using each of the 16 sources were provided. Future research could compare the more specific actions that students engage in during tasks (e.g., typing while viewing a source), and the degree to which these more specific actions vary across sources. Although these data were available in the present study, such analyses extended beyond the scope of the six specified research questions. Similarly, the decision to examine overarching indicators of source selection and use necessarily limited the focus on how students integrated information across mediums. Future research could examine the degree to which students move between print and digital formats, and how they use these sources in conjunction to create their responses.

In other words, do students tend to work with digital sources for a length of time and then move to print sources, or do they frequently shift between mediums?

Additionally, other features specific to sources (e.g., trustworthiness, usefulness) could be compared across print and digital sources in future studies. While this was beyond scope of the present study, this would extend prior research examining these features in sources within a single medium (Bråten et al., 2009; Britt & Aglinskas, 2002; Rouet et al., 1996; Stadtler & Bromme, 2009). Given that students infrequently use source characteristics to evaluate information online (Britt & Aglinskas, 2002; Walravin et al., 2009), building on the current research to examine the degree to which source medium explicitly influences source use decisions is a step for future research.

Future research should also examine multiple source use tasks with print and digital sources that provide conflicting information. The present study focused on corroboration across sources rather than participants' integration of conflicting sources. The MD-TRACE model of multiple source use and related empirical research (Cerdan & Vidal-Abarca, 2008; Cerdan et al., 2009; List et al., 2012; Rouet, 2006) support the importance of the task in shaping multiple source use behaviors and outcomes. Therefore, given the findings of the present study, it is necessary to see whether the behaviors are replicated across different tasks requiring print and digital sources.

Additionally, given that much of the information was repeated in different sources, it was challenging to discern whether participants engaged in verification of information across sources. At times this was evident, such as when participants used a second source to modify information that they had typed in their PowerPoint presentation based on an earlier source. However, in cases when the information was identical across

sources, it was not possible to infer whether participants used a second source to verify information from the first. In this sense, the outcome measure may have underestimated the degree to which participants integrated across sources through verification. Additionally, future studies could examine the relation between individual differences and source use behaviors with measures of more enduring knowledge building. In the present study, participants engaged in immediate recall, and the availability of the information written in their PowerPoint enabled them to present the information without much recall beyond the text or images they recorded. Future studies might examine to what degree participants recall information after a length of time, and to what degree they can apply the knowledge to novel tasks.

Assessment of Interest and Curiosity

There were two main limitations to the assessment of interest and curiosity in the present study. First, the I-type and D-type curiosity measures, while established in the literature (Litman, 2008; Litman & Jimerson, 2003; Litman & Spielberger, 2003), are problematic in the degree to which they capture curiosity as compared to other related constructs. For instance, the items on the D-type curiosity scale present some overlap with conceptualizations of anxiety. Specifically, items include, “I can spend hours on a single problem because I just can’t rest without the answer” and “I brood for a long time to solve a problem” (Litman & Jimerson, 2003, p. 150). To one end, these items map on to the definition of academic or epistemic curiosity as a need or desire for knowledge, information, or the exploration of academic environments (Kang et al., 2009; Litman, 2010; Litman & Silvia, 2006). However, they represent an anxiety- or frustration-driven need to resolve a particular knowledge gap and therefore do not align with other common

aspects of curiosity such as positive emotions (Gallagher & Lopez, 2007; Swan & Carmelli, 1996).

Additionally, it cannot be discerned whether the heightened attention characteristic of curiosity is due to curiosity or to anxiety. Similar challenges can be identified in the I-type scale. In this scale the items may reflect enjoyment rather than curiosity. For instance, items such as "I find it fascinating to learning new information" (Litman & Spielberger, 2003, p. 79) focus on the positive emotions surrounding curiosity and allude to collative variables such as novelty. At the same time, this item does not reflect a need or desire for knowledge or information that defines academic and epistemic curiosity (Kang et al., 2009; Litman, 2010; Litman & Silvia, 2006). Instead, the focus is on the enjoyment of learning something new, which has concerning overlap with interest. Future research should consider whether these items achieve sufficient validity for inclusion in studies of education, and efforts should be made to develop measures of epistemic trait curiosity that more closely reflect conceptual definitions.

Second, retrospective interviews provided some insight into students' motivationally related justifications for source use. However, future studies should also examine in-time measures in addition to retrospective accounts. In-time measurement was determined to be unfeasible in the present study, given the disruption that this would cause during the task and the challenge of determining points during the task to probe students. Previous research that has looked at in-time measures of interest and curiosity has done so either through digital prompts (e.g., Ainley et al., 2009) or through think aloud protocols (see Fox, 2009). Given the presentation of print and digital sources, digital prompts were not determined to be adequate. Further, thinking aloud while

creating a presentation might have been too taxing on working memory. Additionally, the inability to tease interest and curiosity apart in the post-hoc interviews limited the insights gained. Although valuable information related to the target of the interest or curiosity was gained, there was no way to determine whether participants were experiencing interest, curiosity, or both during the task. Moreover, it was not possible to examine whether the targets differed between interest and curiosity. Future research should identify other possible ways to separately capture situational interest and state curiosity.

Separation of Surface and Deep Indicators

Fourth, the separation of task performance into deep and surface indicators was both a delimitation and limitation of the present study. The decision to categorize indicators as either deep or surface was made to maintain consistency with previous studies of multiple source use (Le Bigot & Rouet, 2007; Wiley & Voss, 1996). However, despite the practice of dividing performance into these categories in the multiple source use and educational psychology literatures (Alexander et al., 2010; Wiley & Voss, 1996), this is an artificial separation. In the present study, it was anticipated that within category indicators (e.g., surface-surface) would be more highly correlated compared to cross category indicators (e.g, surface-deep). This hypothesis was not supported, as there were only three significant correlations between surface-level indicators and two significant correlations between deep-level indicators. Additionally, a moderately strong correlation between the sets of surface- and deep-level indicators suggested that this division was not as clear as originally suggested.

Although certain indicators such as making transformations can be well justified as a deeper-level indicator, this classification is not as clear for other indicators. For instance, on the one hand, references, categorized as a deep-level indicator, might be added as a result of building a more specific source model for each text. On the other hand, including references may have been done as a habitual action that students simply regarded as a component required for PowerPoint presentations. Future research should approach performance indicators as falling along a continuum or as representing a range of surface and deep indicators. Additionally, future research should examine overall ratings of performance. This could be done through grades assigned by teachers, or ratings provided by students. Providing an overall performance rating would take into account both surface- and deep-level indicators and would provide an additional meaningful evaluation of task performance.

Inability to Discern Uniqueness and Overlap of Interest and Curiosity

Despite theoretical accounts of the potential overlap and relations between interest and curiosity, a limited number of studies have included measures of both variables (Boscolo et al., 2011; Connelly, 2011; Silvia, 2005, 2008). Thus, there is little empirical evidence regarding the degree to which interest and curiosity are overlapping or related. Although the present study included measures of interest and curiosity, the sample size and data collected did allow for statistical analysis of this question. Future research should recruit a larger sample size in order to apply factor analysis as a means of determining the degree to which interest and curiosity are overlapping or unique. As measures of individual interest and trait curiosity are structured in different ways, this analysis would need to account for measurement differences.

Although the degree of overlap or uniqueness could not be discerned in the present study, the relation between interest and curiosity in their enduring forms was examined. However, the relations between the variables conflicted with the hypothesized relations and differed between the main study and pilot study data. It was hypothesized that interest and curiosity would not be related in their enduring forms of topic interest and trait curiosity. Although it has been suggested that individuals who are more curious have the tendency to be interested in a greater variety of topics, there was no particular reason to hypothesize that increased trait curiosity would be related to interest in Alzheimer's disease and other neurodevelopmental disorders. Yet, for participants in the main study, topic interest was significantly related to I-type curiosity at a moderate level (r=.27). Interest was also related to D-type curiosity (r=.27), that while not significant at the .05 alpha level, was similar. The present study examined topic interest for only one topic, neurodevelopmental disorders, and therefore it is not known whether this relation would extend to interest in a more diverse range of topics.

However, the relation between topic interest and trait curiosity was not present in the pilot data. Aggregating the data from pilot study 1 with the time 1 data for pilot study 2 (n=75), topic interest did not relate to I-type curiosity (r=-.003, p=.98) or to D-type curiosity (r=-.02, p=.88).

Table 39

Summary of Interest and Curiosity for the Main Study and Pilot Studies

	Main Study		**Combined Pilot Studies**	
	Range	**Mean (*SD*)**	**Range**	**Mean (*SD*)**
Topic interest	29-1000	480.80 (223.25)	32-1000	513.57 (223.11)
I-type trait curiosity	13-25	18.58 (3.07)	11-25	19.49 (2.83)
D-type trait curiosity	7-25	16.16 (3.34)	5-25	16.21 (4.01)

An examination of the descriptive statistics for the main study and the combined pilot studies suggests that participants in the main study were similar to the pilot study participants in their overall levels of interest and curiosity (see Table 39). However, it is worth noting that individuals in the pilot studies reported slightly higher topic interest than the participants in the main study (M_{pilot}=513.57, M_{main}=480.80). Given the relations among the variables, it seems that for participants in the pilot studies, the increased interest in neurodegenerative disorders was not accompanied by a similar increase in either type of trait curiosity, thus attenuating the relation in the pilot studies.

The students in the pilot studies, although recruited from courses in the same department as the main study, were enrolled in different courses than the main study participants. Participants in pilot study 1 were recruited from a human development course in creativity, and participants in pilot study 2 were recruited from a course on human development and societal institutions. It is possible that the motivational characteristics of students in the main study who were enrolled in a research methods course differed from students enrolled in the other elective courses. More diverse participant selection is needed to better understand the relations among these motivational variables.

Nonetheless, despite the relation between topic interest and trait curiosity in the main study, topic interest, I-type curiosity, and D-type curiosity exhibited differential relations to multiple source use variables. Specifically, for digital compositional source use, topic interest and D-type curiosity emerged as unique predictors even when controlling for each of the other variables. Topic interest was also a significant unique predictor of digital focused source use. Future research combining factor and regression

analyses has the potential to further explicate the overlap and relations between interest and curiosity.

Video Recording Method

Finally, the novel recording method served as a strength and weakness of this study. On the one hand, it allowed for capturing the data in a way that was not particularly obtrusive to participants. With the ability for the researcher to view participants' in-time actions, the retrospective interviews were linked to participants' multiple source use decisions. This was critical for prompting participants to reflect on their specific reasons for using each of the sources they selected. However, it is possible that the laboratory setting and the awareness that their behavior was being remotely observed encouraged participants to be more diligent and to expend more effort than they typically would have done. Although the head camera may have been unobtrusive compared to other ways of capturing the data (e.g., direct observation by a researcher), this is still a potential limitation. However, when asked what they would have done differently if they were doing this for a class, participants frequently mentioned that they would have spent more time on the task. Although in the present study students were consistently on task perhaps due to the sense of being observed and the lack of distractions, future research should consider how students engage in multiple source use in more typical settings selected by participants.

Given the technological needs of this study, there was a portion of data that were lost data due to equipment malfunction or to errors related to the technology. For example, although the GoPro camera has a battery life of several hours and participants were scheduled in two hour blocks, one participant spent an above average time

completing the task (more than 100 minutes), which did not allow for the battery to be completely charged before the start of the next participant, therefore resulting in lost data. This challenge was unexpected, and was resolved through purchase of an additional battery. Other technical malfunctions arose due to the need to reformat the memory disk for unknown reasons.

Conclusion

This investigation sought to understand how students in the 21st century engage with print and digital sources and the degree to which motivation matters. It uncovered patterns across print and digital sources of various types, suggesting that for students today, navigating multiple sources is a process that engages their understandings of print and digital texts. Moreover, this study suggested that despite tendencies of students to engage with digital sources, when provided with the opportunity to use print sources, students frequently still prefer to do so, and engage with printed sources for a more extended period. Although the relations between motivation and multiple source use processes and outcomes were limited and somewhat disappointing for researchers and teachers hoping to understand how to support source use, there was evidence that students were engaged in multiple source use, and that they experienced some interest and curiosity along the way. As research moves forward and the desire to support students in engaging in the challenging task of knowledge building, it will be important to increase our understanding of what variables do and do not influence source use.

Appendix A: Demographic Questionnaire

1. Age: _____

2. Sex: Male Female Other

3. Race:
– Non-Hispanic White
– Hispanic
– Black
– America Indian
– Asian/Pacific Islander
– Other (Please specify): _____

4. Native English-speaker: Yes No

5. Year in School:
– Freshman
– Sophomore
– Junior
– Senior
– Other: _____

6. Major(s): _____
7. Minor(s): _____
8. Overall GPA: _____
9. How many college-level courses in developmental psychology or human development have you taken? _____
   If any, please list course name and/or UMD course number(s):

10. How many college-level courses in neuroscience or neurophysiology have you taken? _____ If any, please list course name and/or UMD course number(s):

11. How frequently do you use the following materials when doing research for class? Please slide the bar to the appropriate position:

Printed books
Very infrequently |----------| *Very frequently*

Printed articles
Very infrequently |----------| *Very frequently*

Printed pictures or diagrams
Very infrequently |----------| *Very frequently*

Online or electronic books
Very infrequently |----------| *Very frequently*

Online articles
Very infrequently |----------| *Very frequently*

Online pictures of diagrams
Very infrequently |----------| *Very frequently*

Appendix B: Topic Interest Questionnaire

Please rate each of the following topics by making a corresponding slash on the line:

1. **Down's Syndrome**

   Not at all interested |----------| *Very interested*

2. **Parkinson's Disease**

   Not at all interested |----------| *Very interested*

3. **Alzheimer's Disease**

   Not at all interested |----------| *Very interested*

4. **Tourette's Syndrome**

   Not at all interested |----------| *Very interested*

5. **Multiple Sclerosis**

   Not at all interested |----------| *Very interested*

6. **Autism**

   Not at all interested |----------| *Very interested*

7. **Epilepsy**

   Not at all interested |----------| *Very interested*

8. **Dementia**

   Not at all interested |----------| *Very interested*

9. **Huntington's Disease**

   Not at all interested |----------| *Very interested*

10. **Cerebal Palsy**

    Not at all interested |----------| *Very interested*

Appendix C: Trait Curiosity Questionnaire

Instructions: Respond to each of the following statements according to how you *generally feel*.

Instructions: Respond to each of the following statements according to how you *generally feel*.

	Almost never				Almost always
Interest-Type Epistemic Trait Curiosity					
1. I enjoy exploring new ideas	1	2	3	4	5
2. I find it fascinating to learn new information	1	2	3	4	5
3. I enjoy learning about subjects that are unfamiliar to me	1	2	3	4	5
4. I enjoy discussing abstract concepts	1	2	3	4	5
5. When I learn something new, I like to find out more about it	1	2	3	4	5
Deprivation-Type Epistemic Trait Curiosity					
6. I can spend hours on a single problem because I just can't rest without the answer	1	2	3	4	5
7. I brood for a long time to solve a problem	1	2	3	4	5
8. Conceptual problems keep me awake thinking	1	2	3	4	5
9. I become frustrated if I can't figure out the problem, so I work harder	1	2	3	4	5
10. I work like a fiend at problems that I feel must be solved	1	2	3	4	5

Appendix D: Topic Knowledge Measure

Items marked with a * were retained for analysis in the main study.

Select the best response to each of the following questions:

1. Alzheimer's Disease can be definitively diagnosed through
    a. Psychological testing
    b. Behavioral observation
    c. Brain autopsy
    d. Genetic testing

2. *Which of the following genes has been identified as a risk factor for late onset Alzheimer's disease:
    a. APOE
    b. CFTR
    c. SOD1
    d. SAPAP3

3. *For individuals in the early stages of Alzheimer's disease, which of the following is most affected?
    a. Short-term memory
    b. Long-term memory
    c. Mobility
    d. Personality

4. *Alzheimer's disease is associated with abnormal levels of:
    a. Glutamate
    b. Myelination
    c. Hemoglobin
    d. Beta-amyloid plaques

5. The presence of which of the following in the brain has been associated with Alzheimer's Disease?
    a. Dopamine abnormalities
    b. Prion abnormalities
    c. Vascular abnormalities
    d. Insulin abnormalities

6. Early onset Alzheimer's disease is diagnosed as occurring prior to which of the following ages?
    a. 25
    b. 40
    c. 60
    d. 75

7. *Which of the following accurately describes the relation between “Alzheimer’s” and “dementia”?:
    a. Alzheimer’s causes dementia
    b. Alzheimer’s and dementia are synonyms
    c. Dementia causes Alzheimer’s
    d. Alzheimer’s is a severe type of dementia

8. *Which of the following symptoms often appears for the <u>first time</u> in the <u>late</u> stages of Alzheimer’s disease?
    a. Swollen joints
    b. Hallucinations
    c. Convulsions
    d. Memory difficulty

9. Which of the following is symptom of Alzheimer’s disease and is not a typical sign of aging?
    a. Forgetting what day of the week it is
    b. Losing keys from time to time
    c. Forgetting how to use a pencil
    d. Difficulty balancing a checkbook

10. Which of the following is not a change in the brain associated with Alzheimer’s disease:
    a. Neuronal proliferation
    b. Increased ventricles
    c. Decreased hippocampus
    d. Shrunken cerebral cortex

Appendix E: Source List

Printed Sources		
Source	**Citation**	**Description**
Textbook	Berger, K. S. (2011). *The developing person through the life span.* New York: Worth.	Section of a developmental psychology textbook on Alzheimer's Disease
Book	Ali, N. (2012). *Understanding Alzheimer's.* New York: Rowman & Littlefield.	Book covering topics related to Alzheimer's Disease
Encyclopedia	American Medical Association. (2006). *Concise medical encyclopedia.* New York: Random House.	Entry from a medical encyclopedia on Alzheimer's Disease
Graph	National Vital Statistics System (2010). *Age-adjusted death rates for Alzheimer's disease.* Retrieved from: http://www.cdc.gov/nchs/data/databriefs/db116.htm	Bar graph depicting frequency of death rates for Alzheimer's Disease across races and ethnicities
Image	InTech Science. (n.d.). *Neuron comparison image.* Retreived from http://www.intechopen.com/books/neurodegenerative-diseases/therapeutic-interventions-in-alzheimer-disease	Contrasting pictures of neurons in brains with and without Alzheimer's Disease
Fact sheet	Alzheimer's Disease Education & Referral Center (2011). *Alzheimer's disease fact sheet* [Brochure]. Bethesda, MD: National Institute on Aging.	Printed informational handout on Alzheimer's Disease
Journal article	Williams, S. C. P. (2013). Mapping the brain's decline. *Nature, 502,* S84-S85.	Article in a journal on how brain imaging provides insights into Alzheimer's Disease
News article	Gallagher, J. (2013, October 10). Alzheimer's breakthrough hailed as 'turning point.' *BBC News.*	News article on a brain chemical that may prevent death of cells affected by Alzheimer's Disease

Digital Sources		
Source	**Citation**	**Description**
Textbook	Dunn, W. L., & Craig, G. J. (2013). *Understanding human development* (3rd. ed.). New York: Pearson.	Pages from a developmental psychology textbook on Alzheimer's Disease

Book	Draper, B. (2013). *Understanding Alzheimer's disease and other dementias.* [Kindle version]. Retrieved from Amazon.	Book covering topics related to Alzheimer's Disease
Encyclopedia	University of Rochester Medical Center (2014). Health encyclopedia. Retrieved from http://www.urmc.rochester.edu/Encyclopedia	Entry on Alzheimer's Disease from an online health encyclopedia
Graph	Harvard School of Public Health (2011). *Public's perception of common symptoms of Alzheimer's disease* [Graph]. Retrieved from alzheimer-europe.org	Bar graph comparing perception of whether common symptoms are associated with Alzheimer's Disease
Image	Malonie Health. (n.d.). *Brain comparison image* [Image]. Retrieved from www.malonie.com	Contrasting pictures of a brain with and without Alzheimer's Disease
Fact sheet	UCSF Memory and Aging Center (2014). *Alzheimer's disease.* Retrieved from http://memory.ucsf.edu/education/diseases/alzheimer	Online informational handout on Alzheimer's Disease
Journal article	Kosik, K. S. (2013). Study neuron networks to tackle Alzheimer's. *Nature, 503,* 31-32.	Article in journal on how monitoring collections of neurons provides clues to Alzheimer's Disease
News article	Gupta, S. (2013, August 18). Can we predict Alzheimer's a decade before symptoms? *CNN Health.* Retrieved from http://www.cnn.com/2013/08/17/health/alzheimers-test-eye/	Online news article on novel methods to identify factors related to Alzheimer's Disease

Appendix F: Source Comparability

Source type	Tone and Audience	Credibility	Length and Format
Textbook	Textbook for undergraduate course in human development	Written by university professors with expertise in psychology and development; includes scholarly references	Print: 4-page segment Digital: 4-page segment
Book	Popular press book written for patients and caregivers; includes technical terminology	Written by medical doctor (print) or dementia researcher (digital); reference scholarly research	Print: 367 pages Digital: 223 pages
Encyclopedia	General medical encyclopedia for general, non-technical audience	Edited by established medical organizations	Print: 467 words Digital: 456 words
Graph	Graph to accompany news brief or website for general audience	Created by respected governmental organizations	Print: 1 page, bar chart with 4 categories Digital: 1 page, bar chart with 5 categories
Image	Image to accompany website for general audience	Limited source information included	Print: 1 page, picture of 2 brains Digital: 1 page, picture of 2 neurons
Fact sheet	Brochure written for general audience of patients and caregivers	Created by respected health organizations	Print: 2740 words Digital: 2003 words
Journal article	Technical article written for general scientific or research audience	Peer-reviewed journal article summarizing scholarly research with citations	Print: 1738 words Digital: 1404 words
News article	Popular press article written for general audience	Articles by correspondents for popular press news outlets; reference to scholarly studies	Print: 613 words Digital: 638 words

Appendix G: Coding Scheme for PowerPoint

Category	Abbreviation	Description
Borrowed	B	Information taken directly or paraphrased from a single source with only slight modifications Information taken from one or more sentences of text or from information visible within a graph without making inferences or interpretations If information came from more than one sentence or part of a visual representation, any connections that were made were directly stated or visible (e.g., the text stated that there were three brain changes and described these in separate sentences, and the participant combined them in a list in the same sentence)
Added	A	Information that could not be directly accessed or inferred from any of the selected sources Information from prior knowledge or experiences; could be drawn from personal or academic background
Within Source Transformation	TW	Inference or conclusion formed from the information contained in a single source OR information within a single text combined in a novel way within the source Could involve the addition of prior knowledge to draw conclusion or inference of the material in a source but is focused on information within the source rather than an addition
Multiple Source Transformation	TM	Inference or conclusion from information in more than one source OR information combined from multiple sources Could involve the addition of prior knowledge to draw conclusion or inference of the material in multiple sources but is focused on information within the source rather than an addition

Appendix H: Interview Protocol

In order of source use, ask participant questions.

Questions for each source

- Why did you choose to look at or use this source?
- How did you use this source?

Repeat for each source used. Participants may revisit the source in order to remind themselves of the content of the source.

Questions for PowerPoint

- Going through each of your slides, why did you choose to include what you did in your PowerPoint?

General Questions

- Now that you've done this task, would you want to learn more or read more about Alzheimer's Disease or some aspect of this topic? Why or why not?
- Are there particular aspects of the topic or the sources that drew you in?
- How interested or curious did you feel while doing this task? Why? Can you explain?
- As you were doing the task, did your interest or curiosity increase, decrease, or stay stable?
- How typical was this task to something you might do for a class?
- How is what you did similar to or different from what you would normally do for an assignment like this?

Appendix I: Source Use Coding

View Codes

Abbreviation	Code	Description
Digital Source		
OB	Digital Book	Single digital source in view; if more than one source or object in view, there is evidence (e.g., pointing, proximity to camera, central placement, obstruction by source of other objects, inclusion of source material directly into PPT) to indicate that the one specific print source is receiving attention.
OFS	Digital Fact Sheet	
OT	Digital Textbook	
OG	Digital Graph	
OI	Digital Image	
OE	Digital Encyclopedia	
OJ	Digital Journal	
ON	Digital News Article	
Print Source		
PB	Print Book	Single print source in view; if more than one source or object in view, there is evidence (e.g., pointing, proximity to camera, central placement, obstruction by source of other objects, inclusion of source material directly into PPT) to indicate that the one specific print source is receiving attention.
PFS	Print Fact Sheet	
PTX	Print Textbook	
PG	Print Graph	
PI	Print Image	
PE	Print Encyclopedia	
PJ	Print Journal	
PN	Print News Article	
PowerPoint		
PPT	PowerPoint	Only PPT in view
OPC	Digital source and PowerPoint combination	Simultaneously have PPT and digital source open; *include specific digital source in notes*
PPC	Print source and PowerPoint combination	Simultaneously have PPT and and print source open in view; *include specific print source in notes*
RDP	Directions or Reference List and PowerPoint combination	Simultaneously have PPT and directions and/or reference list in view
NPC	Notes and PowerPoint combination	Simultaneously have PPT and notes in view
Other		
MUL	Multiple sources open at once	More than one source open; could be multiple print, digital, or combination; *include specific sources in notes*
NSC	Notes and source combination	Simultaneously have notepad/notesheet and print or digital source open; *include specific source in notes*
DIR	Direction sheet	Only direction sheet in view; use same indicators as print and digital sources if in view alongside other materials
REF	Reference list	Only reference list in view; use same indicators as print and digital sources if in view alongside other materials
RD	Reference list and directions sheet	Viewing both the reference list and direction sheet with no additional indication of which one is attended to
DRS	Directions or Reference List and Source	Simultaneously have print or digital source and directions and/or reference list in view; *include specific souce in notes*
HP	Digital homepage	Only homepage open
NO	Notes only	Looking at notesheet only
SP	Scanning print sources	Looking back and forth between print sources without picking up any
TH	Other	Looking at materials unrelated to the study (e.g., looking around the room, checking cell phone, searching other webpage outside given resources); or adjusting camera

Action codes

Abbreviation	Code	Description
Actions associated with PowerPoint		
TYPE	Typing	Typing, adding text, copying-pasting, moving text, deleting text, highlighting text; Can be in PowerPoint or notepad (or handwritten notes)
FORM	Format	Changing the size, font, color of the text/textbox; changing the background
STAT	Static	Inactive/static; no changes to text or formatting; scrolling through without making changes; clicking to another page
PIC	Picture	Inserting or formatting picture; includes resizing, and repositioning
Actions associated with Print sources		
TYPE	Typing	Typing, adding text, deleting text, highlighting text while vision is directed at print source; can be in PowerPoint or notepad (or handwritten notes)
SCAN	Scanning	Flip through pages at a speed that is too fast to read/comprehend material
STAT	Static	Stationary; stay on page or slowly flip page at pace that material could be read/comprehended
CLOSE	Closing and put away print source	Closing and putting back book
TOUCH	Touching source	Touch source, may lift slightly, but not out of the plane of the rack; doesn't pick up fully; for books, only cover is viewed
Actions associated with Digital sources		
TYPE	Typing	Typing, adding text, deleting text, highlighting text while vision is directed at digital source or if both source and PPT open; can be in PowerPoint or notepad (or handwritten notes)
SCAN	Scanning	Scroll through pages at a speed that is too fast to read/comprehend material
STAT	Static	Static; stay on page or slowly scroll at pace that material could be read/comprehended
RESIZE	Resize or rotate	Changing the size of the digital source; change the orientation of the digital source (e.g., rotate 90 degrees)

Appendix J: Two-Level Coding Scheme for Post-Hoc Expressions of Interest/Curiosity

First Level of Coding: Interest/Curiosity-Related Expressions

Interest/Curiosity	Not Interest/Curiosity
▪ Expressions including the terms *interest* or *curiosity*, or any iterations of these terms ▪ Wanting to learn, see, find out, or know something ▪ Expressions noting that attention was caught	▪ Expressions regarding whether something was *liked* or *enjoyed* ▪ Expressions regarding wanting to do or to add something

Second Level of Coding: Target of Interest/Curiosity

	Description	Examples
Content	Expressions related to the material contained within sources or the desire to learn about or retrieve the information contained within a source. Included explanations related to the interest/curiosity of the title.	*Participant 7:* "I wanted to see more of the brain." *Participant 35*: "I was curious to see what each one had to offer"
Source Features	Expressions that mentioned the type of source or the features of a source as the cause of interest/curiosity. Included expressions related to the images on the outside cover of the source.	*Participant 43*: "I looked at all the graphs. I'm a very visual person, so I sort of wanted to see what was here." *Participant 9:* "I was just looking a printed sources and they seemed easy to go through so it automatically caught my eye."
Audience	Sensitivity to what the audience of their presentation would find interesting/curious, or a desire to increase the interest/curiosity of the audience.	*Participant 25:* "I needed a picture…to make it interesting." *Participant 2*: "…because they're going to go to college, they're going to go to medical field or research or whatever, so maybe that kind of interests them to maybe I want to look more into this."

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