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Examining Instant Messaging Impact On Learning Using An Integrated Worked-example Format

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EXAMINING INSTANT MESSAGING IMPACT ON LEARNING USING AN INTEGRATED WORKED-EXAMPLE FORMAT

by

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ABSTRACT

Instant messaging with Internet-based software is a ubiquitous form of communication in industrialized nations. In fact, many educators are observing that students engage with instant messaging while simultaneously engaged in academic activity. Though this type of multitasking is pervasive, educational researchers have not examined how the practice of instant messaging impacts learning outcomes. This dissertation describes the background, empirical and theoretical foundations, methods and results of a study examining the impact of instant messaging activity on learning, where instant messaging and learning are simultaneous activities. The question posed is grounded in the related areas of instant messaging practices, the Generation M profile, Cognitive Load Theory, and integration of instant messaging in K-16 classrooms. This work presents empirical evidence pointing out the necessity of conducting empirical study regarding how instant messaging activity might impact learning. Quantitative methods used to conduct the study are presented including data collection instruments.

The results of the study are discussed in broad terms related to Generation M and Cognitive Load Theory. Methodological limitations related to practice opportunities for the research sample as well as the performance measure used are detailed. In addition, implications of the results in relationship to those teaching members of Generation M in K-16 classrooms as well as those designing instruction for this population are discussed. The discussion concludes with recommendations for further research in this area.

DEDICATION

For Vincent and Marie-Therese

and

For those who have gone before and those who are yet to be.

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CHAPTER 1: INTRODUCTION

As with the emergence of new technologies in the past, during this first decade of the 21st century, educational researchers and practitioners in industrialized nations like the U.S. have turned their attention toward students use of digital technology (Ba, Tally, & Tsikalas, 2002; Brown, 2002; Salaway, Caruso, & Nelson, 2007; Prensky, 2001a,b). This movement has provided an additional line of inquiry to the investigation of how digital technology might enhance the classroom experience, a topic common in research literature since the 1990s (Kuh & Vesper, 1999). Most of the studies regarding digital technology use by the current Kindergarten through grade 16 (K – 16) population provide insight related to a variety of trends toward which this group is moving (Dede, 2005; Salaway, Caruso, & Nelson, 2007; Jones, Harmon, & O'Grady-Jones, 2005; Oblinger & Oblinger, 2005; Rideout, Roberts, & Foehr, 2005). In addition, there is a substantial amount of extant discussion focusing on the subject of practices related to teaching and learning with digital technology in contemporary classrooms (Dornisch & Sperling, 2006; MacGregor & Lou 2004; Talbert-Johnson & Oberlander, 2004).

Essentially, many scholars believe that teacher-education faculty and K – 12 teachers must become more adept at seamless inclusion of digital technology in curriculum to effectively educate today's students (Dexter, Doering & Reidel, 2006; Dornisch & Sperling, 2006; MacGregor & Lou, 2004; Neo, 2007). One might assume that there is conclusive evidence about the impact of digital technology use on learning because scholars are increasingly focused on this issue. This is not the case, as some scholars lament the absence of research establishing whether or not K – 16 students' digital technology use impacts learning outcomes (Dornisch & Sperling, 2006; Penman & Lai, 2003).

This study examines the impact of instant messaging on a learning task. Instant messaging is a synchronous form of communication facilitated by Internet-connected computers and is one of

the most popular forms of digital technology in use by those with access to such equipment (Rideout, Roberts, & Foehr, 2005). A variety of studies examine issues related to the influence of digital technology on the teaching and learning process. Much of the work addresses teacher preparation (Motteram, 2006; Wedman & Diggs, 2001), improving instruction through multimedia design (Cairncross & Mannion, 2001; Zydney, 2005), and technology integration – both general and subject-specific (Dexter, Doering & Riedel, 2006; Dornisch & Sperling, 2006; Rowley, Dysard, & Arnold, 2005). In addition, there are studies which examine the digital technology use profile of current K – 16 students. Multitasking is one habit of the current school-aged population receiving a fair amount of attention, albeit indirectly. That is, many studies examine how to integrate instant messaging with instruction. In addition, there are studies investigating the impact of other computer-mediated communication media both in and out of the school setting (Burnett, Dickinson, McDonagh, Merchant, Myers, & Wilkinson, 2003; Uhler & Bishop-Clark, 2001). Dresner and Barak (2006) go as far as referring to "conversational multitasking" in CMC environments as a communication competency. However, these studies and others like them, fail to study the direct impact of CMC such as instant messaging on learning outcomes (Cox, Carr, & Hall, 2004; Hrastinski, 2006; Penman & Lai, 2003).

Consistent with the lack of research on digital technology use impact is the dearth of empirical work focusing on how instant messaging habits impact the engagement of working memory during encoding of new information. Most instant messaging studies focus on how the medium is used to present information or provide a sense of community for students. Indeed, much of the literature investigating instant messaging produces trends in facilitating distance education (Contreras-Castillo, Perez-Fragoso, & Favela, 2006) as well as library services and student affairs activities in higher education settings (Rutter, 2006; Taddeo, 2006).

The Problem

The problem educators are facing is a lack of empirical evidence to guide research and practice. We do not know the extent to which simultaneous use of instant messaging during learning impacts learning outcomes. Therefore, the purpose of this study was to examine the impact of instant messaging on a learning task. This study addresses a need in the fields of teacher preparation, educational technology, and instructional design to understand how the unique multitasking behavior of digitally literate students impacts contemporary teaching and learning.

Research Question and Hypothesis

In an effort to address the lack of empirical research related to instant messaging impact on learning, this study explored the following question:

> Is student performance during lesson implementation affected by intermittent instant messaging activity?

The study tested the following hypothesis to address the aforementioned research question:

> H_0: There is no statistically significant difference in assessment score between students who engage in intermittent instant messaging and those who do not engage in intermittent instant messaging during lesson implementation.

For this study lesson implementation was defined as a method for delivering to-be-learned content via face-to-face interaction where multimedia design methods are often employed. Student performance was measured by participant achievement on a criterion-referenced assessment designed to test the instructional lesson presented in an introductory educational technology course. Finally, intermittent instant messaging was defined as instant text-based communication via the Internet where presence awareness capability exists facilitating the

periodic exchange of information among members in the same network (Cameron & Webster, 2005).

The post-test only with control group design was employed to test the hypothesis for this study. Participants were admitted as undergraduates under the same academic requirements in the college of education at a large metropolitan university located in the Southeastern U.S. For this post-test only with control group research design, intermittent instant messaging was the treatment and the main variable (X_1). The research design is represented thusly:

R	X_1	O_1
R		O_2

Figure 1. Post-test only with control group research design

This study was conducted with sections from the Spring 2008 offering of the introductory educational technology course at the selected university, EME 2040: Introduction to Educational Technology. Students taking this course are a subset of the population under study and represent grade levels 13-16. To determine participants' various levels of instant messaging engagement, an Instant Messaging Engagement Questionnaire was administered prior to random assignment to either the control or treatment group. The lesson with accompanying assessment was used to measure the impact of the instant messaging treatment. Finally, a post-treatment questionnaire was administered to the treatment group, the purpose of which was to confirm participants' levels of instant messaging engagement during lesson implementation.

Various design and research techniques were employed to facilitate effective data collection efforts. The InspireData software lesson (hereafter referred to as InpireData) was designed to include the integrated worked-example format (Atkinson, et al, 2000) which is described below. Threats to validity related to the maturation and history effects (Shadish, Cook, & Campbell,

2002) were addressed by implementation of new content for the participants using the integrated worked-example instructional approach as well as the post-test only with control group research design. Data were analyzed using the analysis of variance statistical procedure to evaluate differences between assessment scores for those in the control and treatment groups.

This study focused on one aspect of the digital technology use habits of today's students: computer-based communications for multitasking. Computer-based communications is often referenced in the research literature as computer-mediated communication (CMC) and includes synchronous forms of communication like instant messaging. While CMC is inclusive of all forms of communication via Internet-connected computer (Pena-Shaff, Martin, & Gay, 2001), synchronous communications narrows the focus to real-time communications via computer (Penman & Lai, 2003). However, the term instant messaging captures the essence of the synchronous communication format under review, which is instant communication via the Internet where presence awareness capability (e.g. knowing who is available to communicate) exists (Cameron & Webster, 2005). Therefore, this study used instant messaging when referring to synchronous CMC.

Researchers are beginning to explore the possibility of predicting motivation to use instant messaging among members of Generation M (Chung & Nam, 2007) where results show that self-efficacy and usefulness are factors in the decision to engage with instant messaging. However, it is clear that members of Generation M engage with instant messaging to maintain friendships, family relationships, and social networks (Valkenburg & Peter, 2007) even while simultaneously engaged with other activities such as gaming and doing homework. Indeed, instant messaging activity occurs under a variety of circumstances including social as well as work and school (Shaw, Scheufele, & Catalano, 2007). This study examined the social aspects of

instant messaging while participants were simultaneously engaged in a learning activity. Specifically, this proposal outlines a study where instant messaging activity occurred while learning when new information was being presented. Participants accessed existing instant messaging contacts available during the delivery of new content in a face-to-face section of the course accessed for observation.

Overview of Empirical and Theoretical Foundations

A variety of literatures embodying theory, practice, and survey analysis informed the pursuit of this inquiry. The following section details the extant discussion of the various topics which converge in the study. The conceptual framework supporting this study is from four distinct areas of educational research: (a) Generation M, (b) Instant Messaging, (c) Cognitive Load Theory, and (d) Instant Messaging in the Classroom. This overview begins with a look at the Generation M Profile and continues by reviewing instant messaging, cognitive load theory, and instant messaging in classrooms. Research from these areas is further detailed in chapter 2.

Generation M

It was critical to provide an appropriate name for the population under consideration in this study. This study focuses attention on current undergraduate teacher-education students from industrialized nations like the U.S. When referring to this group of students, scholars and educators have devised a number of labels. Table 1 lists the most popular trends in naming current K – 16 students along with the defining characteristics of each.

Table 1. Trends for naming today's student population

Name	Author/Defining Characteristics
Digital Natives	Those persons within the current K - 16 school population who use digital technology in their lives daily (Prensky, 2001a).
Generation M	Where 'M' = media: Those within the current age 8 - 18 population with the ability to adapt to the pace of change for all communication media (Rideout, Roberts, & Foehr, 2005).
Net Generation	Where 'Net" = Internet: Those within the current K - 16 school population with ability to develop literacy with multiple media forms (Oblinger & Oblinger, in Oblinger, 2005).
Millennials	Those within the current K - 16 school population who maintain a high level of social interaction with family and friends through highly skilled use of information technology (Strauss & Howe, 1992).

Given the variety of naming conventions for the current K – 16 population, it was necessary to select one which clearly identifies the population being investigated; therefore, this study used the Generation M label during implementation because it is inclusive of aspects described in each identifier listed in Table 1. The reader will note that Generation M is defined as those within the current age 8 - 18 population who have the ability to adapt to the pace of change for all communication media (Rideout, Roberts, & Foehr, 2005). However, given that the oldest members of Generation M are now populating undergraduate classrooms, it was appropriate to use the Generation M moniker for the population under study. Additionally, the work of both Oblinger & Oblinger (2005) and Strauss and Howe (1992) suggest that university freshman and

sophomore level students be included for this examination of instant messaging impact on learning outcomes. The reader should bear in mind that the scope of this study does not include the entire population of Generation M as described in the work of Rideout, Roberts, and Foehr (2005).

The myriad naming conventions for Generation M discussed earlier underscore the intensity of academic discussion in terms of the varied and unique characteristics of today's K – 16 students. There are those who indicate that the uniqueness of Generation M is manifested in its distinction of being the very first generation of students born into a society where digital technology use is completely ubiquitous (Brown, 2002; Oblinger, 2005; Prensky, 2001a). The oldest members of Generation M (now about age 21) were born around the time personal computers were introduced, and they all have used computers and other digital devices by the time they reach their late teens (Salaway, Caruso, & Nelson, 2007; Oblinger, 2005; Rideout, Roberts, & Foehr, 2005).

Rideout, Roberts, and Foehr (2005) and Salaway, Caruso, and Nelson (2007) agree that Generation M has an unprecedented amount of access to all kinds of media, digital or otherwise. Rideout, Roberts, and Foehr also found that the access to and utilization of new media has not detracted from the use of previously existing media such as television and music. As an example, the authors cite findings which state that members of Generation M who spend the most time using computers during the day watched approximately one hour more of TV and listened to one hour more of music than those who reported not using a computer during the same time period.

The Salaway, Caruso, and Nelson (2007) study asked a national sample of over 27,000 undergraduate students to classify how they used computers on a weekly basis. Table 2

highlights some of the responses to items related to activities and hours spent on a computer per week.

Table 2. Activities and hours spent on a computer per week

Activity	Hours engaged per week
Surfing the Internet for pleasure	1-2
Creating, reading, sending email	1-2
Instant messaging	3-5
Downloading media (music/video)	1-2
Playing computer games	<1

Taken individually, the amount of time survey respondents spent engaged in a given digital technology activity per week may not seem overwhelming. However, when the activity timeframes in Table 2 are combined, the result is that respondents spent an average of between 7 and 11 hours per week engaged in some form of computer-related activity where digital media were often incorporated (Salaway, Caruso, & Nelson, 2007).

Some scholars have suggested that all of this multimedia access should have an impact on the teaching and learning process (Ba, Tally, & Tsikalas, 2002; Brown, 2002; Prensky, 2001b); however, one will not find a definitive study where the impact of digital technology use on learning is quantified by student achievement on a learning measure. Studies typically explore how one kind of digital technology or other impacts student participation, attitude, and engagement in learning (Cox, et al, 2004; Hrastinski, 2006; Nicholson, 2002; Pelowski, Langley, Cabral, & Yu, 2005).

Instant Messaging

This study makes a statement regarding the impact of instant messaging on learning where there is a lack of empirical review (Cox, et al, 2004; Hrastinski, 2006; Rutter, 2006). In other words, there are no studies published which explains the degree to which instant messaging activity impacts learning outcomes. Instant messaging is a form of computer-mediated communication which may be defined as messages composed using "messaging" software which arrive to recipients singly while multiple interactions with other individuals is possible via a presence awareness component (Cameron & Webster, 2005; Kubey, Lavin, & Barrows, 2001; Penman & Lai, 2003). Most of the research on instant messaging is trending toward curriculum integration in elementary through graduate school environments (Burnett, et al, 2003; Cox, et al, 2004; Pena-Shaff, et al, 2001), impact on student interaction and participation (Dietz-Uhler & Bishop-Clark, 2001; Pena-Shaff, et al, 2001; Rutter, 2006), and academic support (McCreary, Ehrich, & Lisanti, 2001; Penman & Lai, 2003; Taddeo & Hackenberg, 2006). There is some argument against the ubiquitous use of digital technology in general and instant messaging in particular by Generation M (Kubey, et al, 2001); however, recent trends in studies of instant messaging encourage its use in academic settings (Cox, et al, 2004; Hrastinski, 2006; Nicholson, 2002; Pelowski, et al, 2005).

This study attempts to address some of the methodological issues raised by preceding studies evaluating the impact of instant messaging including elimination of sample self-selection, unequal comparison groups, low sample size, and instrument validation. These issues are further detailed in chapter 3.

Cognitive Load Theory (CLT)

CLT has been applied by those designing instruction because of its insistence on reducing working memory load, thereby increasing information processing and encoding during the learning process. CLT exploits the link between a limited working memory and a virtually unlimited long-term memory (Bruning, Schraw, Norby, & Ronning, 2004). In fact, CLT posits that long-term memory schemas (cognitive structures – or schematics – of various concepts and processes) are developed in and transferred from working memory to long-term memory. Another important aspect of CLT is categorization of cognitive load. A discussion of the three types of cognitive load assumed to be created during instruction: intrinsic, extraneous, and germane (Sweller, van Merrienboer, & Paas, 1998) is important when considering the Generation M's proclivities toward multitasking behavior. Indeed, Generation M is known to engage with digital technology media while working on a learning task (McMahon & Pospisil, 2005; Oblinger, 2005; Rideout, Roberts, & Foehr, 2005).

CLT research examines how the various kinds of cognitive load for specific learning tasks are impacted by a variety of effects (i.e. redundancy, split-attention, expertise reversal, worked-example, etc.). In other words, these studies have been designed to examine the cognitive load placed on individuals engaged in learning a new concept or task onto which all their available cognitive resources are focused during the treatment period. CLT researchers have not focused attention on the cognitive processing abilities of Generation M which may include the ability to split cognitive resources between different tasks while learning. Related to the ideas behind CLT is that of divided attention (DA) which will be discussed in chapter 5. This study adds to the extensive body of CLT research by focusing attention on how multitasking via instant messaging during learning impacts the learning outcome.

Integrated worked-example lesson format.

Participants in this study were presented with content designed, in part, using CLT's integrated worked-example format. This format has been shown by CLT researchers to be a very effective design for introducing new material to learners (Mwangi & Sweller, 1998; Stark, 2003). The notion of integrated worked-example content presentation is simple. Essentially, a concept is presented with an integrated explanation of its components in order to reduce both intrinsic and extraneous cognitive load (Atkinson, Derry, Renkl, & Wortham, 2000). Consider the format of Figure 2 where a completed cluster diagram (e.g.mind map) for an essay on music is illustrated.

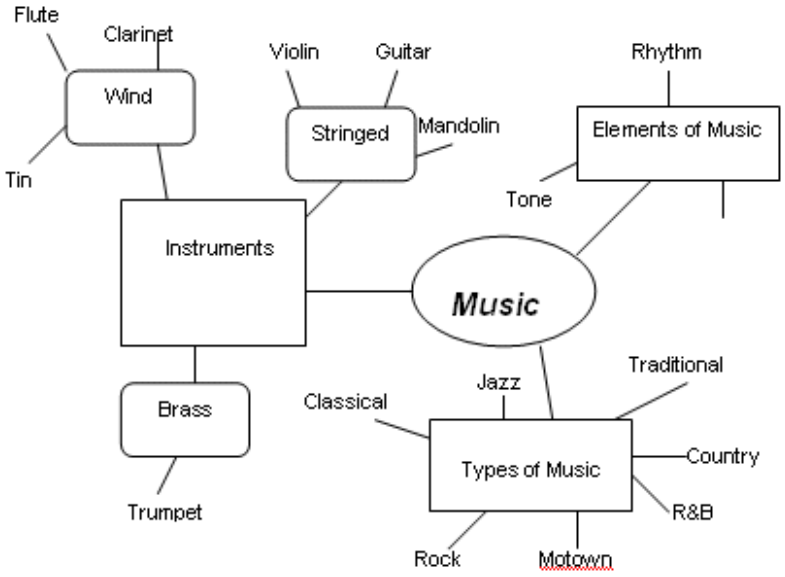

Figure 2. Worked example presentation of essay brainstorming from http://www.qub.ac.uk/images/cramlap/exemplars/19a.gif

The idea illustrated in Figure 2 is to give students and example of how each part of an essay on any particular topic may be outlined at the main and sub-topic as well as details levels. In essence, the essay outlining method has been "worked" through as an example for novice level learners.

Instant Messaging in the Classroom

There is increasing interest among teacher-educators to improve preparation of pre-service teachers to integrate digital technology in the context of subject integration (Dexter, Doering, & Reidel, 2006). Scholars writing about the nation's teacher education program describe a lack of digitally-well prepared pre-service teachers entering the field (Fryer, 2005; Longhorn, 2001; Porter, Ledong, & Rivard, 2005; Prensky, 2001b). In fact, many teachers report that they have been ill-prepared to work effectively with digital technology and content in the classroom (Fryer, 2005; Ireh & Bell, 2002; Wedman & Diggs, 2001). This trend is also prevalent among those studying the proliferation of instant messaging among Generation M. Literature in this area can be categorized into two areas: (a) Generation M Engagement with Instant Messaging, and (b) classroom integration of instant messaging.

Pedagogical use of instant messaging. Many researchers are examining how pedagogical uses of instant messaging may enhance or detract from student learning (Burnett, Dickinson, McDonagh, Merchant, Myers, & Wilkinson, 2003; Kubey, Lavin, & Barrows, 2001; Wang & Beasley, 2006). Though most studies reviewed here report inconclusive results, researchers agree that finding authentic uses for instant messaging within learning contexts is worthwhile.

Significance

The significance of the problem addressed by this study is noted in the proliferation of digital technology use by students outside of the school setting (Salaway, Caruso, & Nelson, 2007; McMahon & Pospisil, 2005; Rideout, Roberts, & Foehr, 2005; Windham, 2005). As more and more digitally literate students and teachers enter classrooms, colleges of education and school systems will need to equip teachers with useful strategies to meet the unique educational needs presented by the prevailing preference of students to use digital technology while learning

(Dede, 2005; McMahon & Pospisil, 2005; Windham, 2005). Essentially, the view of many scholars is that teacher-education faculty and K – 12 teachers must become more adept at seamless inclusion of digital technology like instant messaging in curriculum to effectively engage today's students (Dexter, Doering & Reidel, 2006; Dornisch & Sperling, 2006; MacGregor & Lou, 2004; Neo, 2007).

In addition, the significance of this study points toward broad implications for its results. Understanding how access to and use of digital technology impacts learning outcomes is far-reaching and may influence the direction of future CLT studies with Generation M as well as using instant messaging in classroom contexts. In other words, the ANOVA results reported in chapter 4 may prompt CLT researchers to begin investigating how Generation M students are able to learn new information while dividing cognitive resources between distinct tasks. Indeed, this study may prompt CLT researchers to focus specifically on Generation M as they continue to investigate human information processing. Generation M's instant messaging habits might impact the efficiency with which working memory operates as they acquire new information.

In addition to providing CLT researchers with information, teacher-education programs can look to this study for information as to how incorporating instant messaging into curriculum impacts learning outcomes. Moreover, teacher-education programs may look to replicate this study to determine if pre-service teachers are impacted by their instant messaging activity during learning. Additionally, instructional designers will see practical application for instructional design issues in terms of considering the information processing habits of various audiences. Specifically, instructional designers will be able derive useful information from this study to append to existing techniques for the analysis, design, and development of instructional materials

for audiences who routinely engage in multitasking behavior. Finally, the results of this study answer a resounding plea for empirical review of how instant messaging impacts learning.

Summary

The four areas of research which inform this study are drawn together in commonality by the Generation M thread. In essence, it is important for educators at all levels to understand how this demographic group processes information, and it is important to provide a stable theoretical framework within which investigation related to Generation M information processing can occur. Using the tenants of CLT to explore Generation M's information processing practices will provide such a framework.

CHAPTER 2: REVIEW OF LITERATURE

The conceptual framework driving the need to conduct this study is based on four research areas: (a) Generation M, (b) Instant Messaging, (c) Cognitive Load Theory, and (d) Instant Messaging in the Classroom. However, each of these areas is connected by issues related to Generation M's use of digital technology.

Trends suggesting that instant messaging is ubiquitous among members of Generation M as well as the relatively low level of preparation and support teachers have to incorporate technology like instant messaging frequently surfaces in the literature and will be discussed in this chapter. In terms of information processing, Cognitive Load Theory is the theoretical foundation of this study because of its grounding in the Working Memory Model of Baddeley and Hitch (1974) (as cited in Baddeley, 2002). In addition, Cognitive Load Theory is well-represented in literature across a variety of psychological and educational domains (Ayers, 2006; Olina, Reiser, Huang, Lim, & Park, 2006; Sweller, van Merrienboer, & Paas, 1998). Finally, instant messaging in schools is presented because literature related to both Generation M and Instant Messaging in schools suggest that pre-service and in-service teachers are not well-prepared for how this population prefers to interact. This chapter focuses on the relevant trends and issues found in these literatures and begins by examining Generation M.

Generation M

In the 1990s, much of the extant discussion on technology use by the K – 16 population explored the role of the Internet as well as other computer-based applications as instructional tools (Kuh & Vesper, 1999). Recently, these discussions have given way to examination of the ubiquitous nature of digital technology. In particular, scholars have noted the proliferation of digital technology use and media consumption by the current K – 16 populations of

industrialized nations like the U.S. (Dede, 2005; Oblinger & Oblinger, 2005; Prensky, 2001a; Rideout, Roberts, Foehr, 2005).

Scholars from a variety of sectors are studying the digital technology use habits of the current K – 16 population (Ba, Tally, & Tsikalas, 2002; Brown, 2002; Salaway, Caruso, & Nelson, 2007; Prensky, 2001a,b). In fact, a good deal of this discussion revolves around the profile of these students access to and utilization of various forms of media and digital technology (Salaway, Caruso, & Nelson, 2007; Rideout, Roberts, & Foehr, 2005). In addition, others have attempted to begin a discussion regarding the impact which daily use of digital technology may have on the information processing capabilities of these students (Brown, 2002; Prensky, 2001b). This section attempts to organize the cacophony of voices jostling for space in the research conversation related to Generation M. Additionally, the evolution of naming conventions in terms of similarities and differences is reviewed, and the trends and issues regarding this population of students are forwarded.

Consistent with research on event-driven naming of various generations (Stauss & Howe, 1992), many scholars have sought to classify Generation M by associating it with the development of the commodity Internet as well as their sophisticated use of digital technology and other media (Salaway, Caruso, & Nelson, 2007, Oblinger, 2005; Rideout, Roberts, & Foehr, 2005). Some of the naming conventions used during this decade include Digital Natives, Millennials, and Internet Generation (Oblinger, 2005; Prensky, 2001a, Stauss & Howe, 1992). Strauss and Howe present the names listed in Table 3 for consideration when referring to the K – 16 population based on their event-driven, generational naming paradigm.

Table 3. The Strauss and Howe (1992) naming conventions for generations

Name	Birth Years
Baby Boomers	1940s-1960s
Generation Y	1970s–1990s
Echo Boom Generation (aka Generation X)	1980s–1990s
Millennial Generation	1982–2000s
Internet Generation	1990s–2001

The names listed in Table 3 betray their meanings: Generation Y preceeds Generation X in terms of age, Echo Boom implies that this generation shares the large numbers of the Baby Boomer generation, Millennials are those born just prior to the turn of the 21st century, and the Internet Generation was born during the beginning of the commodity Internet's rise. Strauss and Howe (1992) are very thorough in terms of classifying generations. Their categorization of the current K – 16 population, where the oldest members were born around the time personal computers were being introduced to industrialized societies like the United States (U.S.) (Oblinger, 2005), is particularly apropos to this discussion. The sheer number of naming options for this group can be daunting. Table 4 (repeated from chapter 1) narrows the list to the most popular trends in naming the current K – 16 population found from a variety of sources.

Table 4. Trends for naming the current K – 16 population (repeated from chapter 1)

Name	Author/Defining Characteristics
Digital Natives	Those persons within the current K - 16 school population who use digital technology in their lives daily (Prensky, 2001a).
Generation M	Where 'M' = media: Those within the current age 8 - 18 population with the ability to adapt to the pace of change for all communication media (Rideout, Roberts, & Foehr, 2005).
Net Generation	Where 'Net" = Internet: Those within the current K – 16 school population with ability to develop literacy with multiple media forms (Oblinger & Oblinger, in Oblinger, 2005).
Millennials	Those in the within the current K – 16 school population who maintain a high level of social interaction with family and friends through highly skilled use of information technology (Strauss & Howe, 1992).

Generation M - trends and issues

Generation M was used as a label for the population under examination in this study because it incorporates elements of the other popular naming conventions listed in Table 4. The reader should bear in mind that the scope of inclusion for this group is limited to K – 16 students in the U.S. and other similar industrialized nations (Oblinger, 2005; Strauss & Howe, 1992). However, the trends and issues related to Generation M are many and embody concerns across various fields including the related areas of education, technology, and digital communications. It becomes apparent from even a cursory reading of the current literature that Generation M is defined by its overwhelming preference to use digital technology across all aspects of daily life.

Table 5 represents a composite list of Generation M information processing preferences gathered from Brown (2002), Dede (2005), Oblinger (2005), and Prensky (2001a,b).

Table 5. Generation M information processing preferences

Preferences
Prefers Fast Access to Information
Prefers Random Access to Information
Prefers Parallel Processing with Multiple Sources of Information
Prefers to Multitask
Always Connected to Network (live and virtual)
Prefers Responses at Twitch Speed
Emphasis on Doing over Knowing
Prefers Frequent Rewards to Intrinsic Motivation

The characteristics listed in Table 5 suggest that Generation M is radical in its desire for massive amounts of information. This observation is born out in Rideout, Roberts, and Foehr (2005) who suggest that Generation M has an unprecedented level of access to various media, digital or otherwise, as discussed in chapter 1. However, the Rideout, Roberts, and Foehr study also includes a thorough report of the relationship of media use to individual traits in the over 2,000 ages 8 to 18-year olds surveyed in the Generation M study. The study goes into great detail about how individual traits of the sample relate to media-use behavior as well as the relationship between self-reported academic performance and media exposure. The reader will bear in mind that the Generation M study acknowledges participants' tendency to inflate academic performance. Nonetheless, survey respondents who report lower grades (mostly Cs /Ds/and

below) report spending more time engaged with various forms of media than do their counterparts who report receiving mostly As/Bs. These lower grade reports would suggest that higher levels of digital media consumption negatively impact academic performance. In addition, Rideout, Roberts, and Foehr (2005) were able to classify survey respondents as light, moderate, or heavy users of media; more importantly, however, these statistics are also reported in terms of multitasking behavior.

Because the current study focuses on multitasking among undergraduate teacher-education students (e.g. instant messaging during learning), the aggregate findings related to multitasking among 7th to 12th grade members of Generation M are reported in Table 6.

Table 6. Generation M (7th to 12th grade sub-set) multitasking rates.

Medium	Most of the time	Some of the time	Little of the time	Never
Reading	28%	30%	26%	16%
Watching TV	24%	29%	28%	19%
Listening to music	33%	30%	25%	12%
Using a computer	33%	29%	23%	14%
Multiple computer activities	39%	25%	19%	14%

Though the percentages in Table 6 are striking, a very compelling component of Table 6 is the Multiple Computer Activities variable where a total of 64% of respondents report that they engage in multiple computer activities most or some of the time. The Generation M questionnaire defined multiple computer activities as simultaneous use of email, instant messaging, etc. (Rideout, Roberts, & Foehr, 2005) which is specifically relevant to this current study where the impact on instant messaging on learning outcomes was explored. Furthermore,

the Generation M study also found that the access to and utilization of new media types has not detracted from the use of previously existing media such as television and music. As an example, the authors site findings which state that members of Generation M who spend the most time using computers during the day watched approximately one hour more of television and listened to one hour more of music than those who reported not using a computer during the same time period. In fact, the Generation M study suggests that empirical review is warranted to determine whether multitasking behavior impacts cognitive processing.

Trends reported in the Generation M study are consistent with findings from an annual study conducted by the Educause Center for Applied Research (ECAR) regarding trends in undergraduate student use of digital technology (Salaway, Caruso, & Nelson, 2007). As previously mentioned in chapter 1, the ECAR study asked a national sample of over 27,800 undergraduate students to classify how they used computers and Internet-related technology on a weekly basis. Table 7 presents some of the responses to items related to various activities and the frequency of those activities.

Table 7. Frequency of activities spent on a computer per week

Activity	Students Engaged (N=27,846)	Frequency
Use course management system	83%	Several times weekly
Creating, reading, sending email	99.9%	Daily
Create, read, send instant messages	84.1%	Daily
Downloading web-based media	77.8%	Weekly
Playing computer games	78.3%	Weekly

Results of the 2007 ECAR study notes that about 28% of female respondents and about 25% of male respondents engage in some type of computer/Internet-related activity between 6 and 10 hours per week. In addition, about 19% of female respondents reported computer/Internet-related engagement 11-15 hours per week while 17% of male respondents selected the same choice. Taken individually, the amount of time survey respondents spent engaged in a given digital technology activity per week may not seem overwhelming. However, when these activity timeframes are combined, the result is that over 40% of both male and female respondents spent an average of between 6 and 15 hours per week engaged in some form of computer-related activity where digital media were often incorporated (Salaway, Caruso, & Nelson, 2007).

Some have suggested that all of this digital technology and media access should create significant issues related to impact on the teaching and learning process as well as digital literacy (Ba, Tally, & Tsikalas, 2002; Brown, 2002; Lewis & Fabos, 2005; Prensky, 2001b); however, one will not find definitive empirical evidence where digital technology use impact on learning is quantified by student achievement on a learning measure. Most studies in this area show how various kinds of digital technology impact student participation, attitude, and engagement in learning (Cox, et al, 2004; Hrastinski, 2006; Nicholson, 2002; Pelowski, Langley, Cabral, & Yu, 2005). However, one trend consistently appearing in the literature is that use of digital technology in classroom environments promote authentic learning experiences where Generation M students carry over their 'learn by doing' habits which are honed, in part, by hours of digital technology use (McMahon & Pospisil, 2005; McNeely, 2005; Staudt, 2001).

Generation M is a fascinating group and their proclivities toward media consumption and use of various digital technologies reveal the uniqueness of their profile. The agility and versatility of Generation M with media and anything digital invites close observation and

empirical review. Though many educators have a sense that ubiquitous access to digital technology impacts how Generation M processes information there is a dearth of quality, empirical research establishing the impact of high access to digital technology in general, instant messaging in particular, on teaching and learning (Dresner & Barak, 2006; Hrastinski, 2006; Rutter, 2006). This lack of research regarding the impact of digital technology access on learning for Generation M is why this group was selected for observation in this study. The research on Generation M was also useful for identifying an appropriate name for the group under observation as well as providing an appropriate framework within which to investigate how Generation M processes to-be-learned information while engaged with instant messaging.

Instant Messaging

There is a great deal of discussion regarding the popularity of instant messaging among members of Generation M (Kenzie, Whitaker, S., & Hofer, 2005; Kubey, Lavin, & Barrows. 2001; Valkenburg & Peter, 2007). Some have suggested that the high level of engagement with instant messaging and other computer-mediated communication by Generation M has been detrimental to academic performance, particularly to undergraduates, as they matriculate through academic programs (Kubey, Lavin, & Barrows. 2001). Others suggest that instant messaging can be successfully integrated into classroom environments as a support mechanism (Contreras-Castillo, Perez-Fragoso, & Favela, 2006). Conversely, research has been conducted which is inconclusive regarding the rate of participation between those who adopt instant messaging and those who do not in online courses (Hrastinski, 2006). In addition, some empirical research demonstrates that instant messaging is helpful in the development of healthy friendships among adolescents (Valkenburg & Peter, 2007). Those who study the effects of computer-mediated communications like instant messaging on teaching and learning are also focused on how instant messaging changes the level of interaction among students and teachers. In general, research in

this area has trended toward two conclusions by investigators: (a) instant messaging is effective in terms of providing support for academic pursuits, and (b) more research is required to determine how use of instant messaging impacts teaching and learning (Dietz-Uhler & Bishop-Clark, 2001; Penman & Lai, 2003; Rutter, 2006).

Though discussion of issues related to instant messaging has been robust, there is not a consensus regarding an official definition for the term. In some cases, instant messaging is used in concert with the term chat. In fact, it seems that for every empirical study or theoretical paper cited in this review, one will find unique definitions for either or both of these terms. Chat is not used in this study to simplify matters because of its limited characterization: use within course websites and/or course management systems where communication sessions are pre-arranged (McCreary, Ehrich, & Lisanti, 2001; Rutter, 2006). Instant messaging was operationally defined in chapter 1 as instant communication via Internet-connected computers where presence awareness capability exists. This definition embodies the elements of many definitions encountered throughout the literature where instant messaging is discussed but is most compatible with Cameron and Webster (2005). Table 8 lists a composite of instant messaging definitions according to various researchers.

Table 8. Instant messaging definitions

Author(s)	Definition
Cameron and Webster (2005)	A communication technology allowing individuals to send and receive text-based messages in real-time while being able to see who is online and available to receive messages.
Contreras-Castillo and Perez-Fragaso (2006)	A brief message that receives no response or is responded to with one single message.
International Engineering Consortium as cited in King (2003)	An Internet protocol-based application that provides convenient communication between people using a variety of device types, the most familiar being computer-to-computer instant text messaging.
Nicholson (2002)	A tool that can be used to reproduce the role of common spaces (i.e. classrooms, hallways, cafeterias, etc.), making it easy to communicate with others who happen to be online at the same time.

For the purpose of the study, the Cameron and Webster (2005) definition used in Table 8 applies. That is, participants were engaged with instant messaging via an Internet-connected computer during class with no pedagogical purpose.

Instant messaging - trends and issues

Though the exact definition of instant messaging is in flux, there is agreement concerning the fact that members of Generation M engage with instant messaging in order to be connected to

their social networks: family, friends, and school-mates (Kenzie, Whitaker, & Hofer, 2005; Lewis & Fabos, 2005; Valkenburg & Peter, 2007). Valkenburg and Peter (2007) test a variety of hypotheses related to their model of online communication and closeness to friends. Though they found that only 30% of survey respondents (N = 665 in the Netherlands) viewed online communication as more effective than offline communication, they report that 88% of the respondents use the Internet as a primary tool for maintaining existing friendships. This trend was also noted by Zucco in 2003 (as cited in Lewis & Fabos, 2005) where 70% of adolescents ages 12 – 17 who used the Internet regularly engage with instant messaging to be in contact with their social networks. Lewis and Fabos also report findings from of a study where people who instant message usually manage three or more conversations simultaneously. Managing multiple instant messaging conversation is consistent with the Generation M profile discussed above where there is an overwhelming preference for members of Generation M to be constantly connected to their social networks.

Conversational multitasking

Cameron and Webster (2005) define multitasking as the use of multiple media at the same time. Generation M has a unique ability to engage in multitasking within instant messaging environments, managing several textual conversations simultaneously. Cameron and Webster discuss the idea of polychronic communication where several conversations are managed within the same timeframe. Dresner and Barak (2006) refer to this ability as conversational multitasking.

Dresner and Barak explore the effects of space and color as determining factors which may explain Generation M's ability to engage in conversational multitasking. They examined instant message conversations happening between individuals in alternating color patterns. In addition,

multiple instant message conversations are shown in different instant message interfaces for the individual to manage. Dresner and Barak found that these factors contribute to effective management of multiple instant message conversations. Indeed, Dresner and Barak come very close to examining instant messaging activity impact on learning, but caution that the measure used is not sufficient to assess comprehension. This trend toward conversational multitasking addresses the trends illuminated in the work of Rideout, Roberts, and Foehr (2005) that Generation M wants to be constantly connected to those within their network of family and friends.

Instant messaging as a learning tool

As previously mentioned, there appears to be a lack of empirical studies suggesting how the instant messaging habits of Generation M impact achievement on a learning measure. However, educational researchers have turned their attention toward novel pedagogical uses of instant messaging at elementary – grade 16 and graduate school levels. The range of issues under examination in this area include academic support outside the school setting, facilitating blended and face-to-face course activities at the collegiate level, and facilitating course delivery in distance learning formats. The essential finding from those investigating instant messaging within learning environments is that students benefit from its use but that more empirical research is warranted.

There are some empirical studies of which the reader should be aware when considering this issue. Based on the idea that the informal nature of instant messaging might enhance students' ability to communicate, and therefore learn, Burnett, Dickinson, McDonagh, Merchant, Myers, and Wilkinson (2003) investigated how scheduled instant messaging can be implemented in order to facilitate interactions among students regarding academic content within an informal

setting. Through extensive analysis of the pre-arranged instant messaging transcripts, Burnett and her colleagues found that useful collaborative discussion among students can be achieved using pre-arranged instant messaging. They were able to determine this by classifying transcript data according to what they identified as the three components of online learning: commitment, coordination, and communication (Burnett, et al, 2003).

The study that Burnett and her colleagues conducted was with 55 undergraduate students; however, there are studies examining how use of instant messaging might support the academic needs of elementary school students. In 2001, McCreary and her colleagues were interested in examining how scheduled instant messaging might impact student-student and student-teacher interactions for children in rural school districts. One of the main contentions in this study has to do with the geographic barrier preventing rural students from obtaining help after school hours on academic tasks. McCreary and her colleagues report that the 24 fifth-grade participants in their study took advantage of what they expressed to be a less daunting environment (e.g. instant messaging) to ask questions and share concerns. Moreover, this study reports that teachers were able to develop deeper, more meaningful relationships with their students. In addition, the study suggests that students were able to socialize and plan learning activities equally well during implementation of the study.

In addition to creating a support vehicle for students, use of instant messaging in distance learning environments is well-documented in educational research literature. In 2001, Penman and Lai looked at level of interaction among students and intent of messages during scheduled instant messaging sessions in an online course with undergraduate students to assess higher-order thinking. They found that higher-order thinking can be cultivated by using synchronous communication in an online course, observing that higher-order entries increased over the span

of exposure to course content and the synchronous medium. Furthermore, Penman and Lai suggest that over time, students report feeling a sense of community as participation in instant messaging deepens. The Penman and Lai study is included here because later studies involving instant messaging and distance education tend to support these findings. In fact, a variety of researchers examining instant messaging in distance learning courses ranging from computer tutorial sessions to teacher education to instructional design agree that the medium is useful for undergraduate and graduate student populations (Contreras-Castillo, Perez-Fragoso, & Favela, 2006; Hrastinski, 2006; Nicholson, 2002; Pelowski, Langley, Cabral, & Yu, 2005; Wang & Beasley, 2005).

Though the distance education literature demonstrates that instant messaging use can be beneficial to learners, the aforementioned studies have only examined pre-arranged or structured instant messaging. An exception to the literature represented here is Nicholson (2002) who looked at the instant messaging habits of self-selected distance learning graduate students in residence for degree requirements. By and large, the results of instant messaging studies in distance education programs show that peer and instructor support is a predictor of success (Pelowski, et al, 2005); those who adopt instant messaging may have a higher degree of participation in a distance learning format (Hrastinski, 2006). Moreover, instant messaging holds tremendous promise as a pedagogical tool for distance education courses (Contreras-Castillo, Perez-Fragos, & Favela, 2006; Wang and Beasley, 2005). The reader will note that Nicholson (2006) looked at how access to instant messaging in distance education courses facilitated the naturally occurring conversations which happen after class and even in hallways and other venues for traditional brick and mortar institutions. This is an important distinction for this

current study which examined the impact of naturally occurring instant messaging on learning outcomes.

Aside from using instant messaging to support academic activity, researchers are examining how instant messaging might be incorporated into learning tasks for face-to-face and blended learning environments, primarily at the collegiate level. Issues impacting this line of inquiry have to do with support for using instant messaging as a pedagogical tool, factors impacting student participation with instant messaging, and level of discourse (academic or social). The qualitative analysis of 10 university students at a South African institution shows that instant messaging must be seamlessly incorporated into course design, student group dynamics impact the quality of the individual experience with instant messaging, and further research is warranted to investigate whether the medium provides an ideal learning environment (Cox et al, 2004).

Dietz-Uhler and Bishop-Clark (2001) as well as Kenzie and her colleagues (2005) go in a different direction than Cox and her colleagues to investigate how instant messaging might improve class discussions during subsequent face-to-face meetings and during classroom lectures respectively. Kenzie and her colleagues suggest that undergraduate students can successfully engage in instant messaging during class in order to explore their perceptions about the instructional content being presented (2005). Dietz-Uhler and Bishop-Clark (2001) found that students learn from, enjoyed, and were committed to using instant messaging to improve subsequent class discussions. In fact, both groups agree that pre-arranged instant messaging to support classroom activities is useful; however, Kinzie and her colleagues report that the student and instructor participants in their study suggest that instant messaging interferes with classroom lectures due to divided attention in student participants. However, this latter study does not

measure cognitive load per se; data is qualitative and based on self-reported observations of the participants.

Clearly, the literature on CMC is substantial. The related area of instant messaging produces high level research studies as well. However, literature in this area suggests that not enough empirical research related to Generation M's instant messaging habits has been conducted. In addition, instant messaging research does not provide evidence as to how naturally occurring instant message conversations impact learning outcomes. Therefore, this study examined the issue of instant messaging impact on learning with members of Generation M. Moreover, the medium was used to examine cognitive load for those engaged in a learning task. Cognitive overload must be considered an essential element of any study examining instant messaging during learning and is discussed in the next section.

Cognitive Load Theory (CLT)

The body of literature examining CLT and its many applications is considerable. CLT is rooted in the 1974 work of Baddeley and Hitch (as cited in Baddeley, 2002). Any discussion of CLT's evolution as a theory of human information processing must begin by describing the ideas behind working memory.

The term working memory has been used across a variety of disciplines, but among those studying cognitive psychology working memory references the cognitive systems involved in temporarily maintaining and manipulating information when it is introduced to the learner (Baddeley, 2002). The working memory model suggests that human beings process limited amounts of information in the working memory system; that is, 5 ± 2 information chunks (Bruning, Schraw, Norby, & Ronning, 2004). Essentially, the working memory system includes three parts: (a) the visuospatial sketchpad, (b) the phonological loop, and (c) the central executive. However, the model was updated in 1996 to include an additional role for the central

executive working in concert with a component called the episodic buffer (Baddeley, 2002). Working memory is a complement to the long-term memory (LTM) where novel information is held prior to encoding for storage in LTM (Bruning, et al, 2004). Figure 3 depicts the updated working memory model.

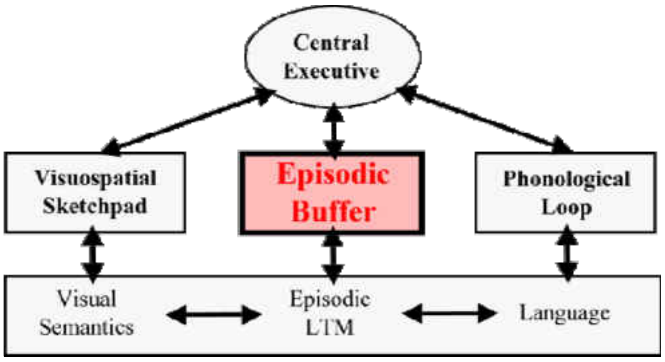

Figure 3. Baddeley's (2002) Working Memory Model
(Image from: http://www.smithsrisca.demon.co.uk/PICbaddeley2000.gif)

Now, enter CLT which seizes upon the idea of a limited capacity working memory for empirical examination. This examination has been ongoing since 1988 when Sweller presented the theory while studying problem solving. However, the theory was more fully developed ten years later (Sweller, van Merrienboer, & Paas, 1998). The basic assertions of CLT have been well documented in the cognitive psychology, education, and instructional design literatures (Carlson, Chandler, & Sweller, 2003; van Gog, Ericsson, Rikers, & Paas, 2005; van Merrienboer, Schuurman, de Croock, & Paas, 2002). Researchers investigating CLT describe it as an index of mental effort which represents how many non-automated iterations in working memory is necessary to solve a problem (Feldon, 2007). However, the reader should be aware of CLT's basic theoretical underpinnings.

CLT assumes a relationship between a limited capacity working memory and a virtually unlimited capacity long-term memory (Bruning et al., 2004). In fact, CLT supports the assertion Baddeley and Hitch made in 1974 (as cited in Baddeley, 2002) that long-term memory schemas

(cognitive structures – or schematics – of various concepts and processes) are developed in and transferred from working memory to long-term memory. The other important assumption of CLT is categorization of cognitive load. Three types of cognitive load are assumed to be created during instruction: intrinsic, extraneous, and germane (Bannert, 2002; Bruning et al., 2004; Carlson, Chandler, & Sweller, 2003; Gerjets & Scheiter, 2003; Sweller, van Merrienboer, & Paas, 1998). Figure 4 illustrates the relationship between the human cognitive architecture (HCA), specifically working memory and the elements of CLT.

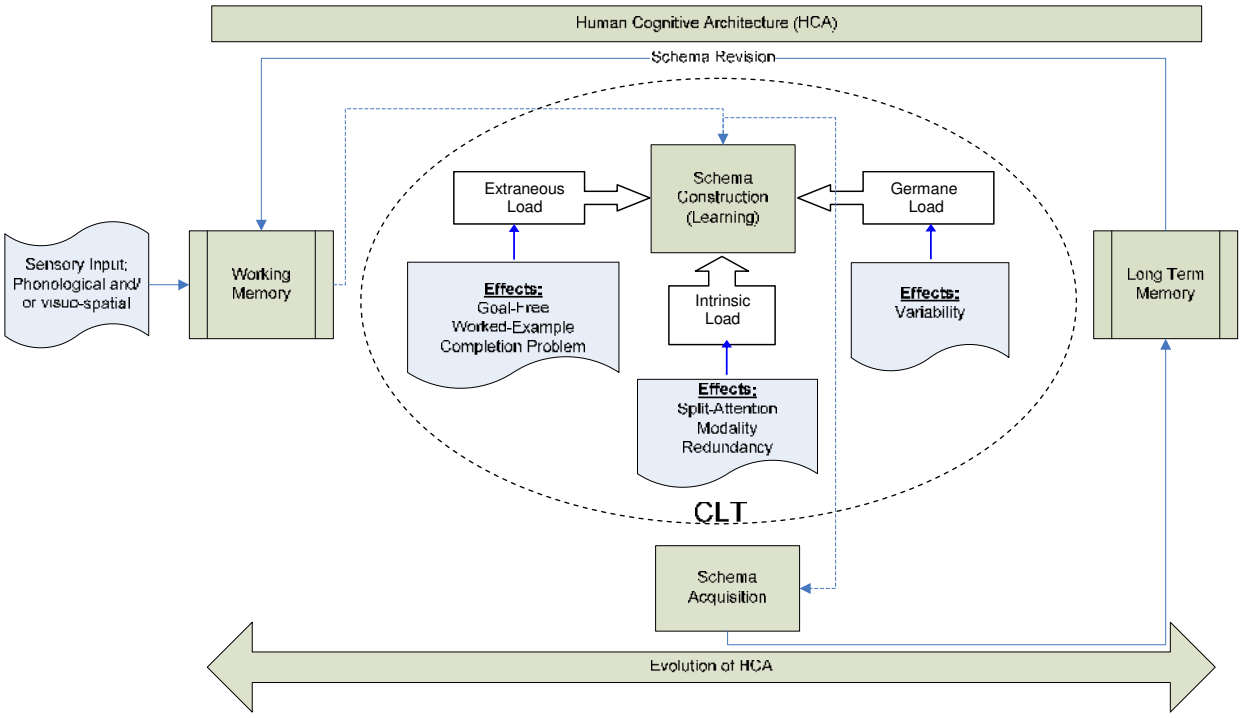

Figure 4. Cognitive Load Theory Model

Figure 4 illustrates the assertion that CLT is rooted in elements of working memory which is taken from the overall idea of a human cognitive architecture as described by Miller in 1956 (as cited in Baddeley, 2002). CLT directs attention toward the effects various types of load have on learning outcomes in students during schema construction as outlined in Figure 4. When a learner receives sensory input, such as a new set of manufacturing procedures, that input is

manipulated in working memory in a process referred to as schema construction (e.g. learning). It is the schema construction process with which CLT is concerned. Accordingly, cognitive load is purportedly imposed upon the schema construction process. Recall that there are three types of cognitive load; they are described below.

Intrinsic cognitive load takes the various elements of a to-be-learned activity into account. Elements involved in the learning process, and the amount of interactivity between those elements, results in high intrinsic load for the activity (Sweller, van Merrienboer, and Paas, 1998). In other words, the naturally occurring complexity of the to-be-learned task places load on the cognitive resources of learners (Seufert, Janen, & Brunken, 2007). For example, learners being introduced to a language's grammar system must contend with the various and complex components which make up that system. The grammar system itself presents elements which increase cognitive load in learners while engaged with various components of the content. Though intrinsic load is daunting for many learners, there are other factors external to the learning task which also increase cognitive load.

Extraneous cognitive load is the result of instructional techniques requiring learners to process information not directly related or even applicable to schema construction. The most common example of extraneous load has to do with irrelevant materials being introduced during learning by instructors. The inclusion of irrelevant events such as acknowledging ambient noise or digression from the to-be-learned topic diverts working memory resources, thereby increasing cognitive load (Feldon, 2007).

Germane cognitive load refers to the process occurring when learners direct unused working memory resources to the learning activity. Specifically, cognitive efforts related to schema construction and automation are considered highly relevant (e.g. germane) to acquiring the to-be-

learned task (van Merrienboer & Ayers, 2005). Though germane cognitive load increases working memory load, this type of cognitive load is considered beneficial to the learner because cognitive resources are being used to further develop schemas for the to-be-learned task (Bannert, 2002; Gerjets & Scheiter, 2003; Sweller, van Merrienboer, & Paas, 1998).

The reader should bear in mind that Sweller updated CLT in 2004 to reflect the inclusion of evolution by natural selection in terms of the HCA as illustrated by the double-sided arrow at the bottom of Figure 4. This study does not address the evolution of HCA; however, for further details, readers should refer to Sweller (2004). Figure 5 details the part of CLT on which this study focuses attention.

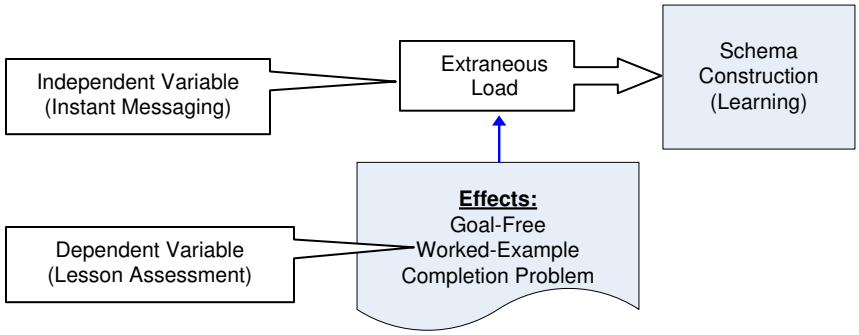

Figure 5. Extraneous load (e.g. instant messaging) during schema construction

The impact of instant messaging on learning outcomes is best viewed through the lens of extraneous load because, as described above, extraneous load is load placed on working memory which is external to the to-be-learned task. For this study the independent variable was instant messaging (e.g. extraneous load) while engaged in schema construction (e.g. learning) through presentation of worked-examples; the dependent variable was the InspireData lesson assessment score used to evaluate schema construction (e.g. learning).

It will be helpful for the reader to divide the extant discussion of CLT among three areas: (a) theory (e.g. development and revision), (b) empirical research of the various effects described in

Sweller, van Merrienboer, and Paas (1998), and (c) applications for instructional design as well as teaching and learning. The following section reviews findings from selected CLT studies representative of the three CLT research areas.

CLT theory development and revision

Sweller (1988) makes a bold statement in a work he published about the level of cognitive load imposed on learners who used what he termed conventional problem solving techniques (e.g. means-end problem solving strategies). His findings suggested that the "cognitive effort expended during conventional problem solving leads to solving the problem goal, not to learning" (p. 283). In other words, Sweller concluded that simply solving a problem and learning the process (developing schema) by which other similar problems could be solved interfere with each other. Sweller's work is the synthesis of what was known about problem solving and human memory systems at the time; he explored distinctions between expert and novice information processing and the idea that traditional problem solving and schema acquisition interfere with each other.

Over the next ten years, Sweller honed his theory and, with his colleagues van Merrienboer and Paas, produced the landmark paper, *Cognitive Architecture and Instructional Design* (1998). Essentially, the cognitive architecture paper defines CLT and presents research establishing several effects within the CLT framework. Moreover, Sweller and his colleagues (1998) firmly established the necessity of considering cognitive load during instructional design. More recently, Sweller (2004) further refined CLT to describe how human cognitive architecture evolved. Indeed, Sweller suggests that human information processing is a component of the evolutionary process of natural selection whereby human memory systems handle vast amounts of information which control human activities and evolve over time. Moreover, human memory

systems continually adapt to complex environments, thereby complicating the evolutionary process over time (Sweller, 2004).

CLT - effects from selected studies

Seven instructional design effects are reported in Sweller, van Merrienboer, and Paas (1998): (a) split-attention, (b) redundancy, (c) modality, (d) worked-example, (e) completion problem, (f) goal-free, and (g) variability. The four appearing most frequently in CLT literature will be discussed here.

A significant amount of attention has been paid to the split-attention effect. The premise is that some instructional designs cause a learner to split her attention between two related examples (i.e. text and graphic) in order to process a task. Rather, CLT purports that the text explaining a graphic should be integrated with the image to avoid placing undue load on working memory resources of the learner (Chandler & Sweller, 1992; Crippen & Boyd, 2007). For example, rather than presenting a U.S. map with a separate explanation of how the map is divided into regions, a geography teacher might present a map which includes clear regional demarcations along with labels naming the regions. In the case of the current study, participants were presented with finished examples of various data displays produced with InspireData software as in Appendix E.

Conversely, the redundancy effect described throughout CLT literature suggests that when multiple formats of a learning task are provided to the learner, excessive cognitive load ensues. The redundancy effect happens when expert learners who are not given redundant information perform better on a learning measure than those who receive redundant information (Yeung, 1999). The modality effect is somewhat related to split-attention; however, rather than using the visuospatial sketchpad exclusively (e.g. text-based), instructional designers present a learning

concept through the phonological loop as well (e.g. visual and auditory) and measure cognitive load. Learners receive both auditory and visual stimulation in order to develop the schema (Mousavi, Low, & Sweller, 1995). The worked-example effect has also received a fair amount of attention in the research literature. Worked-examples essentially amount to annotated illustrations, or even procedures, which incorporate explanations and are ordinarily given after guided instruction is provided. The worked-example effect occurs when learners who are provided with worked-examples perform better than those whose content and illustration was separated (van Gog, Paas, & van Merrienboer, 2006).

Instructional design applications

CLT is a heavy subject, and it is very tempting for educators to assume there are no practical applications of the construct. However, the CLT-related research literature is replete with examples of practical application of the theory for instructional design. Instructional design principles such as scaffolding: simple-to-complex sequencing and whole or part-task presentation and just-in-time information presentation (e.g. supportive information and procedural information) have been used successfully for novice learners (van Merrienboer, Kirschner, & Kester, 2003). For expert learners, van Gog and her colleagues (2005) have forwarded an instructional design framework which incorporates aspects of CLT and deliberate practice within eLearning environments. Essentially, instructional designers preparing materials for experts should identify learners' current performance levels and areas for improvement, consider presentation of material to enhance germane cognitive load, and provide opportunities for learners to assert control during schema development and acquisition (van Gog, et al, 2005).

CLT - trends and issues

Since its introduction, CLT has drawn in researchers from a variety of camps to study CLT effects in order to determine practical application for learners. The basic tenants of CLT have held up remarkably well over the two decades that it has been studied. However, in 2002, the journal Learning and Instruction produced a special issue where the articles published discussed the recent trends and additional considerations for the continued development of CLT. In addition, Gerjets and Scheiter (2003) levied some important criticism of the theory. Table 9 summarizes the issues and trends identified from these sources.

Table 9. Recent issues and trends and issues in CLT

Issue/Trend	Author(s)/Year
Issues:	
CLT routinely ignores individual differences in learners (e.g. learner activities)	Gerjets and Scheiter (2003)
CLT focuses on schema acquisition as the instructional goal rather than teacher goals	Gerjets and Scheiter (2003)
Lack of clarity regarding the relationship of CLT and various learning theories, constructivism specifically.	Valcke (2002)
Trends:	
Development of studies focused on learner management of cognitive load	Bannert (2002)
New approach for controlling intrinsic cognitive load through manipulation of instructional materials	Bannert (2002)

Table 9 summarizes some of the important criticisms of CLT from various researchers. In addition to these, Schnotz and Kurschner (2007) suggest that reducing cognitive load may actually impede learning. These criticisms notwithstanding, CLT is considered a reputable explanation of human cognition in general, and schema acquisition (e.g. learning) specifically. Related to CLT is the notion of divided attention (DA) which is a paradigm designed to study the how learners grapple with two distinct tasks (Lozito & Mulligan, 2006)). Because DA both comes after and uses components of CLT, this study tested its hypothesis with the more firmly established CLT.

Integrated worked-example lesson format

Integrated worked-example lesson format is well-represented in CLT literature (Chandler & Sweller, 1992; Groβe & Renkl, 2006; Lee, Nicoll, & Brooks, 2004; Mwangi & Sweller, 1998). This study used the integrated worked-example format because research has consistently demonstrated that this format reduces intrinsic and extraneous load in learners of varying ages and expertise levels in general, and in novice learners specifically (Mwangi & Sweller, 1998; van Gog et al, 2006; van Gerven, et al 2002). The basic premise of integrated worked-examples is this: a concept is presented with an integrated explanation of its components in order to reduce both intrinsic and extraneous cognitive load (Atkinson, Derry, Renkl, & Wortham, 2000). Figure 6 is an example of how the integrated worked-example format relieves the working memory load placed on learners who might otherwise have to split their attention between the probability solved example and its explanation.

PROBLEM TEXT: From a ballot box containing 3 red balls and 2 white balls, two balls are randomly drawn. The chosen balls are not put back into the ballot box. What is the probability that a red ball is drawn first and a white ball second?

SOLUTION:
STEP 1:

Total number of balls:	5
Number of red balls:	3
Probability of red balls on first draw:	3/5

STEP 2:

Total number of balls after first draw:	4
Number of white balls:	2
Probability of white balls on second draw:	2/4

STEP 3

Probability that a red ball is drawn first and a white ball is drawn second:	3/5*2/4 = 6/20 = 3/10

ANSWER: The probability that a red ball is drawn first and a white is second is 3/10.

Figure 6. Worked example presentation from Renkl, Atkinson, and Maier, 2000

Figure 6 effectively integrates explanations of probability in a simple example which learners may use to study and subsequently develop schema for encoding in long-term memory. Many CLT-related studies show that implementation of integrated worked-examples is an effective instructional design technique, minimizing cognitive load and thereby improving learning of a new concept (Crippen & Earl, 2007; Sweller, 2006; van Gerven et al 2002).Though the CLT literature largely affirms the effectiveness of integrated worked-examples for presentation of to-be-learned content, some researchers have conducted studies, the results of which, question the degree to which this format is useful (Darabi, Nelson, & Palanki, 2007; Moreno, 2006).

Though cognitive psychologists debate about the effectiveness of worked-examples, K – 16 educators use the format liberally along with other instructional approaches. Because a large portion of Generation M is educated in K – 16 environments where worked-examples are used, this method of presenting the to-be-learned information for this study was appropriate. In addition, the reader will note that CLT provides an appropriate theoretical foundation for studying the impact of instant messaging on learning due to its identification of extraneous load on learning. Finally, this study sought to examine instant messaging impact on learning through CLT because it is the dominant information processing theory within which many instructional design models are grounded.

Instant Messaging in the Classroom

The U.S. Department of Education's National Education Technology Plan (NETP) includes several recommendations for improving ubiquitous access to and innovation with current and future digital technologies. The report, titled *Toward a New Golden Age in American Education*, supports many of the findings educational researchers are reporting from their studies of Generation M (NETP, 2004). In fact, the report suggests that students who are comfortable in the Internet age out-perform public school teachers in terms of computer literacy. The report acknowledges that Generation M has an overwhelming preference to access academic content from the Internet where the information is plentiful and current.

Not only are the NETP findings confirmed by those conducting empirical research, but those conducting survey research with this population are coming to similar conclusions. The NetDay (2006) survey of 185,000 K – 12 students produced findings confirming the preference of Generation M for learning with digital technology and being constantly connected to their social network. Indeed, one major finding in the NetDay (2006) report bears quoting: "if students could change how technology is implemented at their school, their number 1 request is: relax school

rules about email, IM (e.g. instant messaging), cell phones and online use, and the number 2 request is: laptops to use at school and home" (p. 1). The NETP (2006) report calls for the public education infrastructure to address the digital technology needs of Generation M. Among the seven NETP recommendations is improving teacher technology training.

The prevailing view among many writing about the nation's teacher education programs is that there is an incredible dearth of digitally-prepared pre-service teachers (Talbert-Johnson & Oberlander, 2004). In fact, many teachers report that they have been ill-prepared to work effectively with digital technology and content in the classroom (Fryer, 2005). Therefore, it is reasonable to assume that both pre and in-service teachers have limited experience utilizing instant messaging pedagogically.

How generation m uses instant messaging

It is clear from reviewing computer-mediated communications literature that Generation M students use the instant messaging medium to stay connected to those within their social networks during class (Grinter & Palen, 2002; Madell & Muncer, 2007). In fact, Valkenburg and Peter (2007) examined how instant messaging contributed not only to maintain friendships, but to develop deeper, closer relationships. Valkenburg and Peter hypothesize that online communications, facilitated in part by instant messaging, stimulates closeness to existing friends. It is not surprising that 88% of participants in their study use the Internet to maintain existing friendships. Yet, of note is that 36% of participants in this study who identify themselves as socially anxious found Internet communication to be more effective than face-to-face communications. The implication here is that for students who have difficulty navigating social constructs in face-to-face settings, instant messaging presents a less risky alternative for communication and may alter existing believes about classroom culture.

Some researchers are investigating how instant messaging activity is changing both social and classroom culture. Lewis and Fabos (2005) report that the ubiquitous instant messaging practices of those within the Generation M framework has spawned a new and complex level of digital literacy and even social identity. Lewis and Fabos suggest that, for their research sample, instant messaging activity encouraged high performance with digital technology and a multi-voiced perspective from users. That is, participants who engaged with instant messaging were able to move quickly from one context to another within the instant messaging environment, even while maintaining multiple, simultaneous conversations. The implication is that participants in the Lewis and Fabos study maintained multiple identities in which they are equally comfortable operating during simultaneous online conversations.

The work of Lewis and Fabos is confirmed by that of Dresner and Barak (2006) where the idea of conversational multitasking is investigated. Dresner and Barak confirm that participants in their study engage in multiple instant messaging conversations simultaneously where they exhibit the ability to "communicate and interact with others in a way that is appropriate and effective" (p. 70). Even more interesting is the finding that, on the assessment used during the experiment, the proportion of correct answers did not correlate with reported levels of instant messaging activity. Though Dresner and Barak caution that the dependent measure is not sufficient for evaluating comprehension, the finding would suggest that instant messaging activity during learning did not impact learning outcomes. These finding also suggest something about what Generation M members expect with regard to instant messaging use in classrooms. Though members of Generation M engage with instant messaging for a variety of social reasons, as students they expect schools to promote instant messaging as a serious means of communication and as a learning medium (Bakker, Sloep, & Jochems, 2007). In survey research

where 43% of participants fit the Generation M profile, 85% of participants report a desire to discuss school tasks with classmates while 74% desire to share files. Brinkerhoff and Koroghlanian (2007) agree with these findings in their work reviewing what online students expect in terms of courseware design. Fifty percent of participants in the Brinkerhoff and Koroghlanian study report a desire to use instant messaging within the online course context while only 21% of respondents report it actually being used. However, 71% of those responding in the study report engagement with individual messaging. The implication of these findings is that though members of Generation M are highly engaged with instant messaging, schools and universities lag behind in terms of pedagogical practice. Essentially, K – 16 classrooms are not taking advantage of the skills students develop through instant messaging engagement. Though instant messaging in classrooms is largely absent (Sternberg, Kaplan, & Borck, 2007), there are some encouraging instant messaging practices currently in use.

Pedagogical innovation through instant messaging

Though there is a perceived disconnect between how Generation M engages with instant messaging and how it is used in classrooms (Brinkerhoff & Koroghlanian, 2007), some researchers are examining how the medium might enhance teaching and learning in a variety of settings. Literature in this area generally fits into one of two categories: (a) facilitating communication in online environments, and (b) enhancing the teaching and learning experience.

Weller, Pegler, and Mason (2005) report that innovations with instant messaging, blogs, wikis, and podcasts all speak to facilitating various kinds of communications within eLearning environments. In fact, they suggest that innovation occurs when instructors understand the demand for using these tools and the contexts within which they best work. Some researchers are making attempts to incorporate instant messaging as a highly structured activity within face-to-

face as well as online learning environments. Kinzie and her colleagues (2005) examined how instant messaging might enhance face-to-face classroom lectures and report that participants were able to engage in productive online discussions during class time. Reseach conducted by Wang and Beasley (2005) support the conclusions reached by Kinzie and her colleagues.

Wang and Beasley examined how structured instant messaging fostered Type II technology applications as prescribed in 2001 by Maddux, Johnson, and Willis (as quoted in Wang & Beasley, 2005). Accordingly, Type II technology applications are considered student-centered and, more pointedly, provide methods for introducing content which would not be otherwise possible without the use of computing technology. Wang and Beasley purport that structured instant messaging activity within an eLearning environment meets the criteria of the five characteristics of Type II technology applications. In fact, they suggest that applying structured instant messaging through a commercial application was student-centered and controlled, provided opportunities for collaborative discussion, and required significant time to master. The idea of instant messaging being student centered is an important theme in research literature related to instant messaging as is echoed in the section of this chapter related to how Generation M uses instant messaging applications. Though the Wang and Beasley study as well as others in this section take place in undergraduate school contexts, there is work being done with instant messaging at K-12 levels, specifically for enhancing teaching and learning at online high schools.

The Florida Virtual School (FLVS) was one of the first online high schools established in the U.S. (Sternberg, Kaplan, & Borck, 2007), and as such has provided the educational research community with lots of information regarding how high school students and teachers innovate with online communications technology. Though the FLVS's use of CMC and other emerging

technologies is limited for safety purposes (Beldarrain, 2006), there are some required interactions in place for teachers working within the FLVS environment. Essentially, instructors are required to engage in communication via instant messaging for classroom management, tutorial, and parent communication purposes (Sternberg, Kaplan, & Borck, 2007). This kind of electronic-housekeeping is elegant in its simplicity as an innovation. The potential for student success is bolstered by the use of communications methods preferred by FLVS students and parents. Working with student and parents through a preferred method of communication is supported by the work of Bakker, Sloep, and Jochems (2007) and Brinkerhoff and Koroghlanian (2007) cited above.

Summary

It can be overwhelming when one considers that four areas of educational research provide a foundation for pursuit of this currently study. However, as the *National Educational Technology Plan* (2004) asserts, Generation M is driving change by the sheer comfort and fluidity with which they use digital technology in their daily lives. Clearly, it is becoming important for educators at all levels to understand how Generation M processes information. Moreover, it is critical that a stable theoretical framework within which empirical investigation can occur be provided. Therefore, this study utilized the well-established tenants of CLT to explore Generation M's information processing practices in an effort to provide such a framework.

In sum, it is essential that educators acknowledge the implications of understanding how access to and use of instant messaging impacts learning outcomes. The implications of Generation M's digital technology use and information processing habits are far-reaching and may influence the direction of future CLT, instructional design, and teacher education studies where Generation M is the subject of investigation.

CHAPTER 3: RESEARCH METHODS

The results of this study have the potential to inform researchers, practitioners, and instructional designers about Generation M's multitasking capability. Of course, researchers will be interested in whether or not this study can be replicated for further investigation and confirmation of results while practitioners will be interested in how instant messaging may be integrated with instruction. Instructional designers will be prompted to consider the multitasking capabilities of their instructional audiences during analysis, design and development of instructional materials.

We know that members of Generation M engage in instant messaging 3 - 5 hours per week (Rideout, Roberts, & Foehr, 2005). If the reader accepts this estimate, then it is reasonable to assume that Generation M is engaged with instant messaging approximately 21 - 35 hours per month or up to 1800 hours per year. We also know from the Rideout, Roberts, and Foehr study that students who engage in instant messaging are often doing other things such as surfing the Internet, playing digital games, and completing homework, in short, multitasking. Because this study has implications for a variety of fields, methods for conducting the study are important. Chapter 3 begins with a discussion of this study's research methods by looking at statistical power.

Statistical Power

Factors influencing the power of statistical tests are: (a) level at which significance is set, (b) magnitude of treatment effect desired, and (c) variability in the population observed (Shavelson, 1996). For this study, α was set to .05 which is considered an acceptable significance target in social science research areas like education. Because the desired power for this study was .90 (β = .10), a reasonable expected treatment effect size (Δ_{II}) is .80 (e.g. large). Therefore, the estimated total sample size for this study is 56 or 28 participants for each group. This estimate is

based on the Case II (i.e. theoretical research), one-tailed significance test research model (Shavelson, 1996). G*Power, v. 3.0.8, by Faul, Buchner, Erdfelder, and Lang (2006) was used to calculate the statistical power for this study.

Subjects

Undergraduate students represent an ideal group from the Generation M population through which to examine instant messaging impact on learning because they are heavily engaged with instant messaging during academic pursuits (Kubey et al, 2001). The University of Central Florida College of Education (UCF COE) undergraduate population was reported at 3,500 for the fall 2006 term. These students entered the UCF COE with an average grade point average of 3.68 while their average SAT scores were Math: 600, Verbal: 598 (UCF Fact Book, 2007). Of the 3,500 undergraduate students at the COE, 858 were classified as either freshman or sophomore. This freshman/sophomore group of education majors is the target population for the proposed study.

Sampling

A random sample of students enrolled in the face-to-face and mixed-mode sections of EME 2040: Introduction to Educational Technology (EME 2040) was accessed for voluntary participation in this proposed study as part of a required assignment for the course. Two instructors were on record for each section of EME 2040 accessed for this study; however, only one instructor delivered the InspireData lesson to both sections of the course. Data from the mixed-mode section was collected during one of the face-to-face meetings. Those who consented to participation in the study via the informed consent letter (see Appendix A), were included in the research sample. Finally, members of the sample were randomly assigned to either the treatment or control condition. A web-based random number generator, available to researchers at the website PsychicScience.com, was used to implement random group assignment.

Data Collection Site: EME 2040: Introduction to Educational Technology

EME 2040 was selected as a data collection site because it offered an opportunity to observe instant messaging activity among the target population as described in the Rideout, Roberts, and Foehr (2005) and Salaway, Caruso, and Nelson (2007) studies. That is, participants in the treatment group completed academic work via Internet connected computers while simultaneously engaged in instant messaging.

All College of Education students are required to successfully complete EME 2040: Introduction to Educational Technology as a part of the core education major course requirements for bachelor degree completion. Recent trends in registration for EME 2040 indicating that approximately 70 people would be available for participation in the study across two sections was born out in actual registration of 68 students across the two sections accessed. EME 2040 was an ideal data collection venue for the study because the course is required of all COE students and because of the computer application interaction inherent within the course. Instructors who teach this course report that students are often engaged in multitasking behavior where instant messaging activity has been observed.

As previously mentioned, EME 2040 is part of the required core for all education majors at the UCF COE. The global syllabus for the course has listed a broad goal for students to successfully integrate instructional technology tools into their evolving teaching methods. In addition, the syllabus indicates that at the successful conclusion of the course, students will be able to demonstrate skill in a variety of areas including the use of word processors, spreadsheet applications, and other productivity applications.

Research Design

To investigate the impact of instant messaging on a learning task via testing the null hypothesis, this study employed a post-test only with control group design. Figure 7 (repeated from chapter 1) illustrates the proposed research design.

R	X1(IM)	O1
R		O2

Figure 6. Proposed Research Design

Figure 6 shows that participants were randomly assigned to one of two groups as indicated by R on both rows. The treatment group is denoted in row 1 by an X while the control group was not subject to the instant messaging ($_{IM}$) treatment condition. This design was selected to avoid sensitizing participants to the content of the lesson introducing InspireData software utilization concepts. This concern is in keeping with the principles of integrated worked-example presentation of content. Finally, the reader will note that participants in each group were observed (O in Figure 6) via scores on the InspireData software lesson assessment.

Dependent and Independent Variables

The dependent variable for this study was the InspireData assessment score (e.g the post-test) which represented student achievement on a learning task. The independent variable was instant messaging activity. That is, either participants were engaged in instant messaging or they were not engaged in instant messaging.

Intervention

The intervention (e.g. treatment) for this study was intermittent instant messaging where participants were allowed to access their existing instant messaging accounts online during lesson implementation. Instant messaging is defined as instant communication via Internet-connected computers where presence awareness capability exists (Cameron & Webster, 2005). Essentially, instant messaging applications use the Internet to facilitate text, audio, and video modes of communication among members of the same online social network. This study focused exclusively on text-based instant messaging.

InspireData lesson

InspireData is a data analysis application the development of which was originally funded by the U.S. National Science Foundation for TERC (formerly known as the Technical Education Research Centers) and subsequently published for profit by Inspiration Software, Inc. (InspireData: Features, 2007). InspireData is designed to expose students from middle school through college to data literacy and interpretation skills. The software is presented as a total data analysis solution where students can enter data, conduct data analysis, and prepare reports with analysis results within the same software package. A newly designed lesson was prepared for inclusion in EME 2040 to introduce data analysis pedagogy to pre-service teachers. The lesson was delivered early in the Spring term for EME 2040 using a combination of guided instruction, practical application methods, and integrated worked-examples.

Instruments

There were three instruments used during implementation of the study: (a) the Instant Messaging Engagement Questionnaire, (b) the InspireData Lesson Assessment, and (c) the Post-treatment Questionnaire. The Instant Messaging Engagement Questionnaire was designed to

ascertain the instant messaging habits of study participants. The InspireData Lesson Assessment was designed to determine the level of comprehension participants could demonstrate after exposure to the lesson during treatment. The Post-treatment Questionnaire was administered to members of the treatment group to confirm instant messaging activity took place during the treatment period. The reader will refer to Appendix B for final versions of the instruments listed here along with their design blueprints.

Validity

The questionnaires used for this study were reviewed by two researchers who have examined pedagogical use of instant messaging, William Beasley of Cleveland State University, Ohio and Malcolm Rutter of Napier University, Scotland. Feedback provide by these expert reviewers was incorporated into the final instrument presentation and may be viewed in Appendix C. Moreover, Amy Scheick, the EME 2040 course coordinator conducted a review of the InspireData assessment. The reader will recall from the population section of this chapter that this study engaged in random sampling of the EME 2040 student population. In terms of internal validity, this is known as using internal controls. That is, participants in both the control and treatment groups are drawn from populations which are descriptively similar (Shadish, Cook, & Campbell, 2002), for example, the UCF COE undergraduate population. Though an internal controls approach does not guarantee descriptive similarity between groups, fewer selection biases are likely to be present than if the control group was composed of external participants (i.e. students from another university, etc.). However, this study might have been subject to an interaction effect, due to the sampling procedures and the instant messaging treatment. This possibility was countered by administering the Instant Messaging Engagement Questionnaire

prior to administration of treatment so as to confirm participants' experiences with instant messaging activity.

Reliability

Participant ratings of various instant messaging activities and purposes obtained from the Instant Messaging Engagement Questionnaire may be considered very reliable for the sample to whom the questionnaire was administered (Cronbach's Alpha Coefficient = .902). Cronbach's Alpha procedure was also used to evaluate the reliability of the Post-test Questionnaire used with the treatment group for this study. Participant ratings of instant messaging engagement during the InspireData lesson obtained from the Post-test Questionnaire may also be considered very reliable, particularly after removal of the First Communication Preference item (Cronbach's Alpha Coefficient = .870).

InspireData assessment

The EME 2040 instructor was provided an instructional treatment plan (ITP) developed for lesson delivery wherein 28 assessment items were listed. Ten items from the ITP were used for the final assessment: 9 items from the ITP and 1 item related to the National Educational Technology Standards for Teachers. The assessment items were criterion-referenced. Each section participating in the study received the same assessment items, though items were randomized for each group by the instructor. The final assessment may be viewed in Appendix D.

Cronbach's Alpha procedure was used to evaluate the reliability of the InspireData assessment used with both the control and treatment groups for this study. Participant answer choices were obtained from the assessment and recoded for analysis. The assessment may not be considered reliable. Though removal of the Database Records and Student Questionnaire items

which showed negative corrected item-total correlations was warranted, the Cronbach's Alpha coefficient did not show any significant improvement (Cronbach's Alpha Coefficient = .305).

Study Implementation Procedures

The following procedures were used for implementation of this study:

1. Undergraduate students registered for EME 2040: Introduction to Educational Technology course at the University of Central Florida College of Education were contacted for voluntary participation in the study during the Spring 2008 term
2. The Instant Messaging Engagement Questionnaire was administered to participants.
3. The sample (N=56) was randomly assigned to either the treatment or control group conditions.
4. The entire intervention was conducted in one class meeting; all participants were given the InspireData lesson
    a. The treatment group was allowed to engage in intermittent instant messaging with their existing contacts throughout lesson administration.
    b. All participants completed the InspireData lesson assessment.
5. Members of the treatment group completed a post-treatment questionnaire to report levels of instant messaging engagement and content comprehension during treatment.

Data Analysis

Quantitative data analysis techniques were applied to data collected from the aforementioned experiment. Specifically, the InspireData assessment scores for the control and treatment groups were analyzed using the Analysis of Variance (ANOVA) statistical procedure. The ANOVA is typically used to evaluate the mean difference between two groups on a measure and is a very robust test.

Descriptive analysis

A variety of demographic data was collected from the Instant Messaging Engagement and Post-treatment questionnaires for analysis. In addition, descriptive details regarding the InspireData assessment scores are reported, including: means, standard deviations, and treatment effect size.

Analysis of variance

As previously mentioned, the ANOVA procedure was used to compare the InspireData assessment score means for the control and treatment groups. The basic assumptions underlying an ANOVA are that the dependent variable is normally distributed for comparison groups. In addition, the variances of the dependent variable should be the same for the comparison groups. Moreover, the cases included in the analysis should represent random samples from the populations under investigation. Finally, the scores on the test variable should be independent of each other. Data for this study met all assumptions for the statistical procedures used for evaluation.

Limitations

Post-test only research designs cannot be used to evaluate learning gains because participants are not subject to a pre-test where baseline data on a measure may be collected and compared with post-test data after a treatment has been applied. This is important because the absence of a pre-test makes it more difficult to determine if the treatment actually impacted assessment scores (Shadish, Cook, & Campbell, 2002).

CHAPTER 4: RESULTS

This chapter presents the research findings for this study in two sections: (a) Null hypothesis testing and (b) survey and assessment analysis. The chapter begins with a review of participant demographics.

Participant Demographics

Undergraduate students at the University of Central Florida majoring in education were the target population for this study and were selected because they embody characteristics of the Generation M profile. A total of 66 students registered in EME 2040: Introduction to Educational Technology, a required course, consented to participate in the study. The sample for the study was demographically similar as indicated in the Table 10.

Table 10. Demographic Summary of Study Participants

Variable	Classification/Count[a]				
	Freshman	Sophomore	Junior	Senior	Percentage
Age					
18-23	3	28	20	0	88
24-29	0	0	3	1	6.9
35-40	0	0	1	0	1.7
Other	0	1	1	0	3.4
Total 58					100
Gender					
Male	2	4	8	1	25.9
Female	1	25	17	0	74.1
Total 58					100
Own a Computer					
Yes	3	27	25	1	96.6
No	0	2	0	0	3.4
Total 58					100
Family's Income					
$0-$9,999	0	2	1	0	5.2
$10,000-$19,999	0	2	1	0	5.2
$20,000-$39,000	1	5	3	0	15.5
$40,000-$59,000	1	6	5	0	21
$60,000+	1	14	15	1	53.1
Total 58					100
Ethnicity					
White/Caucasian	3	23	17	1	77.2
Black/African Descent	0	2	0	0	3.5
Latino/Non-African Descent	0	2	5	0	12.3
Native American	0	1	1	0	3.5
Other	0	0	2	0	3.5
Total 57					100
Length of IM Use					
Less than 1 year	1	6	5	0	21.2
2 years	0	0	1	0	1.8
3 years	0	4	2	0	11
4+ years	2	19	16	1	66
Total 57					100
[a]Note:					
Total Classification Counts	3	29	25	1	
Total Classification Percentages	5.2	50	43.1	1.7	

Table 10 indicates that 50% of the participants were sophomores while 43% were juniors. Freshman and senior representation in the sample was negligible. In terms of age, 88% of study participants reported their ages to be in the 18-23 range. The sample was overwhelmingly female and Caucasian with 74% of the sample reporting a gender of female; 77% of the sample identified themselves as White/Caucasian. In terms of income, the 53% of participants reported a total family income of more than $60,000 while 21% of participants reported family income in the $40,000-$59,999 range; 97% of the sample reported owning an Internet-connected computer. Nearly all of the participants reported having some experience using instant messaging applications with 66% of participants reporting instant messaging use of four or more years.

Null Hypothesis: Post-test Results

A one-way analysis of variance (ANOVA) was conducted to test the null hypothesis that there is no statistically significant difference in assessment score between students who engage in intermittent instant messaging and those who do not engage in intermittent instant messaging during lesson administration.

Data were collected from two sections of EME 2040, both taught during the 6:00 – 8:50 PM timeframe in the Spring 2008 term. The Monday night class was designated as a mixed-mode course with reduced seat time required; data were collected from this section during a scheduled face-to-face meeting in the fourth week of the academic term. The Thursday night section was designated as a face-to-face section which meets weekly. Data from the Thursday night section was collected during the fourth week of the academic term. All data, including questionnaire responses and test scores, were collected during one class session for each of the two sections.

Four Instant Messaging Engagement Questionnaires could not be matched with InspireData assessment scores. In addition, six Post-test Questionnaires could not be matched with InspireData assessment scores. These unmatched records were removed from the statistical

software package prior to analysis. The final control group included 34 participants, and the final treatment group included 24 participants for a total sample of 58.

One-way analysis of variance

The one-way ANOVA was selected to evaluate the relationship between instant messaging activity and InspireData assessment scores because it provides an estimate of effect size as well as a comparison of group means. The independent variable, instant messaging activity, included only one level which was defined as inclusion in the treatment group where instant messaging was encouraged. The dependent variable was the InspireData assessment score. The ANOVA was not significant: $F_{1,56} = .003$, $p > .05$.

Effect size

The ANOVA procedure produces and index measuring effect size known as Partial Eta Square (e.g. η^2). The η^2 index ranges from 0 to 1 and indicates the extent to which the treatment explains scores on the dependent variable. The effect size of $\eta^2 < .01$ indicated that less than 1% of the total variance in InspireData assessment scores was explained by the Instant Messaging treatment.

Descriptive statistics

As indicated by the ANOVA, the group means for the control and treatment groups do not differ significantly. Table 11 lists the means and standard deviations for the control and treatment groups.

Table 11. InspireData Assessment Means and Standard Deviation

Group	Mean[a.]	Std. Deviation	N
Control	7.21	2.750	34
Treatment	7.17	3.074	24
Total	7.19	2.862	58

[a.] Note: Minimum score possible = 0
Maximum score possible = 14

For an ANOVA procedure, the standard deviation scores for the groups under investigation should be similar. The standard deviation from the mean for each group's InspireData assessment scores do not violate this assumption as reported in Table 11. In fact, the means of each group are statistically even.

The results of the ANOVA show that there is no statistically significant difference in the assessment scores of participants who engaged in intermittent instant messaging and those who did not during the InspireData lesson and suggest that the appropriate action is to fail to reject the null hypothesis.

Questionnaires

Instant messaging engagement questionnaire results

The purpose of the Instant Messaging Engagement Questionnaire was to evaluate participants' prior exposure to instant messaging activity. Understanding the extent to which participants were previously exposed to instant messaging practices was important in terms of interpreting the ANOVA results. If participants had little or no prior exposure to instant messaging activity, it is likely that the treatment group would have exhibited very low scores in comparison to the control group due to impact of dividing attention between two new concepts: InspireData content and Instant Messaging activity.

The reader will note from Appendix B that items on the Instant Messaging Engagement Questionnaire were arranged in five categories (excluding demographics): (a) awareness of instant messaging/instant messaging applications, (b) comfort with instant messaging, (c) level of instant messaging use, (d) instant messaging use patterns, and (e) multitasking behavior. A series of correlations using the Kendall Tau-b Rank Correlation procedure were conducted to evaluate the strength of association (e.g relationship) between the Use IM Daily variable and variables in the previously identified categories. The Kendall Tau-b statistic was selected to analyze the questionnaires because it is designed for use with ordinal level (e.g. ranked) data. This statistic takes into account that participants will likely apply varying definitions to points on the questionnaire. Table 12 lists the results of the correlations conducted to evaluate the relationship between the Use IM Daily variable and variables represented across categories on the questionnaire; it also shows the coefficients with effect sizes as prescribed by Cohen (1992).

Table 12. Correlation Results: Use IM Daily Variable and Instant Messaging Engagement Questionnaire Categories[a.]

Category/Variables[b.]	Coefficient[c.]	*Effect Size*
IM Use Pattern		
IM to Collaborate with Classmates	.468	Large
IM to Collaborate with Instructors	.225	Small
IM to Collaborate at Work	.328	Medium
Social Aspects of IM		
IM to Socialize	.682	Large
IM to Know Who's Online	.534	Large
IM to Enhance Relationships	.509	Large
Multitasking Behavior		
IM to Multitask	.553	Large
IM to Manage Multiple Conversations	.481	Large
Instant Messaging Impact		
Recommend IM to Family/Friends	.334	Medium
Prefer IM to other Communication Methods	.588	Large
Level of IM Use	.646	Large

Notes:
[a.] N = 57 for all correlations
[b.] Comparison variable = Use IM Daily
[c.] All p-values are below .05

In terms of instant messaging use patterns, Table 12 shows that there was a positive correlation and statistically significant relationship between the Use IM Daily variable and all three IM Use Patter (e.g. collaboration) variables. Variables related to the social aspects of instant messaging also showed strong, positive correlations as well as a statistically significant relationship with the Use IM Daily variable. Moreover, there were positive correlations between the Use IM Daily variable and variables related to multitasking as well as variables related to the

instant messaging impact category. Effect sizes for these variables range from medium to large with only the IM to Collaborate with Instructors variable registering a small effect size.

Participant comments

Twenty-nine of the fifty-eight participants provided comments in the free-response section of the Instant Messaging Engagement Questionnaire. Six coding categories were identified after the comments were transcribed. Table 13 lists comment categories identified and the frequency of occurrence in the dataset.

Table 13. Instant Messaging Engagement Questionnaire Comment Category Frequency

Comment Categories	Frequency[a]
Prefer face-to-face communication	2
Do not instant message	4
Prefer social networking or texting on phone	5
Prefer/enjoy instant messaging	6
Stopped IM activity after middle or high school	6
Convenient/reach family and friends	7
Total	30

[a] Note: Some comments fit multiple categories.

Table 13 shows that comments coded as Convenient/Reach Family and Friends occurred at a higher rate (n = 7) than all other categories. Prefer Face-to-Face Communication was coded least often among the categories identified from participant comments (n = 2). Of note, however, are the Prefer/Enjoy Instant Messaging and Stopped IM Activity after Middle or High School occurrences (n = 6).

Post-test questionnaire results

The purpose of the Post-test Questionnaire was to determine the level of instant messaging activity in which members of the treatment group were engaged. Determining the level of instant

messaging activity was important so as to confirm that instant messaging activity indeed occurred during treatment and might have impacted the treatment group's InspireData assessment scores.

Four categories were investigated on the Post-test questionnaire which was administered to the treatment group only: (a) Multitasking Behavior, (b) Conversation Content, (c) Extraneous Cognitive Load, and (d) Content Comprehension. As with the Instant Messaging Engagement Questionnaire, a series of Kendall's Tau-b Rank Correlation procedures were conducted to investigate the strength of association between the Level of Instant Messaging Use variable and variables in the previously identified categories. Table 14 displays the results of correlation procedures conducted to investigate the strength of association between the Level of Instant Messaging Use variable and those represented across categories on the Post-test questionnaire.

Table 14. Correlation Results for Level of IM Use and Post-test Categoriesa.

Category/Variables	Coefficient [b.]	*p*-value	Effect Size
Multitasking Behavior			
Managed Multiple Conversations	.807	<.01	Large
Managed Multiple IM Applications	.566	<.01	Large
IM Conversation Content			
IM Content was Social	.637	<.01	Large
IM Content Related to InspireData	.366	<.05	Medium
Managed Multiple IM Applications	.417	<.05	Medium
Extraneous Cognitive Load			
IM Interfered with Completing Lesson	.244	>.05	Small
IM Interfered with Ability to Understand Lesson	.254	>.05	Small
IM Interfered with Ability to Practice Lesson	.199	>.05	Small
Content Comprehension			
Comprehend InspireData Concepts	.216	>.05	Small
Confident in Ability to Use InspireData	.242	>.05	Small
Confident in Ability to Transfer InspireData Skills	.144	>.05	Small

[a.] N = 24 for all correlations
[b.] Comparison variable = Level of IM Use

Table 14 summarizes the correlation coefficients for the Post-test Questionnaire. In terms of multitasking behavior, there was a positive correlation between the Level of Instant Messaging Use variable and variables related to multitasking. Likewise, variables related to instant messaging conversation content in relationship to level of instant messaging use also produced positive correlations showing statistically significant relationships. Variables related to the imposition of extraneous cognitive load as associated with level of instant messaging use produced positive correlation coefficients; however, no statistically significant relationship emerged as reported in Table 14. In terms of content comprehension and level of instant

messaging use reported (e.g. Multitasking Behavior), positive correlations exist. However, no statistically significant relationship between these variables emerges. Effect sizes for these correlations are considered small and large, respectively.

Participant comments

Sixteen of the 24 participants in the treatment group provided responses in the comments section of the Post-test Questionnaire. Six coding categories were identified after the comments were transcribed. Table 15 lists comment categories identified and the frequency of occurrence in the dataset.

Table 15. Post-test Questionnaire Comment Category Frequency

Comment Categories	Frequency[a]
Instant messaging not distracting	1
Experienced technical difficulty	1
Instant messaging should be used at school/work	2
No activity during InspireData lesson	4
Distracted by Instant messaging	9
Total	17

[a] Note: Some comments fit into more than one category.

Table 15 shows that only one individual in each of two instances reported either experiencing technical difficulty or not being distracted. However, most participants reported that instant messaging was a distraction (n = 9). Of note is that four participants, 17% of those commenting, did not engage with instant messaging during the treatment period.

Results Summary

In summary, the results of statistical tests conducted with data collected for this study suggest a fail to reject the null hypothesis decision. There was no statistically significant difference in InspireData assessment scores for those exposed to instant messaging activity and those who were not exposed to instant messaging activity during the InspireData lesson. Strong relationships between variables in the Instant Messaging Engagement Questionnaire emerged indicating that significant relationships exist between daily use of instant messaging and the IM Use Pattern, Social Aspects of IM, Multitasking Behavior, and Instant Messaging Impact categories. On the Post-test Questionnaire, significant relationships emerged between the level of instant messaging use variable and factors related to Multitasking Behavior as well as Instant Messaging Conversation Content. However, there were no significant relationships between the level of instant messaging use variable and variables related to extraneous cognitive load and content comprehension.

CHAPTER 5: DISCUSSION

This chapter presents a discussion of the results reported from chapter 4 in terms of the prior research reviewed in chapter 2. In addition, methodological limitations are forwarded as are suggestions for further research in this area. The discussion begins with a review of the variables used to examine instant messaging impact on learning and results of the null hypothesis test.

Recall that the purpose of this study was to examine the impact of instant messaging activity during learning. Two variables were used to assess instant messaging impact on learning: (a) the independent variable - extraneous cognitive load represented by intermittent instant messaging activity in the treatment group during the InspireData lesson, and (b) the dependent variable - InspireData assessment scores which were used to measure the impact of the instant messaging treatment. Specifically, the assessment scores were used to evaluate any schema development (e.g. learning) as assisted by the presentation content through the integrated worked-example format.

Null Hypothesis Results

The result of the one-way ANOVA conducted to test the null hypothesis for this study indicated that there was no statistically significant difference in the InspireData assessment scores of the control and treatment group: $F_{1,56} = .003$, $p > .05$. The means of each group are statistically similar; control group: $\underline{M} = 7.21$, treatment group: $\underline{M} = 7.17$ (e.g. each could be rounded to 7.2). The ANOVA result is as predicted (e.g. a difference in scores would not be detected) and consistent with the literature describing the Generation M profile.

The closeness in group means indicates that there is virtually no variance in InspireData assessment score among the two groups which signals that one would fail to reject the null hypothesis for this study. However, there exists the potential of committing a Type II error with these data.

Type II error, or β error, occurs if one fails to reject the null hypothesis when the alternative state of being for the phenomenon under observation is actually true (Shavelson, 1996). A Type II error might be made with this study for the following reasons: (a) time for introduction of the InspireData concept may have been insufficient to assess proficiency, (b) the amount of practice given to assume proficiency with InspireData may have been insufficient, and (c) the performance measure used to determine proficiency with InspireData had a low reliability coefficient (e.g. InspireData Assessment's Cronbach's Alpha = .305). Therefore, the discussion presented in this chapter should be interpreted with caution. In addition, results may not be generalized to the Generation M population at large due to the limited demographic profile of the Generation M sample access for this study.

Results in Relationship to the Research Literature

Generation M

Results of the Instant Messaging Engagement and Post-test Questionnaires are consistent with literature regarding Generation M's propensity toward digital connectivity preferences as well as high rates of multitasking behavior. Again, the purpose of administering these surveys was to measure participants' level of engagement with instant messaging prior to the treatment condition and immediately after the treatment concluded. Proficiency with instant messaging was important for this study to assume that participants would not experience a negative divided attention effect. Divided attention is closely related to CLT and is defined as requiring that working memory resources be applied toward multiple stimuli during encoding and schema development such as was implemented in this study (Mulligan, Duke, & Cooper, 2007). In point of fact, all participants (n = 57) reported some level of exposure to instant messaging use.

Rideout, Roberts, and Foehr (2005) report that 64% of Generation M members who responded to their survey engaged in multiple computer activities daily, to include instant messaging. In addition, Salaway, Caruso, and Nelson (2007) report that 84% of respondents to their survey engaged with instant messaging activity daily. Therefore, it is not surprising that a plurality of participants in the current study reported that they use instant messaging daily, with 54% of participants agreeing with the Daily IM Use item. Moreover, 86% of participants indicated awareness of instant messaging availability. It was important to establish the high level of awareness and use of instant messaging to have confidence that the sample possessed sufficient expertise with the medium.

Of note are results from the comments section of the Instant Messaging Engagement and Post-test Questionnaires as compared to previous research. The Rideout, Robersts, and Foehr (2005) study indicated that members of Generation M do not abandon previously existing media for that which is new. However, those providing comments for this current study are in contrast with the Generation M study's findings. Participants in this study indicate that they (a) stopped using instant messaging software after middle or high school (n = 6), or (b) preferred using the text messaging option on mobile phones or social networking sites like Facebook (n = 5). When combined, these data represent 35% of those responding to these questionnaires. While 35% of the sample may not be an overwhelming figure, it is substantial in terms of preferences for newer communications technology over the relatively older instant messaging option. This figure indicates that instant messaging may no longer be the pre-dominate communication preference for the current K-16 population as newer communications media emerge. In fact, Madell and Muncer (2007) as well as Brown (2002) agree that use of digital communications media evolves over time and provides users with a sense of control over how communication occurs.

The homogeneity of InspireData assessment scores between the control and treatment groups suggest that the extraneous cognitive load represented by instant messaging engagement did not result in a negative divided attention effect. One might conclude from these results that members of Generation M are developing some mechanism allowing for processing information from multiple sensory inputs. This potential explanation is in contrast to much of the CLT research found in the literature.

Cognitive load theory

The decision to implement an integrated worked-example approach during lesson implementation is supported by the ANOVA results but may have interfered with measuring the impact of instant messaging activity during learning. Recall that an integrated explanation of complex content reduces both intrinsic and extraneous cognitive load. In the case of the InspireData lesson, content was presented through a combination of guided instruction augmented by the inclusion of integrated worked-examples of various data analysis procedures. Moreover, part-task (e.g step-by-step) videos from the AtomicLearning.com website were made available to participants during the lesson. Figure 7 illustrates the worked-example provided in the InspireData tutorial book to illustrate creating a Venn diagram, known in InspireData as a Venn plot.

Figure 7. InspireData Venn Plot Worked-example.

Because the InspireData software has been on the market for about one year and is, therefore, new to the EME 2040 curriculum, the participants were considered novice learners of the lesson's content. CLT researchers would assert that the group means are similar because the use of integrated worked-example presentation of content allows novice learners to focus limited working memory cognitive resources on understanding the principles and procedures involved with learning the content (Grobe & Renkle, 2006). However, when one section of EME 2040was asked by the instructor about experience with other data analysis software like Microsoft's Access and Excel, some participants indicated that they had been exposed to such software. Therefore, it is reasonable to assume that most participants had some prior knowledge of data analysis software functionality. This study does not measure the level and impact of prior knowledge of data analysis software among the participants which may have impacted their assessment scores.

It is indeed reasonable to expect that the integrated worked-example tools used with the InspireData lesson would be effective in reducing cognitive load with the novice learners accessed for this study as purported in Crippen and Earl (2007). Indeed, the assumed reduction of cognitive load through the application of integrated worked-examples may have confounded

the impact of instant messaging activity on cognitive load. In other words, it is not possible to determine with any degree of certainty if extraneous load presented via instant messaging and the assumed reduction of overall cognitive load through application of integrated worked-examples did not each cancel the effects of the other.

In addition, any assumption of similarities in cognitive load imposed on participants in either the control and treatment group may not applicable due to the introduction of multiple content delivery methods, including integrated worked-examples. That is, the instructor delivering the InspireData lesson used a combination of guided instruction with practical application of the major concepts augmented by the presentation of integrated worked-examples of finished InspireData products. In other words, there is nothing designed in the analysis of data from this study which takes into account how each of the instructional approaches used during lesson implementation impacted the assessment scores used for the comparison of the control and treatment groups.

Extraneous load (instant messaging) impact on learning

Recall that extraneous load is defined as unnecessary distractions which occupy space in working memory, detracting from schema development and knowledge acquisition. These distractions might be internal to the lesson presentation by an instructor or computer-based training environment, or they may be external to the lesson as in noise from another classroom or intermittent instant messaging activity (Feldon, 2007). According to CLT theory, those participating in the treatment group of this study should have produced significantly lower scores on the assessment because working memory resources were divided among two distinct activities (e.g. the InspireData lesson and instant messaging) (Paas, Renkl, & Sweller, 2004), but as noted there was no difference in scores. The result is compelling when viewed in terms of Dede (2005)

which indicates that those whom he identifies as neo-millennials will develop new abilities and methods of expression with digital media.

It is possible that individuals who are highly active with instant messaging and other digital communication media may be developing an ability to effectively filter multiple kinds of sensory inputs in working memory during schema development. In addition to the statistical similarity between control and treatment group assessment scores, no relationship between instant messaging activity and perception of extraneous load was detected on the post-test questionnaire. This result is consistent with cognitive load research conducted in secondary school settings where attempts to reduce extraneous load did not produce statistically significant differences in performance between groups. For example, Olina, et al (2006) examined assessment scores of low and high performing students in English classes where use of comma rules was evaluated. The low and high performing group means only differ by approximately 1 point for the final treatment condition, a result very similar to those of this current study.

Results of the Post-test Questionnaire administered to members of the treatment group showed mixed results. However, in terms of extraneous cognitive load, no significant relationship emerged between participants' reported level of instant messaging use and variables related to extraneous load. Though correlation coefficients on these variables were positive, they were very low (between .2 and .25). Moreover, the p-values on these correlations all exceeded the alpha established for this study of .05). This means that participants reported being able to successfully attend to the InspireData lesson while being engaged in an additional activity which should have produced significant extraneous load on working memory resources.

Of note in this part of the discussion is the compilation of comments from the Post-test Questionnaire where a majority of participants providing comments indicated that instant

messaging activity was distracting to them (n = 9). The correlations and comment frequencies reported are in conflict. That is, though respondents reported that they were distracted by their instant messaging activity, their responses to items related to extraneous load (e.g. distraction) indicate that there is no relationship between their instant messaging activity and content comprehension. Essentially, participants in this study perceived some level of discomfort with instant messaging engagement during learning, but at the same time believed that learning was possible while engaged with instant messaging. However, it should be noted that the mean scores for both the control and treatment groups were low, around 7 which amounts to 50% of the total score possible. Though participants perceived themselves to be learning, their assessment scores suggest that remediation is necessary for both groups, further indicating that the assessment scores may not be explained by instant messaging activity.

Instant messaging in the classroom

This study begins a new discussion in research literature related to how instant messaging is used in classrooms. Heretofore, literature in this area was focused around pedagogical and social uses as in Kinzie and her colleagues (2005) as well as Lewis and Fabos (2005) describe. This current study made an attempt to examine how the combination of instant messaging activity and learning engagement impacts learning outcomes. Notwithstanding the Type II error concerns noted above, results indicate that instant messaging activity during learning may not impact learning outcomes. However, when the ANOVA results are viewed through the prism of results from the study's questionnaires, a different picture emerges.

The Post-test Questionnaire results showed that 29% of participants (n = 7) rated their instant messaging activity during learning as high. However, 67% of Post-test Questionnaire respondents report that their instant messaging content was social (n = 16). The fact that

participants in the treatment group felt distracted while learning suggests that though these participants were able to engage in instant messaging while learning, allowing instant messaging during learning for social purposes is ill-advised. The perception of distraction due to social communications via instant messaging, as described by the participants of this study, my have a negative impact on learning outcomes.

Correlations from the Instant Messaging Engagement Questionnaire indicate that there are very good opportunities for those working with Generation M to make effective pedagogical use of instant messaging activity. Recall that there were positive and significant correlations between the Use IM Daily and Collaboration variables, especially the IM to Collaborate with Classmates (coefficient = .47, N = 57, $p<.01$). Moreover, participants reported a very high level of multitasking via instant messaging where the Use IM Daily and IM to Multitask variable correlate positively as well (coefficient = .55, N = 57, $p<.01$). The effect sizes of these correlations suggest that educators should develop efficient and authentic ways to allow for collaborative efforts among students via instant messaging.

Methodological Limitations

The attempt to implement a tightly controlled, experimental design for this study was only somewhat successful. Therefore, those wishing to replicate this study should address various limitations present here prior to conducting a similar study. Firstly, there were only two opportunities to practice the major InspireData concepts prior to administration of the assessment. Providing additional time for practicing concepts may result in higher scores if not higher variability in group means. Moreover, the relatively low assessment scores (e.g. about 50%) suggests that inadequate practice time may have influenced the potential impact of instant messaging activity on cognitive load. Furthermore, the instructor's inclusion of additional content related to using Google Documents (commonly referred to as GoogleDocs), may have

added extraneous load which was not accounted for in the ANOVA model. Additionally, though the same instructor implemented the InspireData lesson in each section, she was not the regular instructor for the mixed-mode section. The change in instructor for that section may have impacted how students responded to the lesson presentation. A related issue is that each of the sections accessed for this study were offered in different modalities, either mixed-mode or face-to-face. Because the communication practices in mixed-mode sections differ from that of face-to-face sections, assessment scores may have been impacted.

Members of the sample for this study did not reflect the complete Generation M demographic. The overwhelmingly Caucasian, female, and high socio-economic status representation in the sample may have impacted the study's outcomes. In addition, though members of the control group adhered to constraints regarding instant messaging, observation notes made during data collection indicated that some members of the control group did engage in multitasking behavior where they used various websites and checked computer files during content presentation. This indicates that additional controls will need to be in place to prevent control group members from accessing the Internet and other computer-related resources during lesson implementation. Moreover, establishing reliability on the content assessment may impact the outcome of future studies replicating this investigation. Finally, constraints related to attempts to reduce cognitive load must be addressed prior to replication of this study by other researchers. A suggestion is to include extraneous cognitive load as a covariate in the ANOVA model.

Implications

The ANOVA used to evaluate InspireData assessment scores was not significant as previously reported. Moreover, the effect size was very small where less than 1% of scores could

be explained by instant messaging activity. The low effect size implies that, in terms of working memory load and learning outcomes, instant messaging activity is not a significant factor. However, because treatment group participants reported feeling distracted while instant messaging for social purposes, educators should proceed cautiously with regard to allowing social instant messaging during academic content presentation.

Though the results of this study may not be generalized to all members of Generation M, the correlations performed for the questionnaires used in this study point to important implications for those teaching members of Generation M in undergraduate classrooms. Activity from the treatment group indicates that students will engage with members of their networks socially during class when presented with the opportunity to do so. A host of classroom management, academic honesty, and cyber-bullying issues become important when considering this reality. Instructional designers will note that when designing and developing content for undergraduate audiences, use of instant messaging as a tool is warranted as a method of providing support for learning during implementation. Use of instant messaging during learning should be assessed for effectiveness during the formative evaluation stage of instructional materials development as prescribed by Dick, Carey and Carey (2005).

Students are moving quickly to adopt newer communications media. This implication is supported by results from the Instant Messaging Engagement Questionnaire where most participants who provided comments reported that they no longer opt to use instant messaging if mobile phone text messaging is available. In addition, many of these participants reported a preference for using social networking sites like Facebook to communicate. The implication here is that students are heavily engaged with a variety of digital communication media in and outside the classroom which can be worlds apart from classroom culture. These practices do have some

impact on how students perform – even if it's only perception – as demonstrated in the Post-test Questionnaire of this study. How will educators in K-16 contexts apply current as well as up-and-coming digital communications options in classrooms?

Recommendations for Further Research

The results of this study indicate a need to conduct additional research in the area of Generation M's ability to engage in multiple activities while learning. Specifically, researchers will want to focus attention on the intersection of perceived distraction levels and actual performance during learning. Future studies may also seek to evaluate instant messaging impact on learning from a Divided Attention (DA) perspective. Application of CLT in the context of instant messaging during learning did not prove efficient due to its theoretical underpinnings. Where CLT is limited to how various effects impact cognitive load on working memory, DA is designed to examine the impact of simultaneous, yet unrelated activities.

Researchers may also focus attention on rates of instant messaging activity and levels of learning outcomes for participants. That is, for those with high rates of instant messaging activity are there higher or lower scores on the content assessment? A related concern is providing a method whereby prior knowledge with the to-be-learned content is measured.

Investigators will also want to conduct digital multitasking studies, to include other digital communication preferences, with more diverse populations to determine impact on learning with other ethnic and socio-economic groups. As researchers look at digital multitasking with more diverse groups, issues such as digital access and equity become important and should be included in research designs targeting minority groups. In addition, because this study does not come closer to developing an instrument sufficient for assessing comprehension during digital multitasking like instant messaging, researchers may want to extend the efforts made here to provide such an instrument which may be used across the curriculum.

As previously discussed, there are myriad classroom management issues requiring attention when instant messaging is a part of teaching and learning. Educational researchers should begin to examine how various concerns such as academic dishonesty (i.e. plagiarism) and cyber-bullying are facilitated by the advent of instant messaging in classrooms. Moreover, this discussion of instant messaging impact on learning furthers the larger discourse related to teacher preparation to incorporate digital technology into curricula. Certainly, educational researchers should focus more attention on the impact of various technologies on learning including social networking websites, text-messaging via mobile phones, and digital gaming.

Summary

In summary, this study was an attempt to examine what impact, if any, simultaneous engagement with instant messaging activity unrelated to the presentation of academic content had on learning outcomes. Though the reliability of the ANOVA result is threatened by a Type II error, what is reported here is compelling. Essentially, instant messaging activity did not impact learning outcomes for undergraduate teacher education population exposed to novel content presented during this study. However, many participants felt distracted while engaged with instant messaging during lesson delivery.

This study begins to illuminate pieces of the puzzle related to how Generation M engages with digital multitasking in a variety of settings. Though some of the puzzle pieces are in view, just how the pieces fit together in teaching and learning contexts is an exciting problem for which educational researchers may yet find solutions.

APPENDIX A: PARTICIPANT INFORMED CONSENT LETTER

Dear Participant:

I am a graduate student at the University of Central Florida. I am conducting a dissertation study this spring, the purpose of which is to gain an understanding of how instant messaging activity impacts learning. You are being invited to participate in this study because you have been identified as an undergraduate student enrolled in EME2040: Introduction to Educational Technology.

This study will involve working with me over two class meetings, and you must be at least 18 years of age to participate in this study. During the first meeting, participants will complete an instant messaging questionnaire. During the second meeting, participants will engage in course work, and part of the participating group will be allowed to engage with their instant messaging contacts during the session. Finally, participants who were allowed to engage with instant messaging during the lesson will complete a questionnaire to report their levels of instant messaging activity.

Participation in this study involves use of your private instant messaging contacts on computing equipment owned by the University of Central Florida. That means you may be communicating with members of your contact list during a class session. I will not be able to see your communications, nor will an electronic record of your instant messaging conversations during class be filed or kept on record. The College of Education's Information Technology Department has a policy of "scrubbing" computing equipment daily. That means that computers are returned to the original, default state each day.

This study is designed to provide confidentiality to participants; however, it is not an anonymous study. Though a strict protocol to protect your identity is in place, there is a small risk associated with breach of confidentiality where there is the potential of incorrectly disposing of the electronic document containing your name. You may refuse to respond to any question(s) you prefer not to answer. The questionnaires will be given in person, and the researcher will be present during delivery of the selected lesson. In addition, you may refuse to participate in the entire study without penalty from the instructor of record for the class. However, those who participate in the study will be offered extra-credit on the assignment associated with the study.

There are no anticipated risks, monetary compensation or benefits, other than extra-credit on the associated assignment, extended to you as a participant in this study. You are free to withdraw your consent to participate and may discontinue your participation in the study at any time without consequence. If after the study begins you voice an objection to participating, you may opt-out of the study without consequence. Moreover, if you choose not to participate, to opt-out after giving consent, or are under 18 years of age an alternative extra-credit activity of equal effort, time commitment and value will be extended to you. In addition, if you consent to participate in the study but are unable to complete the commitment, you will still receive full-credit for the alternative extra-credit activity should you choose to complete it.

If you have any questions about this research project, please contact my faculty supervisor, Dr. Atsusi Hirumi at 407/823-1760. You may also contact me anytime at 386/871-7101. In addition, information regarding your rights as a research volunteer may be obtained from:

Barbara Ward, Institutional Review Board (IRB) University of Central Florida (UCF)
12201 Research Parkway, Suite 501; Orlando, Florida 32826-0150 Telephone: (407) 823-2901

If you decide to participate in this dissertation study, please sign and return this copy of the consent form. A second copy is provided for your records.

Sincerely,

_____

Angelique M. Nasah
Principal Investigator,
Doctoral Candidate: UCF College of Education

Co- Investigator's Signature:

_____

Atsusi Hirumi, Ph.D., Associate Professor,
UCF College of Education

Project: Examining instant messaging impact on learning using an integrated worked-example format

___I have read the procedure described above. I have read the "Informed Consent to Participate" and agree to allow the researchers to use the information I provide for related presentations and publications.

___I voluntarily agree to participate in the instant messaging study.

Participant _____
(Please Print Your Name)

Signature _____

Date _____

UCF University of Central Florida IRB
IRB NUMBER: SBE-07-05325
IRB APPROVAL DATE: 12/06/2007
IRB EXPIRATION DATE: 12/05/2008

APPENDIX B: DRAFT QUESTIONNAIRES WITH BLUEPRINTS

Draft Data Collection Instruments with Blueprints

Instant Messaging has become ubiquitous among members of Generation M as a means of staying connected to their social networks. Survey analysis studies report that students often engage in instant messaging while completing academic tasks (Kvavik, Caruso & Morgan, 2004; Rideout, Roberts & Foehr, 2005). However, researchers are not looking at the impact of instant messaging on a learning task.

Instant Messaging Engagement Questionnaire

Rationale:

This questionnaire will be designed to help address the lack of empirical evidence regarding the impact of instant messaging on a learning task and will ascertain the level of comfort study participants have with instant messaging activity.

The questionnaire will be constructed using a combination of low and high level domains from Bloom's Taxonomy to facilitate systematic organization of the questionnaire's items. Factors for which the taxonomy does not apply will be noted. The factors identified are a composite list derived from instant messaging literature reviewed in chapter 2. The numbers under the Bloom's Taxonomy Domains section indicate the number of items on the questionnaire which will address the identified factor.

Blueprint:

		Selected Bloom's Taxonomy Domains			
Factors	Items	Knowledge	Application	Synthesis	Evaluation
Awareness of IM/IM applications	1,2,3	3			
Comfort with IM/IM applications	4-8				5
Level of IM use	15,20	2			
IM use patterns	9-13		5		
IM impact	14				1
Multitasking behaviors	16-19		2	2	
Participant demographics (N/A: 9)	21-29				
Free response items	29-30		2		

Total number of items: 30

The Instant Messaging Engagement Questionnaire

IM Logo Here

Instructions: Read each statement carefully; mark an "X" over the response that best describes your opinion on each statement.

Start

	Strongly Disagree SD	Disagree D	Neither Agree nor Disagree N	Agree A	Strongly Agree SA	Not Applicable NA
1. I am aware of the availability of instant messaging via the internet.	1	2	3	4	5	6
2. I do not use instant messaging services.	1	2	3	4	5	6
3. I am aware of at least one free instant messaging application.	1	2	3	4	5	6
4. I use instant messaging applications daily.	1	2	3	4	5	6
5. I use instant messaging applications weekly.	1	2	3	4	5	6
6. I use more than one instant messaging application.	1	2	3	4	5	6
7. I recommend using instant messaging applications to my family and/or friends.	1	2	3	4	5	6
8. I engage in instant messaging to socialize with my family and/or friends.	1	2	3	4	5	6
9. I engage in instant messaging to know when my family and/or friends are online.	1	2	3	4	5	6
10. I engage in instant messaging to collaborate with classmates on academic tasks.	1	2	3	4	5	6
11. I engage in instant messaging to collaborate with instructors on academic tasks.	1	2	3	4	5	6
12. I engage in instant messaging to collaborate with colleagues on work-related tasks.	1	2	3	4	5	6
13. Instant messaging activity enhances the relationships I have with my family, friends, and/or colleagues.	1	2	3	4	5	6
14. I prefer instant messaging to other communication methods.	1	2	3	4	5	6
15. I use instant messaging services to multitask when I have more than one thing to accomplish.	1	2	3	4	5	6

Please continue on the back of this page.

The Instant Messaging Engagement Questionnaire, Page 2

IM Logo Here

Instructions: Read each statement carefully; mark an "X" over the response that best describes your opinion on each statement.

Continue

	Strongly Disagree SD	Disagree D	Neither Agree nor Disagree N	Agree A	Strongly Agree SA	Not Applicable NA
16. I use instant messaging to carry on more than one conversation at a time.	1	2	3	4	5	6
17. I am comfortable engaging in instant messaging and academic activity simultaneously.	1	2	3	4	5	6
18. I use my instant messaging skills in other parts of my life.	1	2	3	4	5	6
19. I consider my level of instant messaging use to be high.	1	2	3	4	5	6

Place mark an "X" next to the appropriate response for items 21-29.

20. I am classified as a
_____ Freshman
_____ Sophomore
_____ Junior
_____ Senior

21. My age is represented in the selected range
_____ 16 - 20
_____ 21 - 25
_____ 26 - 30
_____ 31 - 35
_____ Other: Please specify: _____

22. My gender is
_____ Male
_____ Female
_____ Transgender

23. I own a computer.
_____ Yes
_____ No

24. My family's annual gross income is
_____ $0 - $9,999
_____ $10,000 - $19,999
_____ $20,000 - $39,999
_____ $40,000 - $59,000
_____ $60,000 or more

Please continue on the next page. 

Post-treatment Questionnaire

This questionnaire will be designed to elicit the extent to which study participants engaged in instant messaging during the administration of the InspireData CBT lesson. This questionnaire is being included in the proposed study to assist with the diminishing threats to external validity. Though the level of instant messaging engagement during lesson administration will be self-reported, this check should assist with the generalizability of study result to the population under review.

Again, domains from Bloom's Taxonomy are used here to facilitate the systematic organization of items on this questionnaire. The factors represented are derived from Atkinson et al (2000), Kinzie et al (2005), and Nicholson (2002).

Blueprint:

		Selected Bloom's Taxonomy Domains			
Factors	Items	Comprehension	Application	Analysis	Synthesis
IM application	1-2		2		
Split attention	3-5	3			
Multitasking behavior	6-8			3	
Conversation categories	9-11			3	
Content comprehension	12-14	3			
Communication preference	15		1		
Free response	16		1		

Total number of items: 16

Note: This blueprint refers to a CBT as the lesson implementation procedure. The InspireData lesson was delivered in a face-to-face, instructor-led format.

Instant Messaging Study Post-test Questionnaire

IM Logo Here

Instructions: Mark an "X" over the response that best describes your opinion on each statement below.

Start

	Strongly Disagree SD	Disagree D	Neither Agree nor Disagree N	Agree A	Strongly Agree SA	Not Applicable NA
1. I was able to download my preferred instant messaging application.	1	2	3	4	5	6
2. My instant messaging "buddies" were available during the InspireData lesson.	1	2	3	4	5	6
3. Instant messaging activity interfered with my ability to complete the InspireData lesson.	1	2	3	4	5	6
4. Instant messaging activity interfered with my ability to understand information from the InspireData lesson.	1	2	3	4	5	6
5. Instant messaging activity interfered with my ability to practice concepts presented during the InspireData lesson.	1	2	3	4	5	6
6. I managed more than one instant messaging conversation during the InspireData lesson.	1	2	3	4	5	6
7. I used more than one instant messaging application during the InspireData lesson.	1	2	3	4	5	6
8. My level of instant messaging activity was high during the InspireData lesson.	1	2	3	4	5	6
9. The content of my instant messaging activity during the InspireData lesson was related to social topics.	1	2	3	4	5	6
10. The content of my instant messaging activity during the InspireData lesson was related to InspireData.	1	2	3	4	5	6
11. The content of my instant messaging activity during the InspireData lesson was related to other academic content.	1	2	3	4	5	6
12. I understand the major InspireData concepts presented during the lesson.	1	2	3	4	5	6
13. I feel confident in my ability to use InspireData.	1	2	3	4	5	6
14. I feel confident in my ability to transfer what I learned about InspireData to content in other classes I am taking.	1	2	3	4	5	6

Please continue on the back of this page.

Instant Messaging Study Post-test Questionnaire, Page 2

Continue

Please mark an "X" next the response on items 15 you consider most accurate.

15. My first communication preference is (**select only one**)
_____ Phone
_____ Email
_____ Instant Messaging
_____ Social Networking Site
_____ Other: Please Specify: _____

16. **Use the remaining space to include any comments about your experience with the InspireData lesson and Instant Messaging Activity.**

END

Thank you for completing the Instant Messaging Study Post-test Questionnaire!

If you have questions about how the information you are providing will be presented, please contact Angelique Nasah at ebonypearl@gmail.com.

APPENDIX C: EXPERT REVIEW COMMENTS FOR QUESTIONNAIRES

Three scholars who have conducted studies on instant messaging in pedagogical contexts were approached to provide expert analysis of the questionnaires used during the data collection phase of this study. Two individuals responded, and their comments are listed below.

Reviewer 1:
Malcolm Rutter: (Rutter, M. (2006). Tutorial chat: A case study of synchronous communication in a learning environment. ALT-J: Research in Learning Technology, 14(2), 169-181.)

Received November 29, 2007 via email.

Dear Ms Nasah,

Your questionnaire looks ok to me, but I am in no way an expert on the subject. When I write a questionnaire I often put a section to sign at the beginning or the end, giving me permission to use the data on condition that the person is not identifiable. We are quite twitchy about ethics over here.

There are a few good texts on questionnaire design. Here is one which covers a number of research methods including questionnaires: Robson, C., (2002), Real World Research, Blackwell publishing, Malden MA USA. I expect that being on a doctoral programme, you will have access to a library containing similar texts.

I wish you every success in your studies.

Reviewer 2:
William Beasley (Wang, L.C. & Beasley, W. (2005). Type II technology applications in teacher education: Using instant messenger to implement structured online class discussion. Computers in the Schools, 22(1/2), 71-84.)

Received December 07, 2007 via email

Hello, Ms. Nasah--

I'm honored that you would seek my opinion. Overall it looks like you've done a good job with this. From what I can tell, you're also planning to have students participate in an InspireData lesson while also using IM, which is an intriguing idea. I would love to know the results of that one.

As far as the individual items go, I have only a couple of questions. With respect to item #13 on the first questionnaire as well as item #15 on the second one, I have the same concern... you're asking for a preference of communication method as though a person would have only one for all communication purposes. If I were answering this questionnaire I would have the same problem with both of these: my mind would read the question and I would say "preferred for _what purpose_"? For example, I might prefer IM for conversing with my school buddies, but prefer

telephone for conversing with family members. Or I might prefer IM for communications relating to my social life, and email for academic communications.

For item 26 on the first questionnaire, I could not for the life of me figure out a situation where "N/A" could be the appropriate answer. It seems to me that one is either on the bus or off the bus in this case; can you fill me in on a situation in which neither "yes" nor "no" would be an appropriate answer?

I did have one other thought as I read through your materials, and it is rooted in the experiences I have had dealing with various computer communications tools with my own students. Many of my students (and I suspect many of yours) do not have a clear understanding of instant messaging as a form of communication distinct from other electronic communications. My students confuse IM with at least the following
similar but distinct activities:

*SMS/text messaging (via cell phone)
*Online chat (e.g. IRC)
*Webchat
*Synchronous chat in a structured environment (e.g. Blackboard or WebCT)
*Threaded online discussions
*Email

I don't know to what extent you will preface this questionnaire with some process of clearly defining IM for them, but I can't help but wonder if you ask your students about IM without distinguishing it clearly from these other things how many of them may answer your questions while holding a clear image in their heads of an activity you never meant for them to be considering.

Good luck with your research!

APPENDIX D: INSPIREDATA INSTRUCTIONAL TREATMENT PLAN AND FINAL INSPIREDATA ASSESSMENT

InspireData™ Lesson Instructional Treatment Plan
Instructor: Amy Scheick, Ph.D.
Instructional Designer: Angelique Nasah

Draft - Friday, December 07, 2007

Lesson Title: Introduction to InspireData

Objectives:
Terminal Objectives:
1.0 Given InspireData-ready computers, guided instruction, an InspireData CBT, and a sample data set, students will be able to enter, evaluate, and interpret data by the end of the lesson.

2.0 Given InspireData-ready computers, guided instruction, an InspireData CBT, and a sample data set, students will be able to build conclusions with data data by the end of the lesson.

3.0 Given InspireData-ready computers, guided instruction, an InspireData CBT, and a sample data set, students will present their findings via InspireData's presentation capability

Enabling Objectives:
1.1 Students will be able to enter data in a new InspireData table from a sample dataset with the assistance of a handout.

1.2 Students will import and append an existing data set into InspireData with the assistance of a handout.

1.3 Students will be able to distinguish between InspireData table and plot view functions with the assistance of a handout.

1.4 Students will edit data within the InspireData table view with the assistance of a handout.

1.5 Students will customize data icons and labels with the assistance of a handout.

1.6 Students will distinguish between the four types of plots offered from the InspireData plot view.

2.1 Students will interpret dataset summary information presented via the InspireData plot view with the assistance of a handout.

2.2 Students will identify patterns within the dataset presented via the InspireData plot view with the assistance of a worked-example.

2.3 Students will identify potential relationships within the dataset presented via the InspireData plot view with the assistance of a worked-example.

2.4 Students will edit the dataset within the InspireData table view with the assistance of a handout.

2.5 Students will use the compute function to create new data within the InspireData plot view with the assistance of a handout.

3.1 Students will formulate questions based on information presented in the sample dataset.

3.2 Students will evaluate identified patterns within dataset from the InspireData plot view.

3.3 Students will develop conclusions from the dataset via the InspireData plot view.

4.1 Students will develop an InspireData slideshow presentation using the sample dataset with the assistance of a handout.

4.2 Students will post completed InspireData slideshows on the EME2040 student presentation webpage with the assistance of a handout.

Prerequisites:

- Basic data entry skills
- Basic word processing skills
- Basic PowerPoint development skills
- Basic Internet browsing skills

Required Resources: All resources will be provided to students, including: Computers, InspireData software, CBT unit, and handouts

Approximate Time Requirement: 3 hours

Rationale for Media Selection:
Students will need the assistance of the instructor as well as hands-on, practical application experience using the application in order to develop proficiency with the software. Moreover, PowerPoint handouts will be useful work-aids as student work through exercises prior to the assessment.

Instructional Strategies and Rationale: Integrated worked-example (Atkinson, Derry, Renkl, & Wortham, 2000) and BSCS 5E Model (Bybee, 2002):
The integrated worked-example approach is the principle instructional strategy for this study because of its ability to assist beginning learners with a novel learning task. Worked-out examples of various processes for InspireData will be provided for students throughout the lesson. This approach will be augmented with the inclusion of the BSCS 5E instructional strategy as a framework within which to present integrated worked examples of InspireData processes.

The BSCS 5E model follows the natural progression of inquiry for most people represented as initial engagement, exploration of alternatives, formation of explanations, use of explanations, and evaluation of explanations. Activities designed using this strategy encourages conceptual change and a progressive re-forming of ideas.

Designer's Note: For the Interaction column, abbreviations are: lc = learner-content, ll = learner-learner, li = learner-instructor, la = learner-application.

See the Media Selection Worksheet for the process related to the media column.

Event	Description	Interaction	Media
Engage	Engagement activities help learners to make connections with what they know and can do.	li	Handout/.ppt InspireData Instructor
Explore	Under the instructor's guidance, learners participate in a common set of experiences helping them clarify their understanding of major concepts and skills. *This step will be augmented with integrated worked-examples.*	li, la	Handout/.ppt InspireData Instructor
Explain	Learners explain their understanding of the concepts and processes they are learning; the instructor assists with clarification.	ll, li	Handout/.ppt InspireData Instructor
Elaborate	Learners apply what they have learned and extend their knowledge and skills. *This step will be augmented with integrated worked-examples*	la, ll, li	Handout/.ppt InspireData
Evaluate	Students assess their own knowledge and skills; the instructor evaluates student progress.	la, li	InspireData Instructor

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[top]

Sample Assessment Instrument:

Designer's Note: The order of items in Part II is different from the alignment table above; in addition, some of the verbiage has been refined. Some items may not appear in this sample instrument.

Test #: Introduction to InspireData

Instructions: This test has two parts: Part I: Objective and Part II: Scenario-based. Part I included multiple choice, true/false, and fill-in-the-blank items regarding the utility of InspireData. Part II requires you to apply basic InspireData skills to an existing dataset for analysis and presentation. Good Luck!

Part I: Using InspireData

1. A record includes all of the data for _____.
   a. aspect
   b. person/item
   c. characteristic
   d. observation

2. A field _____ an aspect of the observation you are recording.
   a. analyzes
   b. surveys
   c. names
   d. records

True or False

3. _____ A table consists of records (rows), fields (columns), and icons (pictures).

4. _____ Records (rows) are representative of individual students.

5. You may import all but one of the following types of files when using InspireData:
   a. Excel
   b. Word
   c. Any comma or tab-separated text format
   d. Both "a" and "c"

6. Data is _____ in the table view.
   a. entered and confirmed
   b. entered and organized

c. entered and completed
d. entered and projected

True or False:

7. _____ The plot view allows you to visually analyze data you have entered in the table view.

8. _____ There are only four plots available for viewing data in the plot view.

9. Field names should be changed to _____ with data represented in that field.
   a. perform
   b. fuse
   c. correspond
   d. develop

10. The data type of a field _____ what kind of information can be entered into it.
    a. defines
    b. provides
    c. complements
    d. analyzes

True or False:

11. _____ The order of fields cannot be changed once entered.

12. _____ Record icons may be customized using both InspireData icons and imported images in .gif or .jpg formats.

Part II: Applying InpireData Skills: Start the InspireData application and open the "Student Survey" file from the "Open Resource" submenu.

13. Review the fields and records contained in the "Student Survey" file. Draft one question you might have as a teacher which would prompt you to collect such data. Include your question here:

    _____

    _____

14. Use the "Student Survey" file to add a new field to the "Student Survey" table called Math SAT Score; add following data to that field:
    520, 640, 420, 460, 380, 560, 620, 420, 400, 540, 600, 620, 380, 400, 420, 560, 480, 520, 620, 580, 520, 480, 460, 500, 420, 380, 520, 600, 520, 420

    Add a new field to the "Student Survey" table called Final Exam (Algebra); add the following data to that field:

85, 82, 70, 75, 67, 87, 92, 85, 80, 85, 90, 95, 67, 72, 72, 85, 72, 85, 95, 90, 91, 80, 75, 77, 72, 70, 80, 90, 85, 72

15. Use the "Student Survey" file to create an Axis plot with the following information.
    Label: Eye Color
    X-axis: Hair Color
    Y-axis: Eye Color
    Capture the resultant plot.
    Evaluate and report on the strength of patterns you identified in the Slide Notes area.

16. Use the "Student Survey" file to create a Venn plot using the following characteristics:
    Label" Language(s) Spoken
    Loop 1: Gender = F
    Loop 2: Hair Color = Black
    Loop 3: Eye Color = Brown
    Capture the resultant diagram. Summarize and interpret the data in the overlapping area of the figure in the Slide Notes area.

17. Create a Stack plot using the following characteristics:
    Label: Language(s) Spoken
    X-axis: Hair Color
    Capture the resultant plot; summarize the data identifying patterns you see in the dataset in the Slide Notes area.

18. Revise your Stack plot using the following characteristics:
    Label: Gender
    X-axis: Math SAT Score
    Compute the Math SAT Score Mean using the Compute tool.
    Capture the resultant plot.
    Summarize and report your results in the Slide Notes area.

19. Create an Axis plot using the following information:
    Label: Gender
    X-axis: Final Exam (Algebra)
    Y-axis: Math SAT Score
    Capture the resultant plot
    Summarize and interpret the results in the Slide Notes area.

20. Using the Math SAT/Final Exam axis plot, develop a conclusion statement based on patterns you identify.

21. Save the "Student Survey" file you have been working with as
    StudentSurvey_LastNameFirstInitial
    Post the completed Student Survey file to your WebCT presentation page.

22. Describe a scenario where InspireData might assist you with reaching conclusions regarding student classroom performance?

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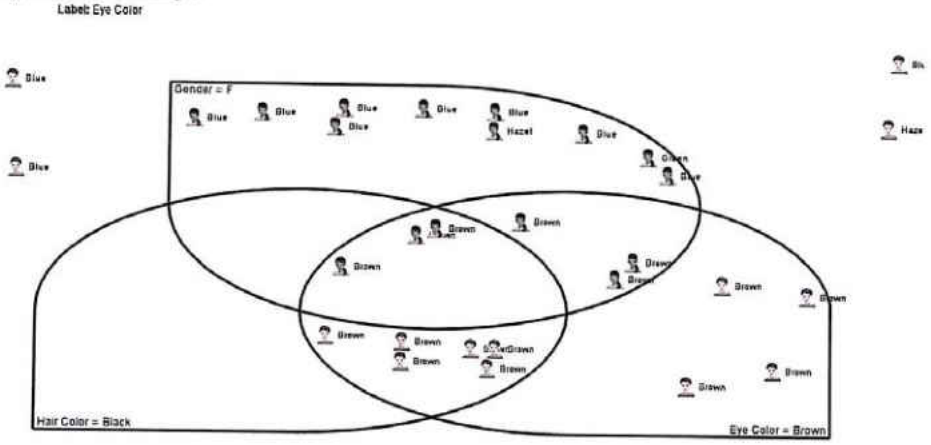
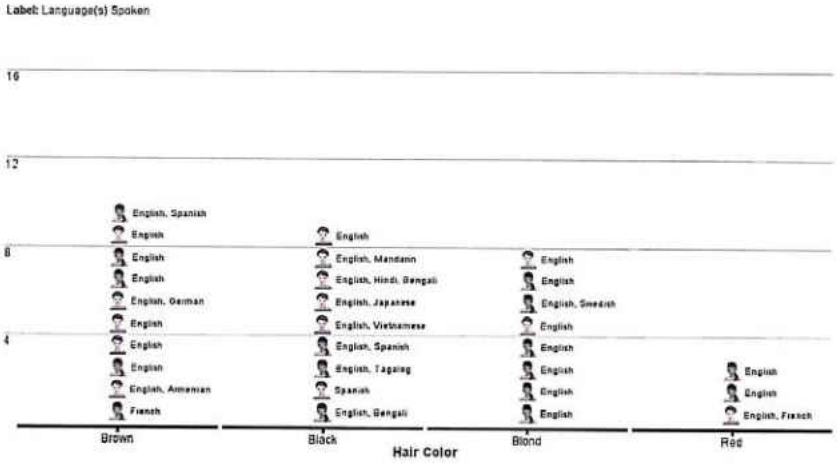
Appendix: Sample Screen-shots for Items in Objectives 2.X – 3.X

Objective 2.1 Example



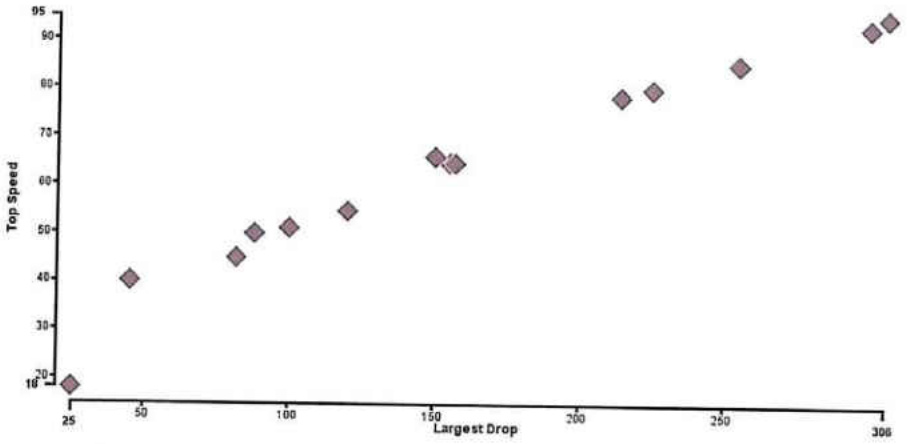
Those with light eye color (e.g. blue, green, and hazel) do not tend to have black hair. 9 students share all three variables reviewed.

Objective 2.2 Example



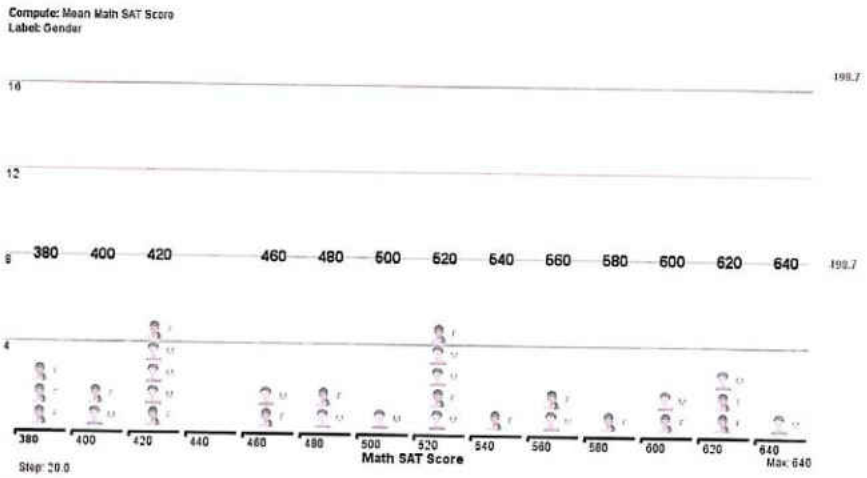
Those with light colored hair tend to speak English only while those with dark hair color have a higher rate of bi-lingual ability.

Objective 2.3 Example



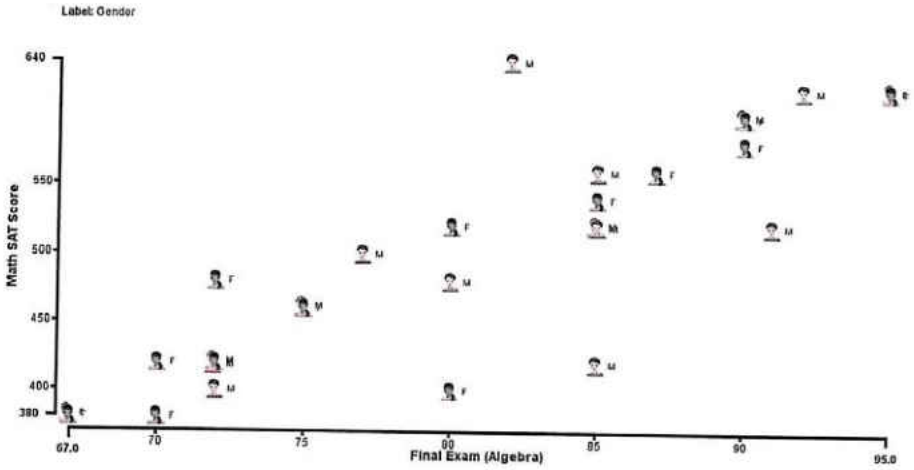
As roller coaster drops increase, top roller coaster speeds also increase.

Objectives 2.4 – 2.6 Example



The range of Math SAT scores is from 380 - 640. Though more students have scores over 500, the number is not significant enough to draw any conclusions (only 2 more

students). There is an almost equal number of male and female scores on both ends of the spectrum. The mean Math SAT score for these students is 498.7 or 499.

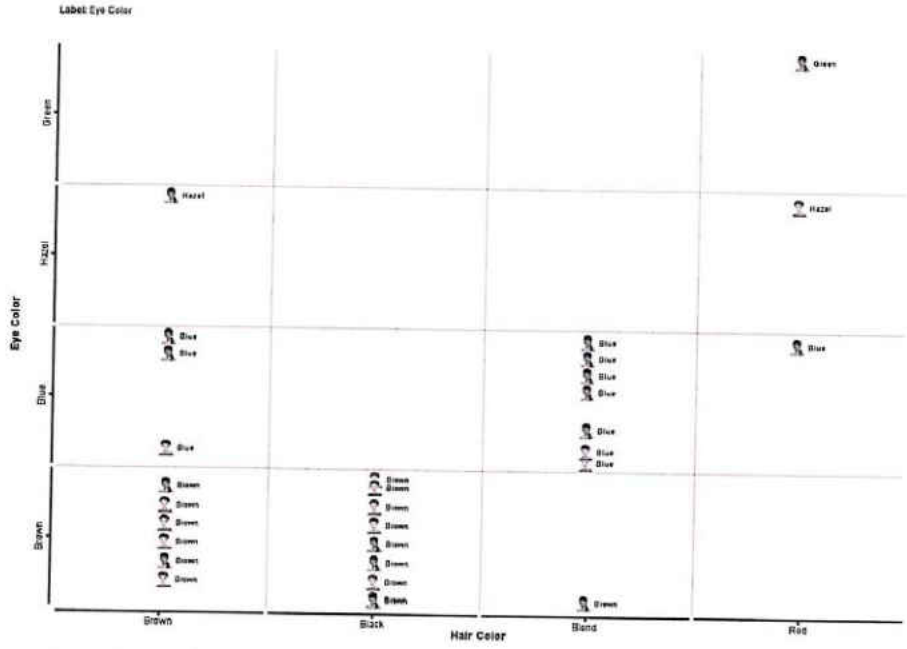


Though there are exceptions, as Math SAT scores increase the final exam scores increase as well. Final exam scores range from 70 - 95 on a 100 point scale while Math SAT scores range fron 400 - 640 where the highest possible score is 800.

Objective 3.1 Example (Answers must be evaluated individually)

Question: Does eye and/or hair color impact bi-lingual status?

Objective 3.2 Example



With the exception of four individuals, these students exhibit a pattern of darkhaired people having brown eyes while light-haired people have blue, hazel, and green eyes.

Objective 3.3 Example (Answers must be evaluated individually)

Math SAT/Final Exam Conclusion: Because there appears to be a correlation between Math SAT Score and Algebra proficiency, the Math Department and XYZ High School should work to strengthen the core algebra curriculum as well to expand the algebra tutorial program.

InspireData Assistance Scenario: InspireData can be helpful in the following ways:

- Pre/post test analysis
- Compare content presentation techniques via learning outcome across multiple sections
- Identify patterns in learning outcomes for individual students
- Data literacy teaching tool

Final InspireData Software Lesson Quiz as Presented to Participants in University Course Management System (WebCT) Note: Correct response in bold-face type. Note that items were scrambled prior to being presented to each section of the EME 2040 course accessed for this study.

Question 1 (1 point)

A database record includes all of the data for _____.

- a. aspect
- b. **person/item**
- c. characteristic
- d. observation

Save answer

Question 2 (1 point)

A database field _____ an aspect of the observation you are recording.

- a. analyzes
- b. surveys
- **c. names**
- d. records

Save answer

Question 3 (1 point)

A table consists of records (rows), fields (columns), and icons (pictures).

- **a. True**
- b. False

Save answer

Question 4 (1 point)

Records (rows) are representative of individual students.

- **a. True**
- b. False

Save answer

Question 5 (1 point) **There are two correct answers for this question: b and e. The item was removed from statistical analysis.**

You may import all but one of the following types of files when using InspireData:

- a. Excel
- **b. Word**
- c. Any comma or tab-separated text format
- d. Both "a" and "c"
- **e. Both "b" and "c"**

Save answer

Question 6 (1 point)

_____ diagrams are useful for comparing and analyzing potential relationships between sets of data.

- a. Pie
- b. Axis
- c. Stack
- **d. Venn**

Save answer

Question 7 (1 point)

_____ plots allow you to investigate if the plots of two fields move in the same general direction (correlation).

- **a. Axis**
- b. Pie
- c. Stack
- d. Venn

Save answer

Question 8 (1 point)

When using InspireData you must use the assigned icon.

- a. True
- **b. False**

Save answer

Question 9 (1 point)

To update a slide in an InspireData slide show you must...

- a. Delete the slide and add it again.
- b. **Click on update slide**
- c. Click on revise and then resave it.
- d. Click on Edit and then resave.

Save answer

Question 10 (1 point)

The student questionnaire is designed for more than 1 person to add their information at a time.

- a. True
- **b. False**

Save answer

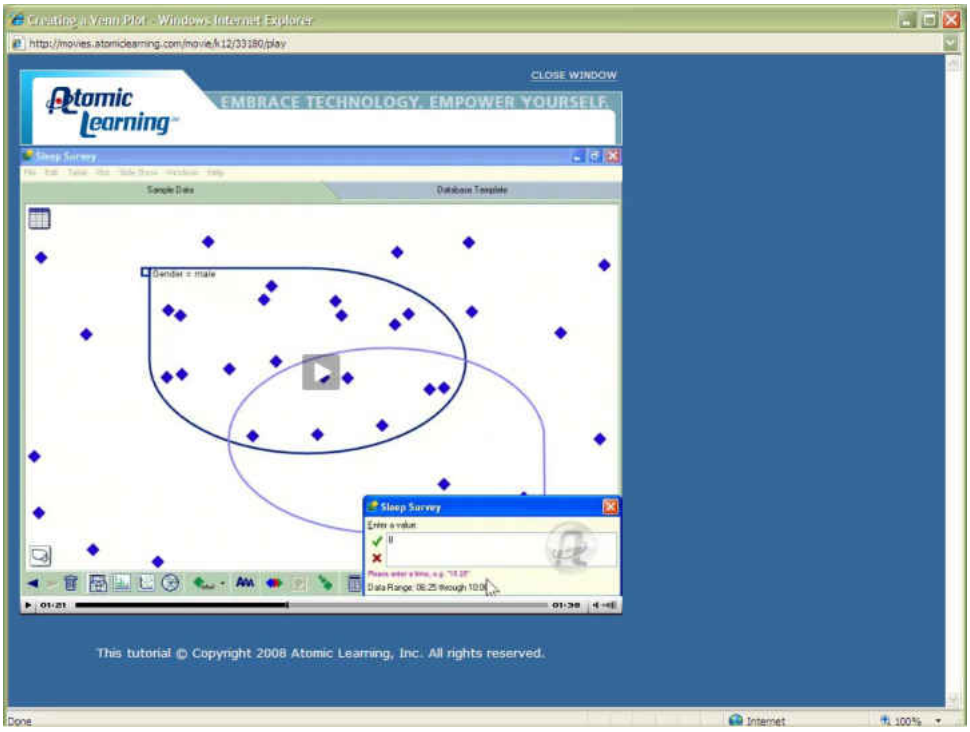
Question 11 (5 points)

Standard 4 states: Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies. Which of the following statements is NOT a teaching standard for the NETS-T standard 4 Assessment and Evaluation?

- a. Teachers apply technology in assessing student learning of subject matter using a variety of assessment techniques.
- b. Teachers use technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning.
- c. Teachers apply multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.
- d. **Teachers provide technology for a variety of learning experiences**.

Save answer

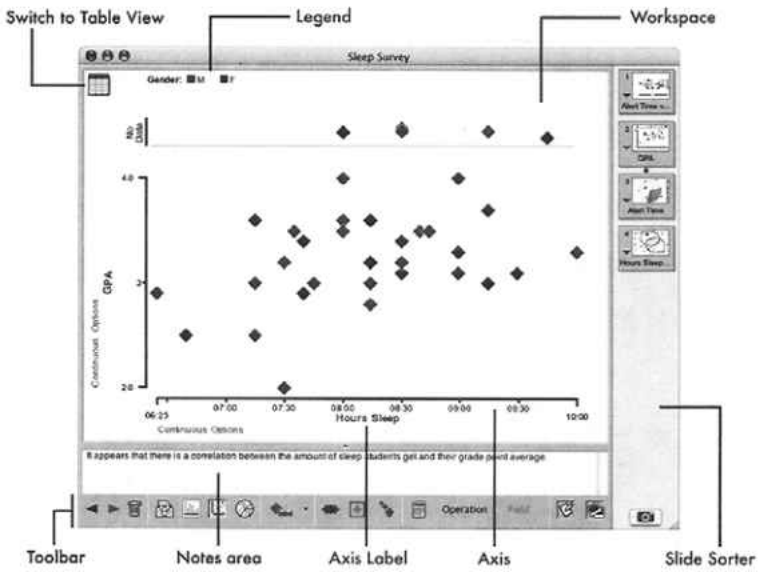
APPENDIX E: INSPIREDATA WORKED-EXAMPLE DATA DISPLAYS



Note: From the AtomicLearning.com video series on InspireData processes

Plot View

Use Plot View to analyze data visually by creating and manipulating plots that illustrate trends and outcomes.



Note: From the InspireData Quick Start Tutorial

APPENDIX F: UCF INSTITUTIONAL REVIEW BOARD NOTICE OF APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To : **Angelique M Nasah**

Date : **December 07, 2007**

IRB Number: **SBE-07-05325**

Study Title: **Examining Instant Messaging Impact on Learning Using an Integrated Worked-example Format**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Chair on 12/06/2007. **The expiration date is 12/5/2008.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

> 7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form.

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Barbara Ward on 12/07/2007 03:50:02 PM EST

IRB Coordinator

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