2011

Multi-Tasking: The Effects of Interacting With Technology On Learning In A Real-Time Classroom Lecture

Lucia Zivcakova
Wilfrid Laurier University

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ISBN 978-0-494-75395-8
Our file Notre référence
ISBN 978-0-494-75395-8

Multi-tasking The Effects of Interacting With Technology On Learning In a Real-Time Classroom Lecture

by

Lucia Zivcakova

Hon B Sc University of Toronto, 2008

THESIS

Submitted to the Department of Psychology/Faculty of Science

In partial fulfillment of the requirements for

Master of Arts

Wilfrid Laurier University

Abstract

An experiment was conducted with the primary purpose of determining whether multi-tasking while listening to lectures impacts on learning performance Four digitally-based multi-tasking activities (texting using a cell-phone, emailing, MSN messaging and Facebook) were compared to 3 control groups (a paper-and-pencil note-taking, a word-processing note-taking and a natural technology/note condition) over three sessions The natural use control group was included to assess what level of multi-tasking, if any, occurs naturally in an authentic classroom lecture The 7 (condition) X 3 (session) mixed design, revealed that participants in the Facebook and MSN conditions performed more poorly than participants in the paper-and-pencil use control Fidelity measures indicated non-compliance with instructions within all conditions Subsequent analyses, taking compliance into account, revealed that participants who did not use any technologies in any of the three lecture sessions, outperformed students who used some form of technology, even for as few as one session Consistent with the Cognitive Bottleneck theory of attention (Welford, 1967), simultaneously performing 2 or more tasks results in decrements in performance in at least one of the tasks Overall, contrary to popular beliefs, findings indicate that using technology can have a detrimental impact on learning The implications of the study are discussed with regards to educational initiatives that promote the use of digital technologies to increase learning opportunities

Acknowledgments

First of all, I would like to thank my advisor, Dr Eileen Wood, whom I am very blessed to have the opportunity to work with Eileen has taught me a multitude of skills, academic and otherwise, and continues to be very supportive of me in every way I am not certain that any words I say could ever truly express my gratitude

I would like to thank all of the members of my committee, Dr Alexandra Gottardo and Dr William Hockley, not only for their knowledge, expertise and guidance, but also for their immense flexibility and understanding

In addition, I would also like to thank my lab mates and my best friends, Domenica, Karin, Seija and Amanda (not in any particular order), for their unconditional friendship and support As the saying goes, you find out who your true friends are when life gets tough I have found this to be completely true They have definitely proved to me on many occasions that this saying is true and I only hope that one day I will be able to reciprocate everything that they have given me

I would like to thank everyone who helped with this study, all of the research assistants and especially, my research partner, Petrice Gentile All of their work is greatly appreciated, as this project would be impossible without them

Last but definitely not least, I would like to thank my family for all of their continued love, support and encouragement Without them, this very long process of becoming an academic as well as the person that I am, could never have happened

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With the introduction of multiple types of portable digital technologies, questions regarding our ability to engage in multi-tasking behaviours have become increasingly prevalent in both the popular press and in research (e g , Eby, Vivoda, & St Louis, 2006) Multi-tasking refers to doing more than one activity simultaneously (Paschler, 1994) Multi-tasking is not a new phenomenon For example, in the past people often multi-tasked by doing activities such as cooking or mowing the lawn while caring for children What has changed, however, are the number and types of activities in which people are now multi-tasking Specifically, the increase in new portable digital technologies has made it possible to use these technologies anywhere and anytime In addition, it is very common for people to carry and use more than one digital technology at any given time, such as a cell-phone and an ipod In fact, statistics from as early as 2003 showed that the average household included multiple non-mobile and mobile digital technologies, specifically, three TV's, three DVD players, two videogame consoles, three iPods, two cell-phones and one computer (Rideout, Vandewater, & Wartella, 2003) Since 2003, several new portable technologies have been introduced and are also widely available and used (e g , Blackberry, iPad) Multi-tasking with digital technologies is especially prevalent among younger adults and youth when compared to older adults (Carrier, Cheever, Rosen, Benitez, & Chang, 2009), so much so that young people view multi-tasking as an easy thing to do and as a "way of life" (Rosen, 2007 as cited in Carrier et al , 2009)

Outcomes of recent research and social policy question the appropriateness of multi-tasking with new digital technologies and raise questions about the ability to multi-task with digital technologies at all However, to date many of the concerns have been related to safety issues related to digital technology use while driving (Caird, Willness, Steel, & Scialfa, 2008) The present thesis extends existing research by investigating the impact of multi-tasking in an educational context Specifically, the study addresses learning performance when university students engage in multi-tasking with digital technologies while attending "real-time" classroom lectures

Roadmap

The following literature review will explore issues related to multi-tasking The review will identify the key concepts of attention and multi-tasking and provide a working definition of these terms for the thesis The issue of attention, and its role in understanding multi-tasking, will be considered Subsequently, existing literature that examines multi-taking in an applied domain, such as the impact of multi-tasking on driving performance, will be examined Following from this applied context, the educational application studied by the present thesis will be introduced

Attention

Attention has been a focal point of study in the cognitive literature for several decades A precise definition of attention is elusive and depends to some extent on the nature of the task at hand Even in early research in this domain there was acknowledgement of the multiple understandings of what constituted attention and often these understandings differed as a function of the task at hand For example, Posner (1990) classified existing definitions of attention within 3 main categories that referred to

alertness or arousal to the task at hand, selectivity whereby some stimuli would be acknowledged more so than others, and limited processing which acknowledged competing demands within a limited system Johnston and Heinz (1978) further characterized attention as flexible, such that individuals have voluntary control over what stimuli they choose to attend to at any given time For example, these researchers obtained evidence that people are easily able to shift from attending to physical characteristics of messages received, to listening for the meaning of the message received This conceptualization seems necessary for understanding how learning occurs within classrooms and how learning occurs when multi-tasking is an option

Multi-tasking: What is it?

Multi-tasking is defined as doing more than one activity simultaneously (Paschler, 1994) In the extant literature, multi-tasking is typically indirectly defined via the interference it produces Specifically, the interference due to multi-tasking has been defined as the inability to simultaneously perform two or more overlapping tasks each of which requires the selection of a response – a decision task, due to a general slowing in the performance of the second task (Levy & Pashler, 2001, Levy, Pashler, & Boer, 2006, McCann & Johnston, 1992, Pashler, Harris, & Nuechterlein, 2008, Pashler & Johnston, 1989, Schumacher et al , 2001, Welford, 1952)

This interference arises from a constraint in decision-making also referred to as Cognitive Bottleneck (Welford, 1967) There are several theories that propose the constraint of a cognitive bottleneck These theories differ with respect to where the bottleneck occurs, namely in early selection that occurs before perceptual processes (Broadbent, 1958 as cited in Solso, MacLin, & MacLin, 2007, Treisman, 1986 as cited in

Solso, MacLin, & MacLin, 2007) or late selection that occurs after the analysis stage (Deutsch & Deutsch, 1963, Norman, 1968) Some researchers also propose that different tasks produce different kinds of interference general vs specific (Brooks, 1968, Hirst & Kalmar, 1987)

General interference occurs in dual-tasking situations in which a person performs two unrelated tasks, such as reading a sentence (a verbal task) and pushing a button in response to a certain word (motor task) On the other hand, specific interference occurs when a person performs two closely related tasks, such as listening to a message (verbal task) and producing a verbal response to that message (also a verbal task) These researchers state that general interference tends to be lesser than specific interference in terms of magnitude, as specific interference is caused by two highly related tasks, both of which draw on the same, limited, pool of resources (Brooks, 1968, Hirst & Kalmar, 1987) In addition, when two tasks draw on the same overall resources as well as the same processes, performance would be expected to be especially low In other words, the allocation of resources to a verbal and a motor task may be easier than the allocation of resources to two verbal tasks (e g , writing and listening to a lecture) Although in both cases attempting to complete two tasks draws upon same limited available resources, the first draws on different processes and the second draws on the same processes (competing verbal), thus leading to a "double" interference In terms of multi-tasking using a digital technology during a lecture, it should be easier to listen to a lecture (and process the meaning of the message) while looking at pictures on Facebook (verbal/visual task) than it would be to listen to a lecture and type messages on MSN (verbal/verbal task)

Generally, cognitive bottleneck is studied using a paradigm, in which individuals try to perform two simultaneous or rapidly successive tasks as quickly as possible (Pashler et al , 2008) The resulting effect, referred to as dual-task slowing (Pashler, 1994), shows as a general slowing of responding to the second stimulus (Pashler et al , 2008) Furthermore, the shorter the time between Task 1 and Task 2, the longer the reaction time to Task 2 (Levy & Pashler, 2001) These effects have been very well established, however, some researchers have demonstrated conditions under which these effects can be overcome For example, Meyer and his colleagues proposed an alternate model of dual-task interference, called Executive-Process/Interactive-Control (EPIC), where practice plays an important role (Meyer et al , 1995) Specifically, skilled performance is accomplished by converting declarative knowledge into procedural knowledge through practice and when this conversion has been accomplished, the processes required to complete two tasks at once can be performed simultaneously (Meyer et al , 1995, Schumacher et al , 2001) In the Schumacher and colleagues (2001) study, participants either identified a low, medium or high tone that they heard, or they identified the location of a particular visual stimulus relative to others (i e , the position of the letter O with respect to dashes, which could be in the front, center or behind the O) The researchers measured reaction time and accuracy With sufficient practice, the slowed reaction time that is typically present, disappeared (Schumacher et al , 2001) While acknowledging this finding, some researchers have argued that the removal of the slowing of performance associated with a cognitive bottleneck can only be circumvented in very simple and highly practiced tasks and not for more complex real-world situations (Paschler et al , 2008)

Would multi-tasking with digital technologies elicit the slowing of tasks or interference typically associated with a cognitive bottleneck? If so, would the effects persist when individuals were highly experienced users of the digital technologies? In order to address these questions, it is first important to understand how individuals might use digital technologies in a multi-tasking situation It might appear conceivable that interference from two different tasks would be less likely to cause interference than two highly similar tasks For example, listening to music while texting may appear to be easier than attempting to text a message and type on a notebook at the same time In this latter case, people's use of digital technologies might not be reflective of multi-tasking per se Rather, people might be engaging in one of the two tasks divided attention or rapid switching between tasks (Posner, 1990)

These two attention tasks differ Divided attention is synonymous with dual-tasking and refers to attending to more than one stimulus at a time, however, the selection of information is imperfect (Smith & Kosslyn, 2007) Therefore, as specified above, when people attempt to simultaneously perform two different tasks, the performance on the second task may be slowed down Rapid Attention Switching refers to switching attention from one stimulus to another stimulus in a rapid succession, but only one stimulus is attended to at any given time (Posner, 1990) The work of Posner and Cohen (1984) provided a framework for understanding the attentional tasks involved in rapid attention switching (Posner & Cohen, 1984) They discovered that patients with brain damage in different areas of the brain had difficulty with different types of attention Specifically, lesions in the parietal lobe seemed to cause deficits in disengaging attention while lesions in the midbrain seemed to produce deficits in moving attention (Posner,

1990) Based on these findings, Posner (1990) developed a model of attention that involves three separate mental operations These three operations are disengaging attention from the current object or activity, shifting or moving attention to a new object or activity, and finally engaging attention in the new object or activity This model has also been used to explain attentional problems in individuals diagnosed with Attention Deficit/Hyperactivity Disorder (ADHD), a disorder characterized by inattention, impulsiveness and/or hyperactivity (Faraone, Sergeant, Gillberg, & Biederman, 2003) Specifically, people suffering from ADHD, resulting from underactive frontal lobes, show deficits in sustained attention or paying attention to any given task at hand for a prolonged period of time (Schachar & Logan, 1990) This deficit can be seen as a deficit in engaging attention to a new stimulus Understanding that attention impacts on performance in learning tasks is an important consideration when examining multi-tasking in an educational context Although the present study does not propose to directly manipulate or control attention, the selection of competing multi-tasking activities and experience or "practice" with the digital technologies was assessed Specifically, all but one of the multi-tasking conditions involved a technology that required verbal information, with one mixing verbal and pictorial information while students were attending to an ongoing lecture that was predominantly verbal with pictorial supports In addition, all participants were asked about their pre-existing experience with digital technologies, as well as having multiple trials with the technology in the learning context to better understand the role of practice

Multi-tasking: Definitions

As mentioned above, multi-tasking can be defined in at least two ways Divided attention or dual-tasking, that refers to simultaneously attending to more than one stimulus (Smith & Kosslyn, 2007) and Rapid Attention Switching, which refers to the rapid switching of attention between two (or more) stimuli (Posner, 1990) For the purposes of the present document it is recognized that both of these definitions of multi-tasking are applicable, but the distinctions made in earlier, highly controlled, cognitive studies are unnecessary for the purposes of the current study Instead, within the present study, multi-tasking will be understood more simply as doing multiple tasks at once, where one task is a primary task (the learning task) and the other task is secondary (using digital media), consistent with the instructions

Real World Applications of Multi-tasking: Driving and Cell-Phone Use

To date much of what is known about multi-tasking in "real-world" contexts is based on research involving cell-phone use while driving Cell-phone use more than doubled from 2001 to 2005, rising from 2 7% to 5 8% of drivers using a cell-phone while driving and was projected to reach 8 6% in 2010 (Eby et al , 2006) Concerns regarding the use of cell-phones, both hand-held and hands-free models, have centered around safety factors For example, the risk of being involved in a car accident or crash when using cell-phones is comparable to risks associated with the use of the maximum legal limit level of 0 08% blood alcohol (Redelmeier & Tibshirani, 1997), or 24 hours of sleep deprivation which accounts for the second most frequent cause of motor vehicle accidents (Iudice et al , 2005) Indeed, using a cell-phone while driving for even as little as 1 hour per month increases the risk of crashing from 400 – 900% (McEvoy et al , 2005)

Although one could argue that simply talking to anyone while driving could be identified as a major distraction, conversations with passengers in a car are much less risky than having conversations using cell-phones while driving (Charlton, 2009, Hunton & Rose, 2005) Hunton and Rose (2005) propose that the lack of non-verbal cues that are normally readily available in face-to-face conversation requires the use of more cognitive resources for compensation Furthermore, Charlton (2009) discovered a phenomenon he called "conversation suppression" that occurs during in-car passenger conversations, in which the passenger slows down the conversation as the driver approaches a road hazard or the driving situation becomes more complex and difficult In addition, the passengers in these studies also alerted the driver when a traffic hazard was approaching Conversation suppression facilitates attention to critical situations and is only available when passengers (typically adult passengers) can see and respond to the driving situation In cell-phone conversations, the cell-phone partner does not "see" or have access to the driving context cues and therefore, the partner does not engage in conversation suppression (Charlton, 2009)

A meta-analysis by Caird et al (2008) revealed that drivers who used cell-phones, both hand-held and hands-free, had a higher average reaction time (0 25 seconds) to events in front of them than drivers who did not converse on a cell-phone Other harmful changes in driver behaviours reported include decreased braking anticipation and increased reaction time in braking (Charlton, 2009, Levy & Pashler, 2008, Levy et al , 2006), failure to maintain sufficient headway (Alm & Nilson, 1994, Caird et al , 2008), failure to reduce speed (Caird et al , 2008), greater variability in speed, such as driving too slowly or too quickly (Alm & Nilson, 1994, Rakauskas, Gugerty, & Ward, 2004,

Rosenbloom, 2006, Tornros & Bolling, 2005), a two-fold increase in failing to detect traffic signals, slower reactions to the detected signals (Strayer & Johnston, 2001), avoidance of road and traffic hazards (Charlton, 2009), impaired gap judgments (Cooper & Zheng, 2002), increased traffic violations (Beede & Kass, 2006), increased approach speed (Charlton, 2009), increased curve speed (Charlton, 2004), reduced checking of rearview mirrors (Brookhuis, de Vries, & de Waard, 1991), impaired eye scanning of the immediate environment (Harbluk, Noy, Trobvich, & Eizenman, 2007), impaired vehicle control (Treffner & Barrett, 2004) and even increased frequency in striking pedestrians (Kass, Cole, & Stanny, 2007) Moreover, drivers who converse on a cell-phone create less durable memories of objects in their field of view even when looking at the objects directly (Strayer & Drews, 2007) Similar deleterious effects on driving performance were found with using MP3 players (Chrisholm, Caird, & Lockheart, 2008), speech-based email systems (Jamson, Westerman, Hockey, & Carsten, 2004) and music systems (Stutts et al , 2005) All of the above findings are consistent with the Cognitive Bottleneck theory of multi-tasking, which states that two tasks, especially two cognitive tasks, cannot be performed simultaneously without a cost to performance, if the 2 tasks exceed the available limited resources

However, Shinar, Tractinsky and Compton (2005) reported that 5 sessions of repeated experience in cell-phone conversations while driving decreased the interference in young, but not older people (Shinar, Tractinsky, & Compton, 2005) This finding suggests that age might be a mitigating factor in driving while conversing on a cell-phone However, this is a preliminary study and much more work needs to be conducted to determine at what age effects from practice fail to show benefits as well as how much

practice yields differences in performance A key point is that interference is potentially decreased with age and may be related to practice

Multi-tasking and Learning

One outcome that the literature on cell-phone use consistently supports is the decrement in performance in one task when participants were engaged in a second task Given that multi-tasking hindered performance in the complex naturalistic task of driving, it is reasonable to assume that multi-tasking in an educational context would impede learning The notion that multi-tasking hinders learning is supported by Rubinstein, Meyer, and Evans (2001) The researchers found that people who were required to multi-task (do two tasks at one time) took longer to finish their two tasks, than it would take them to finish both tasks if they concentrated on one task at a time The increase in time for multi-tasking was attributed to lost time from switching back and forth between the tasks, especially when the tasks became more complex (Rubinstein, Meyer, & Evans, 2001) A neuro-imaging study on learning while multi-tasking supported this finding Specifically, participants who learned without distractions were able to correctly learn the information presented to them, and apply it flexibly to new situations, utilizing the medial temporal lobe system, which is associated with declarative memory On the other hand, the participants who multi-tasked, were still able to correctly learn factual information using mostly the striatal regions responsible for implicit learning However, they were not able to apply this information flexibly to new contexts The authors concluded that while multi-tasking does not seem to affect rote memorization, it may hamper higher-order tasks that involve understanding material and application of the material to novel situations (Foerde, Knowlton, & Poldrack, 2006) The

results of both of these studies are in agreement with both the Cognitive Bottleneck theory of multi-tasking as well as Posner's (1990) theory of attention These studies combined provide evidence that attention, especially for complex tasks, can be impaired when multi-tasking is involved These results have clear implications for using digital technologies while learning

Multi-tasking with Digital Technologies and Learning

Computers, especially laptops, and other digital technologies that allow wireless access to the Internet, have become standard technologies in education (Weaver & Nilson, 2005) Initiatives to incorporate digital technologies as a seamless part of instruction have resulted in considerable research discussion and debate The debates involve using digital technologies in several educational contexts, ranging from preschool to university (Lindroth & Berquist, 2010) In general, there is a consensus that existing and emerging digital technologies have the potential to expand the reach and effectiveness of current educational tools (Cuban, 1993) At the same time, effective inclusion of digital technologies into teaching practice has encountered, and continues to encounter, practical and pedagogical barriers (Wood, Specht, Willoughby, & Mueller, 2008) Despite these barriers, technologies continue to develop, and they continue to appear in the classroom whether or not by design At this point, the pace of the introduction of technologies has far exceeded our understanding of if, how and when different digital technologies are effective in the classroom A recent concern that has been raised in the literature is whether utilizing digital technologies competes with learning when traditional teaching methods are used (e g , Willoughby & Wood, 2008)

Multi-tasking with Digital Technologies and Learning: Literature Review

Within the University setting, blended learning offers the potential to receive instruction using traditional means in combination with less traditional remote access Even within traditional classrooms the presence of laptops has become increasingly prevalent and in a few cases is required For example, both Acadia University and Wilfrid Laurier University's education faculty require the use of technology in their classrooms These types of initiatives, often referred to as Anywhere Anytime Learning (AAL), promote the use of digital technologies, especially personal use technologies such as laptops, as a complement to more traditional teaching and learning tools The newest addition to digital technologies that hold promise for expanding the reach of education are mobile technologies which include Blackberrys, iPhones, Smartphones, iPads and cell-phones These devices, when connected to wireless access to the Internet at all times, offer the promise of shifting learning into even more environments than had been envisioned with laptops

Applications that can be delivered through laptops and, more recently, mobile device initiatives, are beginning to become a part of modern educational delivery systems For instance, the Waterloo District Public School Board in Ontario, Canada, has recently decided to integrate Facebook™ into its curriculum to support learning as early as grade 5, starting in September 2010 (D'Amato, L , 2010) Two hundred individuals, including teachers, administrators and even students contributed to this decision The School Board intends to moderate the use of Facebook™ and use this website to promote class discussion using a media with which students are comfortable (D'Amato, L , 2010) In addition, the technologies themselves are being increasingly instituted in public

schools as part of the curriculum to progressively younger students (Windschitl & Sahl, 2002) Although the educational system has quickly embraced technology, technology as an educational tool to enhance learning has not been thoroughly studied and the very limited extant research provides mostly contradicting evidence (Wainer et al , 2008) An additional concern of using multiple technologies has not been explored Using multiple technologies may pose further problems For example, multi-tasking using digital technologies during classroom time can pose a threat of distraction as students often use the technology for non-educational purposes These technologies, therefore, have a strong potential to hinder learning instead of aiding learning To illustrate, several studies show that when students have access to laptops in the classroom, they often engage in distractive multi-tasking behaviours, which is associated with a decrement in performance (Fried, 2008, Grace-Martin & Gay, 2001, Hembrooke & Gay, 2003, Kraushaar & Novak, 2010, Wainer et al , 2008, Wurst, Smarkola & Gaffney, 2008) However, most of these studies are correlational, making causal inferences and solid conclusions on the impact of technology on learning very difficult Similar results have been demonstrated for students using BlackBerry technology where the students self-reported engaging in off-task activities even when the technology was supposed to be used for instructional purposes (Mueller, Wood & De Pasquale, 2011) In addition, several studies have indicated that using laptops in classrooms distracts not only its users, but also other students in close proximity to the laptops (Fried, 2008) There is currently no research that shows whether or not cell-phones also distract others in close proximity to the user Therefore, multi-tasking in a classroom-style lecture using digital

technologies and the related topic of distraction are issues very relevant to education and warrant further and more thorough research

Present Study

The present study extended extant research on multi-tasking and learning through the addition of experimental methodology In addition, the study contrasted the relative impact of a variety of devices on learning performance More specifically, the present experiment examined the impact of multi-tasking when adult learners were required to use digital technologies when learning from classroom lectures In addition, the study compared the relative impact of a variety of technologies and uses of the technology Specifically, the study included use of laptops for assisting in note-taking, for conducting Facebook searches, for communicating (email/MSN messenger) and for free use (allowing students to use the laptop for any purpose) Additionally, the study included the use of cell-phones for responding to social messages (i e , texting) More specifically, participants in the MSN, email and texting conditions exchanged messages with the research assistants via MSN, email and cell-phone texts, respectively Participants in the Facebook condition completed a "scavenger hunt", in which they were asked to find several specific details in several profiles, but they did not communicate with the research assistants There were also 3 control groups a paper-and-pencil control, word-processing note-taking control and a natural use control in which participants were allowed to use technology in an unlimited manner, if they chose to do so, as they normally would during lectures The natural use control group is a "hybrid" control group included in order to determine the relative proportion of students who use digital media in a classroom and in what way they use the technology Participants' use of technologies in all conditions was

captured using a fidelity measure, the purpose of which is described in the method section below Because this study was conducted in a natural classroom context, it was possible that observing others using technologies during a lecture could serve as a distractor However, it is also important to note that the presence of technologies as a distraction would be equivalent across all participants To test the impact of familiarity with technologies, the study required students to use the same technologies over three consecutive lectures

Hypotheses

In total three main hypotheses and one methodological issue were addressed In addition, two of the main hypotheses were layered and included a hypothesis dealing with a subsample of the data collected

1) Given the potential for multi-tasking to tax the resources and distract the learner, it was expected that performance on the post-lecture tests would be lower for the multi-tasking conditions when compared with the note-taking conditions

i) It was also expected that if the natural study control condition did not involve multi-tasking, or involved very minimal multi-tasking, memory performance would be higher for these participants than for the those in the multi-tasking conditions The outcomes for this condition were exploratory

2) If practice facilitated the ability to multi-task, it was expected that performance in all multi-tasking conditions would increase over the three sessions

i) It was also expected that these gains would be particularly salient for those participants in the natural use condition who do not normally use technology, as their use of technology may have become more strategic over time

3) Timing of Responses The participants received instruction to respond to all of the messages sent by the research assistant before the end of the session, however the time of response was not specified The participants were also instructed to simultaneously attend to the lecture This instruction allowed the participants to respond at their convenience and subsequently exert control over their own learning Consequently, there are two possible types of responding, immediate and delayed Firstly, some participants might respond immediately after receiving a message and therefore be more likely to miss important lecture content This type of responding is more likely to negatively impact learning Secondly, the participants might delay a response and wait for a natural break in the lecture to answer a message Utilizing this strategy would make the participants more likely to learn successfully Timing was used to understand performance

4 Although not a direct hypothesis, as a result of the design of the study, it was anticipated that students might engage in multi-tasking with the technologies beyond what was instructed To determine whether this occurred, a fidelity measure was included where participants indicated what multi-tasking activities they engaged in during the lecture This measure was an exploratory measure to allow an estimate of how many multi-tasking activities students engaged in when given the opportunity In addition, if necessary, the results of the fidelity measure were utilized for reassigning participants to conditions based on the modal behaviour indicated by each participant More specifically, when participants did not follow instructions and instead engaged in different multi-tasking behaviours, they would be reassigned to a condition that most closely matched the behaviours in which they indicated they were engaged

Method

Participants

In total, 145 participants were randomly assigned to one of the seven conditions in the present study There were 21 participants in 5 out of 7 conditions and 20 participants in the remaining 2 conditions, namely email and MSN (M_{age} = 19 68, SD = 1 74) Within each condition there was an effort to balance the proportion of male and female participants Of the 116 females, only 108 reported their age M_{age} = 19 56, SD = 1 19, range = 18-23 years, and of the 29 males, 24 reported their age M_{age} = 20 67, SD = 2 33, range = 19-27 years There was a significant difference for age between the males and females, $t_{(130)}$ = 2 27, p = 0 032, however, the mean ages differed by less than a year, which would not be expected, developmentally, to be a significant concern In addition, males and females were approximately equally represented in each condition (see Table 1 for a summary of participants by condition)

Out of the 145 participants, 132 reported their marital status 5 reported living in a common-law relationship and 127 reported being single In terms of ethnicity, 121 participants reported their ethnic background Ethnicity was an open ended question, with a wide range of different backgrounds reported, including but not limited to race, country of origin and religious background Due to the high variability in descriptors, ethnicity was coded according to race and geographic location, and religious background was coded as other The breakdown of the participants ethnic background based on the coding scheme suggested that 67 participants could be identified as white, 3 as Black, 2 as mixed ethnicities In addition, 25 could be categorized as Canadian, 4 as European, 4 as Central Asian, 3 as Middle Eastern, 5 as Southeast Asian, 1 self-identified as oriental

Moreover, 2 self-identified as being Aboriginal, 1 as Hispanic and 4 identified themselves as a function of their religion

The participants were recruited from 2nd year research methods and statistics courses The participants received their choice of compensation of either 1 5 course credits or $15

Materials and Apparatus

The study was comprised of three sessions In all three sessions students were given a 20-minute lecture presentation on research methods, followed by a 15-item quiz and a fidelity measure Before session 1 and after session 3, students completed a pre- and post-test survey, respectively

Pre-test and Post-test Surveys. The pre-test survey assessed demographic variables (e g , age, gender, and ethnic/racial background), technology experience, attitudes towards technology and comfort with statistics courses (see Appendix A for the complete survey)

Technology Experience The broad concept of Technology Experience was assessed through 4 subcomponents general frequency of use of various digital technologies, comfort with digital technologies, affect/ enjoyment of technologies, and frequency of use of various digital technologies for specific tasks For each subcomponent, participants indicated their responses for 13 different devices (see Wood, Mueller, Willoughby, Specht, & Deyoung, 2005) For example, for comfort with technologies, the participants rated each of the following technologies desktop computer, laptop computer, cell-phone (no texting), cell-phone (texting), Smartphone, blackberry, Internet, Twitter, Facebook, My Space or other personal profiles, MSN, email and Skype

These technologies were rated with respect to how comfortable they were using a 5-point Likert-type scale ranging from 1 = *(Very Ill at Ease)* to 5 = *(Very at Ease)* Similarly, affect and frequency of use for each technology was assessed using a 5-point Likert-type scales The Cronbach's alphas for the scales were as follows general frequency of use of various digital technologies = 63, comfort with digital technologies = 76, affect/ enjoyment of technologies = 75, and frequency of use of various digital technologies for specific tasks = 75

Attitudes Towards Technology Attitudes towards 6 different technologies were assessed using an 11-item scale adapted from the Computer Anxiety Scale (CAS)(Cohen and Waugh, 1989) A sample question in this measure was "I avoid using _____ whenever possible " The participants answered this question for each of the 6 technologies (i e , computer, the Internet, Facebook, MSN, Email and texting via Cell-phone) on a 6-point Likert –type scale, ranging from 1 *(Strongly Disagree)* to 5 *(Strongly Agree)*, or a 0 *(Non Applicable)* Reliability was high, Cronbach's alpha = 93

Comfort With Statistics Comfort with statistics was assessed using a 24-item measure called the Statistics Anxiety Rating Scale (STARS) (Hanna, Shevlin, & Dempster, 2008) Specifically, the participants rated each of the 24 statements for their level of anxiety on a 5-point Likert-type scale ranging from 1*(No Anxiety)* to 5 *(Considerable Anxiety)* Reliability was high, Cronbach's alpha = 93

The post-test survey assessed the participants' attitudes and experiences regarding the 3 experimental sessions and their usual use of technologies in a classroom (Please see appendix B for the complete post-test survey) Specifically, attitudes towards the experimental sessions were assessed using a 10-item self-report measure A sample

statement in this scale was "Following the experimental instructions for my condition was easier to complete as the sessions progressed." The participants rated the statements on a 5-point Likert-type scale using anchors ranging from 1 *(Strongly Disagree)* to 5 *(Strongly Agree)* Furthermore, experiences regarding the experimental sessions were assessed via the following open-ended question "Please describe your experiences for each of the sessions you participated in." The participants described their experiences for each of the three sessions separately The usual use of technologies was assessed through two single question measures The first question was "How similar was this experience in comparison to your usual use of technology in a lecture?" The participants rated this question on a 5-point Likert-type scale with anchors ranging from 1 *(Very Dissimilar)* to 5 *(Very Similar)* The second question was an open-ended question where participants described their usual use of technologies in a classroom

The post-test survey also assessed attention deficit/hyperactivity disorder (ADHD) symptoms using self-report questionnaire, Conners 3rd Edition TM Questionnaire (Conners, 2008) Specifically, the participants rated 67 statements such as "I blurt out the first thing that I think of" on a 4-point Likert type scale ranging from 1 *(Never/seldom)* to 4 *(Very often)* Reliability was high, Cronbach's alpha = 88

Instructional Sessions. All participants attended 3 consecutive lectures each lasting approximately 20 minutes The lectures were authentic learning tasks That is, the lectures represented actual course material presented during class instructional time The topics of the lectures focused on research methods topics, specifically, Reliability and Validity, Experiments and Validity, and Threats to Validity Additional sessions were organized for participants who had missed a class

Learning Task. Following each lecture, students completed one, 15-item multiple-choice test (see Appendix C for all three tests) All questions pertained to material presented in the lecture for that session

Fidelity measure. At the end of each lecture, all participants completed a short 26-item fidelity measure, assessing the participants' compliance to instructions and authenticity of technology use during the lecture, along with the estimated time of use (see Appendix D)

Experimental Conditions. Of the 7 conditions, the participants in the multi-tasking conditions were required to use one of 4 social networking tools to communicate with a Research Assistant Specifically, they texted via cell-phones, Email, MSN or they used Facebook™ Texting refers to the process of typing short instant messages and sending them from one cell-phone to another Email is a computer program that utilizes the Internet to allow its users to send electronic mail to other email users MSN messenger is a computer program developed by Microsoft that utilizes the Internet to allow its users to communicate via instant messaging with other MSN users Facebook™ is a social networking website that allows its consumers to stay connected and meet new friends by displaying their personal profiles and sending instant messages

Accordingly, participants in the MSN and texting conditions exchanged messages with the research assistants via MSN and cell-phone texts, respectively Participants in the email condition answered emails sent to them by the research assistants Participants in the Facebook condition completed an information "scavenger hunt" That is, they received an instruction sheet asking them to visit the Facebook profiles of several people

and find specific pieces of information in those profiles The participants in the Facebook condition did not exchange responses with the research assistants

Of the 3 control conditions, one group was allowed to use any technology they wished throughout the experimental session This control group served an exploratory function in order to determine the natural use of digital technologies during classroom lecture It was expected that some participants in this condition would engage in multi-tasking behaviours whereas others would not The purpose of this control was to determine the relative numbers of participants who engaged in multi-tasking behaviours and how many of such multi-tasking behaviours in which they engaged The second group used a laptop but only word-processing application for note-taking and the last group only used paper-and-pencil for note-taking

All of the participants who were required to use a laptop used their own personal laptops (except for 4 participants who used laptops provided by the researchers) and as such, the type of laptop used was not standardized Similarly, the participants' use of the Internet browser was not controlled and they may have used Internet Explorer, Mozilla Firefox or Safari Finally, students used their own cell-phones in the texting conditions (except for 3 participants who used phones supplied to them) Furthermore, the participants in the Word-processing control group used a word processor that was installed on their laptops or on the researchers laptops, but the type of word processor was not controlled across laptops Lastly, email was also not standardized and the participants used their own email addresses to send emails and text messages

Procedure

The study consisted of three consecutive lectures each lasting approximately 20 minutes, followed by a 15-item multiple-choice memory test and a fidelity measure The participants were randomly assigned to a condition as a function of gender in order to achieve equal proportions of males and females in each condition The participants remained in the assigned conditions throughout each of the 3 sessions All of the conditions were conducted simultaneously during the lectures The majority of participants were involved in a large classroom context—two sections of a large methods course However, a subsample of participants attended a smaller classroom context where a make-up session was scheduled for each session Procedures, content, materials, lecturer, and research assistants were identical across the two contexts After the completion of the third session, all participants completed a post-test survey

Pre-test. During the first class of the course, the students signed a consent form and completed the pre-test survey A week before the experiment began, the participants were sent a message outlining the instructions for their randomly assigned condition At the beginning of the first experimental lecture, participants were reminded of their instructions To ensure a large enough sample size, 42 additional participants were recruited from other courses and they completed the study in a smaller classroom along with students attending as a make-up session from the original course The additional participants were also randomly assigned to a condition and received instructions via email one week prior to the commencement of the experiment They were reminded of their instructions on the first day of the experiment after they completed their consent form followed by the pre-test survey

Experimental Sessions. The three experimental sessions occurred within a two-week period In each session, the main researcher – who was blind to participant condition, presented a PowerPoint presentation on a topic of research methods During each lecture, the participants in the email, MSN and texting multi-tasking conditions interacted with research assistants via their assigned technologies Research assistants, located in a separate room, initiated contact at the outset of the lecture and maintained contact until cued to terminate the interactions at the end of the lecture All research assistants followed prepared scripts for the initial interactions as well as responding to spurious or unplanned messages from the target recipient Scripted questions were presented in a pre-selected order These scripts always started with an attempt to book a make-up appointment for the lectures The attempt to schedule make-up sessions was followed by several open ended questions, usually revolving around school issues, such as current or future courses and tests and exams, followed by other current events such as Halloween (see Appendix E) Spurious questions posed by participants were always answered in an attempt to continue the exchange of messages and were immediately followed by the next question in the script Participants in the Facebook™ condition were given a predetermined set of instructions (i e , Scavenger hunt), which required them to access specific Facebook™ profiles and search them to find specific pieces of information (see Apendix F) For all four experimental conditions, the script was different for each of the three sessions All participants in the multi-tasking conditions were instructed to attend to the lecture while engaged in their assigned multi-tasking activities From the 3 control groups, all participants in the paper-and-pencil group and the word-processing groups were instructed to pay full attention to the lecture while

taking notes via their assigned means The participants in the natural use control group were instructed to use technologies as they normally would in a classroom Therefore, there was no imposed limit on the number of technologies permitted, or their use In addition, the participants in the natural use control group were instructed to try to pay as much attention to the lecture as possible The amount of attention allocated to lecture in any condition could not be controlled and therefore was not tracked However, in all cases, participants were aware of the upcoming multiple-choice test and students were also aware that the material being presented would be on their final exam, therefore, participants would have a natural incentive to attend to the material being presented After each lecture, all participants completed the 15-item multiple-choice memory test followed by the fidelity measure

Given that students did require this material as part of their course, additional sessions for each of the three topics were provided after the experiment was complete These sessions were not part of the experiment and did not include experimental participants Instead these sessions were offered as an opportunity for students to be able to acquire the material using study methods and technologies that best suit their individual learning needs It is possible that knowing that additional sessions were planned, may have affected students' attention during the study Specifically, some participants may have chosen to pay less attention to the lecture and more to the multi-tasking behaviours knowing that if they missed important lecture content, they would be able to learn the missed content in the make-up sessions However, only 2 participants attended any of these scheduled sessions, suggesting that this particular concern was not likely

Post-test. Immediately following the completion of the final memory tests and the fidelity measure, all participants completed a short post-test survey The participants were then debriefed and thanked for their participation

Design

This study utilized a 7 (condition) x 3 (session) repeated measures ANOVA design Condition served as the between subjects variable and session served as the within subjects variable Of the 7 conditions, 4 were multi-tasking and 3 were control groups The multi-tasking conditions involved texting via cell-phone, emailing, MSN messaging and Facebook activities, while listening to the lectures The 3 control conditions consisted of a word-processing only group and the paper-and-pencil note-taking group The third, natural use control, group involved using digital technologies as normally used during lectures

Results

Five sets of analyses were performed The first set of analyses examined learning performance in class as a function of condition The second set of analyses extended beyond initial hypotheses and explored the impact of different classroom contexts on memory for the information provided in lecture A third set of analyses examined fidelity to instructions The fourth set of analyses were exploratory and examined which individual variables predicted performance or multi-tasking A final set of analyses addressed post hoc follow-up data regarding time taken to text in text-based technologies

Memory for Information Presented in Class. Participants completed a multiple-choice test after each of the three presentations A 3 (session) X 7 (condition) repeated measures ANOVA was conducted to assess performance on the multiple-choice tests for

each of the three sessions as a function of experimental condition (See Table 2 for means) This analysis addressed hypothesis 1 by examining cross condition differences in performance and whether multi-tasking conditions differed from paper-and-pencil note-taking condition This analysis also addressed hypothesis 2 by examining potential increases in performance over time As set out in the hypotheses, analyses examined outcomes based on the assigned condition in the study Later, these analyses were revised and revisited in accordance with information found in the fidelity measures

There were significant main effects for both condition, $F_{(6, 138)} = 2\ 53, p = 02$ and for session $F_{(2, 276)} = 97\ 28, p < 001$ The interaction of condition by session was not significant, $F_{(12, 276)} = 0\ 97, p = 48$ Dunnett's post hoc comparisons were conducted with the no technology paper-and-pencil condition set as the control condition Participants in the Facebook condition scored significantly lower on the multiple-choice tests than those in the paper-and -pencil condition, $p = 05$ In addition, there was a strong trend for participants in the MSN condition to score significantly lower than the participants in the paper-and-pencil control condition, $p = 059$ This outcome provides partial support for the hypothesis that participants engaged in multi-tasking would score less well than those in the paper-and-pencil control condition

To examine the main effect for session, three paired samples t-tests were conducted Performance in Session 2 (M = 73) exceeded performance in Session 1 ($t_{(144)} = -11\ 74, p < 001$) and Session 3 ($t_{(143)} = 12\ 06, p < 001$) Session 1 (M = 53) and 3 (M = 51) did not differ from one another ($t_{(143)} = 1\ 12, p < ns$) (see Table 2 for means) Instead of the expected continuous increases in performance over time, memory performance was not systematic in the present study This suggests that the material

covered in session 2 was more familiar or easier to learn than material in the other sessions

In summary, overall, not all multi-tasking conditions yielded poorer performance than the traditional paper-and-pencil condition as was predicted in hypothesis 1 However, it appears that Facebook and MSN are more likely to serve as distractions that impact negatively on learning when used during lectures It also appears that repeated practice with the technologies did not systematically improve performance over time in any condition suggesting that repeated practice with multi-tasking activities per se, did not directly influence performance

The third hypothesis was designed to assess whether participants in some conditions were more or less likely to respond immediately or strategically as a function of the technology used Specifically, it was possible that some technologies may have encouraged more immediate responding while others may have encouraged learners to wait until a convenient pause in the lecture presentation before responding Initially, records were made for the time taken to respond to each message sent in each session, however, two unforeseen problems arose during the study, which limited the ability to use this data First, due to technological problems, some data were lost Second, it became apparent upon examination of the data that synchronization across technologies was not achieved for many participants' data, especially for one classroom Therefore, only a small subsample of the anticipated original data could be successfully retrieved Due to the small sample size ($n = 20$) of the remaining data, the resulting analyses were exploratory and were based on 2 Facebook, 5 email, 5 MSN and 8 texting participants for session 1 only

To understand how timing affected performance, two proportion scores were calculated based on the total number of responses generated by each participant The first reflected the amount of time (in minutes) that elapsed between a new PowerPoint slide being presented by the lecturer and a response being sent to the research assistant by the participant The second proportion score reflected the amount of time between a research assistant sending a message and the participant responding

Acknowledging the very small sample sizes in each condition, only visual comparisons of means could be conducted Visual inspection of the means suggested that between a new slide and a response the fastest responses were generated in the MSN condition (M = 30, SD = 16), followed by the texting condition (M = 49, SD = 36) with participants in the email condition waiting the longest amount of time (M = 1 03, SD = 59) The lapse between the researchers' messages and students responses again showed the same pattern with MSN (M = 1 22, SD = 38) being the fastest responding condition, followed by texting (M = 1 81, SD = 66) and then the email (M = 2 90, SD = 38) condition Overall, examination of these groups yielded a consistent pattern for speed of responding with MSN being the fastest responding technology, followed by texting and lastly email

A third analysis compared the length of messages as a function of condition Visual inspection of means indicated that participants in the MSN condition sent the longest messages (M = 136 40) followed by texting (M = 63 00) and email (M = 63 80)

Variations in Multi-tasking Contexts. Two contexts were explored The first was the planned exploratory examination of the natural use condition The natural use condition was included in order to determine whether or not students chose to use

technology when attending lectures, what technologies they employed, and how the choice to employ technology impacted on learning The second context involved comparing outcomes as a function of class size During the study, a proportion of students missed the initial classroom sessions and alternate sessions were offered to accommodate these students Furthermore, some additional students from another research methods section were included to increase the sample size These alternate sessions allowed for an exploratory comparison between large and small classroom effects

Natural Use Condition To address hypothesis 1i, a frequency analysis on the relative use of technology in the natural use condition was conducted The analysis revealed that 9 out of 21 participants in Session 1, 10 out of 21 participants in Session 2, and 9 out of 21 participants in Session 3 indicated they did not use any technologies while listening to the lecture Over all three sessions, only 7 participants did not use technology at all and an additional 2 participants reported using some form of technology for only one of the three sessions Interestingly, 9 participants used technology during every session In summary, almost half of the participants used technology for every class when allowed to use technologies as they normally would during lectures, while approximately one third of students elected to use only paper-and-pencil during lectures The remaining students were inconsistent in their choices regarding technology use

Participants were grouped into two groups based on whether they did or did not use technology Although sample sizes were unequal and relatively low (7 versus 14), an exploratory 2 (technology vs no technology) X 3 (session) ANOVA was performed to test whether the self-selected use of technology impacted on performance in the Natural

Use condition There was a significant main effect for technology use, $F_{(1, 19)} = 8\ 42, p <$ 01 Participants who did not use technology (M = 76) outperformed technology users (M = 59) suggesting that natural multi-tasking negatively impacted on performance in this condition when compared to natural non-technology use Consistent with previous analyses, there was also an effect of session, $F_{(2, 38)} = 15\ 148, p <$ 001, such that Session 2 yielded higher performance than Session 1 or Session 3, and Session 1 and Session 3 did not differ from one another

Given that the overall analysis above indicated that use of MSN and Facebook in particular, had negative consequences for learning, a count was conducted to examine how many participants in the Natural Use condition used Facebook and/or MSN, the two most distracting technologies For Session 1, MSN was used by 4 participants and 3 of these participants also used Facebook For Session 2, two of these participants continued to use both Facebook & MSN and 1 new participant used both sites/programs For Session 3 only one participant used Facebook and/or MSN Overall, in the Natural Use condition, few participants self-selected to use the two most detrimental technologies

Class Size Some participants viewed the presentations in a large-class setting (n = 103) while others attended smaller classes (n = 42) Comparisons were made for performance between these two contexts as a function of condition Therefore, an exploratory 2 (classroom context) X 3 (session) X 7 (condition) ANOVA was conducted There were significant main effects for classroom context, $F_{(1,131)} = 6\ 06, p <$ 02, condition $F_{(6, 131)} = 2\ 24, p <$ 04, and session, $F_{(2, 282)} = 67\ 61, p <$ 001 No interactions were significant Post hoc comparisons indicated that the participants in the smaller classrooms outperformed their peers in the larger classes Consistent with previous

Dunnett's post hoc comparisons, participants in the Facebook, $p < 0\ 5$ and MSN, $p = 55$, conditions were most likely to perform poorly in comparison to the participants in the paper-and-pencil condition Again, the paired samples t-tests revealed that participants scored higher in Session 2 relative to Session 1 and Session 3, which did not differ from each other These outcomes suggest that the size of classroom may impact learning such that learning in a smaller class (M = 63) leads to slightly higher performance than larger classes (M = 57) This may be a direct result of the number of multi-tasking technologies used by participants in the two classroom contexts An independent samples t-test revealed that participants in the smaller classroom context (M = 74) used fewer multi-tasking technologies than did their peers in the larger classroom context (M = 1 5), $t_{(143)} = 3\ 11, p < 01$ Interestingly, however, the pattern of outcomes for multi-tasking was similar to previous analyses in the larger classroom context in that only Facebook and MSN detrimentally impacted earning performance

Fidelity in the Conditions. Following each presentation, participants completed a fidelity measure to determine

1 Compliance Whether or not they had adhered to instruction
2 Technology Use Whether or not they had used any technologies
3 Amount of Multi-tasking Activities If they had used technologies, in how many multi-tasking activities had they engaged?
4 Type of Multi-tasking Activities Chosen Preferred extra technology activities engaged in by participants

Compliance Overall, only 57% of the participants self-reported completely adhering to their instructions for the use of technology in accordance with their assigned

condition across all three sessions (see Table 3 for a count of non-compliance for technology use by condition and session) The remaining participants deviated from instructions either by engaging in one or more activities than they were instructed to *or* by not using technologies/ not engaging in multi-tasking activities when instructed to do so To determine whether simple compliance with instructions yielded significant differences in performance, a 2 (compliant vs non compliant) X 7 (condition) univariate ANOVA was conducted Compliance was defined as full compliance to instructions in all 3 sessions and non-compliance was defined as deviating from instructions in at least one of the three sessions Given that it was possible for students to opt to learn as normally preferred, or having the opportunity to engage freely in technology use, a global comparison of these compliant and non-compliant participants was conducted to examine whether either choice served as an advantage The average multiple-choice score across all sessions was the dependent variable There were no significant main effects nor was there a significant interaction, largest $F_{(6, 144)} = 2\ 56$, $p < ns$ for condition, suggesting that compliance with instructions did not yield systematic differences in performance

Given the substantial amount of non-compliance a separate set of analyses was conducted to explore outcomes with compliance taken into account These exploratory analyses are explained in the following sections

Technology Users Versus Non Users Independent of assigned condition, participants were divided into two groups based on whether or not they had indicated in the fidelity measure hat they had used technology at all during the three sessions In total, only 23 5% (34 out of 145 participants) self-reported not using any technologies in any of the three sessions The remaining 76 5% (111 participants) self-reported using at least

one type of technology/ engaging in a multi-tasking activity in at least one session To determine the impact of using technology on total performance across all three sessions, an independent t-test was conducted There was a significant difference, $t(143) = 4\ 61, p < 001$, with non-users (M = 67) outperforming users (M = 57) on performance on the multiple-choice tests

Amount of Multi-Tasking Activities Participants were only ever instructed to engage in one competing multi-tasking condition (except for those in the natural use condition) However, the fidelity measures clearly indicated that some participants engaged in more than one alternative technology activity when they had access to technology It is possible that the number of alternative activities engaged in during the lecture might have negatively impacted on learning The impact of amount of multi-tasking behaviours on performance was assessed using a univariate ANOVA Participants were divided into 4 categories, depending on the amount of multi-tasking with technology they reported engaging in non multi-taskers, low, medium and high multi-taskers Non multi-taskers were defined as not having used any technologies/ engaged in any multi-tasking behaviours in any of the three sessions, low multi-taskers were defined as having an average of 1 multi-tasking activity over the three sessions, medium multi-taskers averaged more than 1 or equal to 2 activities, and high multi-taskers averaged more than 2 multi-tasking activities across the three sessions There were 34 non multi-taskers, 67 low multi-taskers, 31 medium multi-taskers and 13 high multi-taskers There was a significant main effect for the amount of multi-tasking, $F_{(3, 144)} = 8\ 23, p < 001$) Tukey b post hoc comparisons revealed that non multi-taskers (M = 67) outperformed low (M = 57), medium (M = 58) and high (M = 51) multi-taskers, but participants in

any of the multi-tasking categories did not differ from one another These outcomes are consistent with the above global comparison of technology users and non-users and suggest that distracting technology use per se, rather than number of different technologies used is the important issue in understanding what impacts most negatively on learning

It was also important to determine whether any of the required technology conditions encouraged the use of more multi-tasking than others To examine this issue, a comparison was made among all of the non-compliant participants to assess whether more or less technologies tended to be used as a function of the initial technology assigned Participants in the natural use condition were excluded as they were instructed to use whatever technologies were comfortable to them whereas participants in all other conditions made a conscious decision to ignore instructions in favour of another technology This difference represented a difference in "choice" between the natural use group and other groups Specifically, having 'free' choice, as in the natural study condition may have differentially impacted the types of study behaviours engaged in a way different than was experienced in the groups who were supposed to be confined to a specific technology A ONEWAY ANOVA was conducted to compare the number of multi-tasking activities engaged in as a function of assigned condition for non-compliant participants There was a significant main effect for condition, $F_{(5, 66)} = 4\ 15, p = 003)$ Post hoc Tukey b comparisons indicated that participants in the paper-and-pencil condition (M = 2 00, SD = 1 41) and word-processing condition (M = 2 50, SD = 3 59) engaged in less multi-tasking than participants in the email (M = 7 64, SD = 3 56) and Facebook (M = 7 69, SD = 6 02) conditions, but MSN (M = 4 93, SD = 2 69) and texting

(M = 4 22, SD = 2 44) conditions did not differ from any other conditions In summary, when participants were not compliant, those in the Facebook and email conditions engaged in the greatest number of alternative technologies during the lectures

Types of Multi-tasking Activities The types of multi-tasking activities that non-compliant participants engaged in (i e , activities above and beyond those expected in the condition) were identified in order to determine what activities were most popular across the three sessions (see Table 4 for a description of the most frequent alternate technologies) For participants in the texting condition, the most frequent multi-tasking activities reported were emailing and surfing the Internet for entertainment purposes Participants in the email condition most frequently engaged in checking their own accounts/ schedule online, MSN, Texting and Facebook Participants in the MSN condition mostly surfed the Internet for entertainment purposes, texting, email and Facebook Participants in the Facebook condition engaged in texting, surfing the Internet for entertainment purposes and MSN Participants in the Word-processing condition mostly used texting, MSN, Facebook and email, but the relative number of participants engaging in these activities was low Lastly, participants in the paper-and-pencil use condition engaged mostly in texting A descriptive comparison of participants in each of the conditions suggests that participants in the Facebook and MSN conditions multi-tasked more than participants in other conditions

Predictors of Performance. Two regression analyses were conducted to determine whether the individual difference variables assessed through the surveys were related to performance Specifically, one regression examined experience with

technology and statistics, and the other assessed experience with the sessions and attention

Experiences with Technology and Statistics To determine if experience with technology or attitudes toward statistics predicted performance on the multiple-choice tests, a linear regression using 5 predictor variables was conducted The predictor variables represented aggregated scales from the pre-test survey including comfort with digital technologies, affect/ enjoyment of technologies, and frequency of use of various digital technologies for specific tasks, technology attitudes and belief and comfort with statistics The general frequency of use of various digital technologies scale was excluded from the analyses due to low reliability, Cronbach's alpha = 63 The model was not significant $F_{(5, 105)} = 0\ 61$, $p = ns$ Overall, pre-existing technology skills, general attitudes toward technology and general attitudes toward statistics did not predict performance

Experience with The Sessions and Attention To determine whether feelings about participating in the study, matched natural in-class behaviours and whether individual differences in attentiveness had predictive power on performance on the multiple-choice tests, a linear regression using 3 predictor variables was conducted Specifically, these 3 variables were Attitudes Towards the Experimental Sessions scale, Similarity of Experience to Experimental Sessions variable, and an aggregated ADHD scale The model was significant $F_{(3, 110)} = 3\ 43$, $p < 02$ The Attitudes Towards the Experimental Sessions scale was the only significant predictor, ($t_{(79)} = 3\ 07$, $p < 004$) Specifically, more positive attitudes toward the experimental sessions generally reflected higher performance (See table 5 for a correlation matrix)

Gender and Multi-Tasking

Given that previous research has yielded mixed findings regarding the impact of gender regarding the use of technology, an exploratory t-test analysis was conducted to determine whether gender impacted on the number of technologies used Males and females did not differ in the overall amount of multi-tasking, ($t_{(143)=}$ - 28, p = *ns)*

Post Hoc Follow-up Studies

Two post hoc follow-up studies were conducted There was concern that the technology type may inherently impose differential demands, which might account for performance differences among the conditions Specifically, several technologies involved keyboarding tasks, however, the keyboarding actions differed as a function of the technology Specifically, cell-phone texting condition involved small keyboard type devices or required the use of number pad for typing It was important to assess the time taken to communicate using cell-phone texting and typical keyboarding The two post hoc follow-up tests reflect two assessments of the demands inherent in each of these technologies

In total, 15 participants (4 males, 11 females) were recruited for the first follow-up study Participants were volunteers from the same participant pool as the participants in the original study They also received course credit for their participation The first task involved asking participants to respond to 18 questions posed by a researcher This represented all of the scripted questions that could be posed by a researcher to a student in the study in any one session Participants were asked to respond to each message in any way that was appropriate as soon as they received a message Participants responded to the prompts using two of three technologies including cell-phone texting, MSN

keyboarding or email keyboarding Due to the naturalistic nature of the task, it was possible for participants to send the research assistant messages in addition to the 18 scripted messages The presence of extra messages could not be controlled and this was consistent with the conversations that occurred in the classrooms Total time for the complete exchange was measured in seconds It was expected that participants required to use cell-phones would take longer to send messages than those using full keyboards A univariate ANOVA analysis was conducted, with condition serving as a between subjects variable There was a main effect of condition, $F_{(2, 29)} = 10\ 16, p < 001$ Tukey b post hoc comparisons indicated that MSN (M = 416 5) conversations took the least amount of time in comparison to email (M = 896 4) and texting (M = 1061 60) The times for email and texting did not differ

Participants also indicated their level of comfort with each technology using a 7-point Likert type scale (1= *completely uncomfortable* and 7 = *completely comfortable*) The mean comfort score across the sample for cell-phone (M = 6 70, SD = 68) and laptop (M = 6 87, SD = 35) was very high, reaching a ceiling effect for both technologies It appears that type of activity /platform rather than device impacted the amount of time taken to complete messages

The second follow-up study controlled for the amount of information being "typed" by asking participants to type the shortest and longest messages that were sent in the study In total, 15 participants (3 males and 12 females) were recruited from a convenience sample Each participant "typed" two prepared written text messages (one longest and one shortest) using two different devices (i e , cell-phone and laptop) Cell-phones varied across participants where some participants used their own (familiar) cell-

phone and others were given cell-phones to use (similar to conditions in the original study) In addition, laptops varied with some belonging to the participants and some being provided by the researchers (again paralleling the original study) Time taken to complete the typing exercise was recorded in seconds A 2 (device) X 2 (length of message) repeated measure ANOVA was conducted There was a significant main effect for device $F_{(1, 59)} = 26\ 15, p < 001$) and length of message $F_{(1, 59)} = 170\ 43, p < 001$), such that cell-phones took longer than laptops for typing the messages (See Table 6 for means) Also, as expected shorter messages were completed more quickly than long ones These main effects were qualified by a significant interaction, $F_{(1, 59)} = 21\ 31, p < 001$ The interaction is depicted in Figure 1 where the difference in time taken to complete the short messages was much smaller than the difference in time taken to type the long messages on the laptop versus cell-phone, $t_{(14)} = 5\ 67, p < 001$

Participants in this follow-up study also completed the comfort measure A t-test was conducted to determine whether participants were more comfortable with one technology or the other There was no significant difference in the mean comfort scores for the laptop (M = 6 27) versus the cell-phone (M = 5 27)

In summary, the outcomes of the post hoc follow-up studies indicate that using laptops to communicate is generally a speedier, more efficient way to communicate than using a cell-phone especially when longer messages are being sent In addition, participants using MSN tend to be faster in sending responses to questions than those texting or emailing

Discussion

The primary purpose of the present study was to examine the impact of multi-tasking with digital technologies while attempting to learn from a real-time classroom lecture Specifically, the study examined the relative impact of texting on a cell-phone, emailing, MSN messaging and using Facebook, while simultaneously attending to research methods lectures as part of an ongoing course in a university setting Participants engaged in multi-taking were compared to students taking notes, either paper-and-pencil or word-processing, without the potential for distraction from multi-tasking Students' natural use of technology was also explored Secondary analyses explored students' use of assigned technologies and the impact of other variables, which could impact on performance or choices regarding technology use when learning from lectures A summary of outcomes is presented below

Summary of Findings and Implications

Memory for Information Presented in Class Consistent with the Cognitive Bottleneck theory (Welford, 1967) suggests that two cognitive tasks cannot be performed simultaneously without decrements in performance in at least one of the tasks (Welford, 1967) Consequently, it was expected that requiring students to multi-task with technology while learning would impact negatively on performance The results of this study provided partial support for this hypothesis Specifically, only Facebook and MSN messaging were found to impact negatively on learning when compared to note-taking with paper-and-pencil Two concerns are raised by the partial support of the findings The first question involves why Facebook and MSN did serve as particularly salient multi-

tasking distractors The second concern requires an understanding of why cell-phone texting and email messaging did not pose as a great a problem

With respect to the first concern, clearly both MSN and Facebook are attractive, engaging interactive activities Facebook offers a variety of intrinsically interesting activities to perform, such as viewing pictures of friends, chatting with friends, playing games, posting status updates etc, that can all be performed within a single site As such, the structure of Facebook provides users with a multitude of stimuli to explore, as well as to act on Students assigned to the Facebook condition were required to go to specific profiles to search for target information that they needed to retrieve While navigating through profiles to find target "Scavenger Hunt" information, participants may have been distracted by non-target information that was either visually appealing (other pictures) or generally interesting (i e , finding out personal information about another person) Even the design of Facebook is colourful and visually attractive with icons, links and other aids that are specifically designed to encourage navigation and further exploration, making the use of Facebook a highly enjoyable activity (Nosko, 2011) These features may make Facebook particularly distracting, especially when compared to other platforms that may rely mainly on verbal information presented in a plain visual background such as would be found in text messages or email

MSN also relies primarily on simple exchanges of text-based information However, the page template does present users with a multitude of stimuli, such as visual and auditory emoticons, aside from the messages to be attended MSN is a program that is constantly running when the user is online regardless of other activities in which the user may be engaged Therefore the messages are immediately accessible One feature

that is particularly compelling about MSN is that the user is provided with an instant notification when a message has been received This notification in the form of an auditory signal orients the user to the new message, which can be instantly retrieved and viewed It could be argued that this feature encourages users to attend more regularly and immediately to the incoming information The results of the study provide support to this explanation, as MSN users were the fastest responders Email messages also have the potential to alert users to incoming messages, if the computer is set to allow this function In the context of the present study, however, email messages were not automatically signaled, which may have made this activity less interactive and more asynchronous Also email typically requires the user to open the program, as timed lock outs can occur, and then search to see if new messages have arrived before opening the message to view it Hence, participants may have been more strategic in their use of this activity as they waited for appropriate breaks before responding to messages Although only very tentative evaluations of timing can made due to the very small sample size of participants with available data in the timing analysis, the findings for timing support this conclusion as participants in the email condition were the slowest to provide a response The asynchrony and additional steps required to execute a response to email may have made it less distracting as learners selected when to use it and had fewer activities within the program in which to engage

It could also be argued that cell-phone messages, which either employ a vibration or sound to indicate incoming messages, also would incur an immediate response such as in MSN However, with cell-phones, participants may have been interested to see the received message but may have delayed before answering, as the immediacy of response

may not be as characteristic of this device as it is with MSN Whereas MSN is directly in front of the person, logged in at all times, users often put away their cell-phones after having answered a message Therefore, when they receive a new message, they need to first retrieve the cell-phone to answer the message, leading to increased delays in responding This delay in responding, however, does not necessarily imply that the responding is more strategic It only implies that to immediately answer a text message on a cell-phone takes longer than to answer a message on MSN The results of the study provide support for this explanation, as participants in the texting conditions took only slightly longer to respond than did the participants in the MSN condition Although the type of display and multitude of information in a single location, in addition to the immediacy of notification in MSN, may make Facebook and MSN particularly engaging, these features alone do not separate these two digital technologies from other technologies Clearly, more intensive examination of the features of technologies needs to be conducted in order to understand whether the devices or platforms do promote greater attention and engagement

Another consideration is that participants in both the MSN and Facebook conditions also engaged in more than the dual tasking assignment of their condition Instead they engaged in *multi*-tasking Participants in both the Facebook and the MSN conditions engaged in more multi-tasking activities (e g , went on email and searched the internet for entertainment purposes) in addition to their instructions, than participants in any other condition Therefore, it may be that participants in these two conditions performed more poorly than participants in the other multi-tasking conditions because their attention was spread across many more activities causing an increased use of

cognitive resources, much more so than participants in the other conditions who engaged in fewer additional activities Therefore, the amount of multi-tasking rather than the intrinsic distracting factors of each technology may be responsible for why people in the Facebook and MSN conditions performed more poorly than did participants in the other multi-tasking conditions

Support for distraction for multi-tasking rather than "dual-tasking" however was not confirmed when number of multi-tasking activities was examined among the non-compliant participants Indeed, any distraction (e g , checking email while on Facebook) regardless of number resulted in poorer performance than the no distraction conditions Non-compliant individuals may have represented a different type of user than compliant users However, while these explanations are reasonable possibilities, the results do not completely support these explanations as participants in the email condition engaged in more multi-tasking activities than did participants in the MSN condition, but email condition was not found to be detrimental to performance, suggesting that compliance to instruction and the amount of multi-tasking activities are not the only issues

Overall, the simplest explanations, supported by the results of study, suggest that MSN is the fastest conversational technology because conversations occur using a laptop, which takes less time than to type on a cell-phone Secondly, MSN provides a notification as soon as a message is received and therefore conversations are not hinging on the time taken to check to see whether or not a message has been received, as is the case with email This makes this technology easier to use, and perhaps more likely to be distracting as it is always present and available when running

The results of the present study did not reveal increasing performance with increased practice with the multi-tasking activities, either among the conditions where multi-tasking was assigned or in the natural use study condition This is contrary to previous research, which has shown that under some circumstances people may become better at multi-tasking given sufficient practice (Spelke, Hirst, & Neisser, 1976) It is possible that three sessions was simply not enough exposure or practice to allow participants to acquire fluency with their assigned multi-tasking activity This may be especially true for those participants who did not normally use technology during lectures If this explanation is correct, the results obtained in this study were insufficient to provide evidence to assess the EPIC model of multi-tasking, proposed by Meyer and colleagues (1995), which considers practice as an integral part of the multi-tasking performance In order to properly test this model, practice effects would need to be measured only after a specified mastery criterion has been attained

However, within the constraints of the present study it could also be argued that participants were already fluent and comfortable with the available technologies Indeed, very few students needed to be given a laptop or a cell-phone and all other students had their own devices This availability of technology among the students suggests that they have extensive exposure Also, these participants, given their age, would be considered *digital natives* (Prensky, 2001) in that they would have exposure and experience with computer (including laptop) technologies for all of their lives It is possible therefore, that these students represented very fluent and flexible technology users and that multi-tasking would not be unfamiliar but instead be commonplace for this group Hence using the technologies should not have been a challenge in the classroom context Although it

may be the case that more practice might have yielded different outcomes, within the present study, familiarity with the material rather than the devices seems more likely to account for performance Considering that the learning assessed in this study did not involve any purposeful studying per se, such as in a preparation for an examination, the students performed reasonably well on the learning tasks (53 2% in session 1, 72 8% in session 2, 51 3% in session 3) In addition, participants performed very well on the memory test in session 2 suggesting that the difficulty level of content material rather than multi-tasking practice was explaining differences in performance over time This is contrary to the alternate EPIC model of multi-tasking as proposed by Meyer and colleagues (1995)

Variations in Multi-tasking Contexts The impact of two contexts on performance was explored in this study the natural use condition and class size The natural use condition concerns Hypotheses 1i and 2i specifically, while class size was further explored as it was also found to have significant impact on performance

Hypothesis 1i predicted that those participants who chose not to use technology, or used minimal amounts of technology, would outperform those participants who chose to engage in multi-tasking activities to a greater extent This hypothesis was supported Consistent with the results of amount of technology use on performance for all participants in this study, participants in the natural use condition who did not use any technology outperformed technology users This result is consistent with previous research that shows that technology used in a classroom can serve as a distraction rather than an important instructional tool (Fried, 2008, Grace-Martin and Gay, 2001, Hembrooke & Gay, 2003, Kraushaar & Novak, 2010, Wainer et al , 2008, Wurst et al ,

2008), however, it must be noted that in the present study, only in the word-processing condition, was the technology offered as a potential learning tool

An additional examination involved the impact of class size on performance The results revealed that participants in smaller classrooms outperformed those participants in larger classrooms One possible explanation for this finding is that participants in the smaller classrooms were less anonymous and therefore may have felt more pressure to pay attention to the lecturer, resulting in lower engagement in multi-tasking activities Secondly, participants in smaller classrooms may have been more involved in the lectures as they would be reasonably expected to more likely answer questions when the lecturer asked, than would be participants in larger classrooms (Blatchford, Russel, Basset, Brown, & Martin, 2007) These findings have potential implications for educators and those involved in educational policy when integrating technology in the classroom Perhaps greater perceived supervision by the learner inhibits distracting use of technologies and this may best be achieved in smaller classrooms

Fidelity in the Conditions Overall, compliance with instructions was low, only 57% of the participants self-reported fully adhering to instructions on each of the three sessions Although compliance was not a significant predictor of performance in this study, this finding is very important in itself, as it indicates that when students have technology available, and are given the opportunity to use the technology, they tend to engage in activities that they are not instructed to be engaged

The types of multi-tasking activities most frequently performed by participants were also examined Overall, the results indicated that participants mostly engaged in texting, MSN messaging and email In addition, when not using any technologies for

conversing purposes, participants use the Internet mostly for entertainment purposes and for using Facebook

Predictors of Performance Only attitudes towards the experimental sessions were associated with performance, such that more positive attitudes toward the experimental sessions generally reflected higher performance This is not surprising considering that students' perception of their own performance and experience in the experimental sessions would have impacted their view of the sessions, which was assessed after the sessions rather than before the sessions

Gender In early studies males reported much greater use of technology than women, however, further examination of potential gender differences suggested that women tended to under-report their use of technology relative to men (Henwood et al , 2000) In the present study, gender did not impact on technology use

To conclude, the findings from this study are supportive of the Cognitive Bottleneck Theory of attention (Welford, 1967), which states that performing two tasks simultaneously cannot be achieved without decrements in performance in at least one of the two tasks, given that the tasks draw on the same cognitive mechanisms and/or they exceed the available limited resources In addition, the outcomes from the present study, especially viewed over the three sessions, did not provide support to the EPIC model of attention (Meyer et al , 1995), which predicts that the simultaneous performance of two tasks can be accomplished without decrements in performance, given sufficient practice

Limitations

One of the major findings of this study also served as an important limitation, namely, participants did not comply with instructions This finding is intriguing because

it suggests that having access to Internet-based technologies may be too inviting for many learners Much research has begun to explore the power of multi-media as an instructional tool (Barak, Lipson, & Lerman, 2006, Fried, 2008, Grace-Martin & Gay, 2001, Liao, 2007, Lowther, Ross, & Morrison, 2003, Siegel & Foster, 2001, Wainer et al , 2008, Wurst et al , 2008) but the findings of the present study suggest that the very features that make multi-media platforms attractive as learning tools may also make them distractors This is an important consideration for educational practice In order to increase the external validity of the study's findings and to provide meaningful results for educators and those involved in educational policy, some aspects of the study could not be controlled To better understand the cognitive implications of multi-tasking, however, perhaps more stringent experimental controls need to be employed For example, limiting access to specific platforms, might allow a better understanding of the unique distraction caused by each of the technologies studied in the present paper

An additional significant limitation in the present study involved technical problems, which led to lost or limited data, and hence smaller sample sizes than would be optimal These included intermittent losses in Internet connection and cell-phone reception, and loss of synchrony in timing between a classroom clock and time setting of different laptops Many of these technical problems, in a 'real-world" context are simply unavoidable, however, more stringent measures could be exerted in a lab-type setting to verify findings and extend findings that could not be wholly investigated within the confines of the present study

Directions for Future Research

The present study provided an initial experimental examination of the impact of multi-tasking for classroom-style lecture contexts The findings provide a foundation from which ongoing research can be planned Most notably, the findings clearly indicate that further investigation of the impact of multi-tasking using each of the technologies on learning is needed Immediate extensions of the current work could involve examination of the use of the various technologies under more controlled conditions, ensuring fidelity to instruction and greater power for subsequent analyses In addition, future research should concentrate on determining whether timing when multi-tasking, immediate versus delayed, and therefore, strategic multi-tasking, impacts performance Finally, the present study introduced multi-tasking and the use of technologies as a distracting task It would be useful to examine how these same technologies would be used if users were already engaged with the technologies for task relevant activities Given that technologies are quickly becoming integrated within educational contexts as active, motivating instructional tools (Wurst et al , 2008), it would be important to establish whether learners access 'distracting" activities and to what degree this would impact on performance

Final Remarks

In summary, the results of the present study revealed that using any form of technology, even during a single session for tasks other than the educational task at hand, can have a detrimental impact on learning This finding has important implications for educators and policy makers considering that computers, especially laptops, and other digital technologies that allow wireless access to the Internet, have become standard

technologies in education, and continue to progress as the number of universities adopting laptop initiatives continues to increase (Weaver & Nilson, 2005) Although the educational system has quickly embraced technology in the form of Anywhere Anytime Learning initiatives, the results of this study, in combination with the mixed findings of previous research (in support of technology Barak et al , 2006, Liao, 2007, Lowther et al , 2003, Siegel & Foster, 2001, vs Fried, 2008, Grace-Martin & Gay, 2001, Hembrooke & Gay, 2003, Kraushaar & Novak, 2010, Wainer et al , 2008, Wurst et al , 2008), indicate that this decision may have potentially important and negative outcomes for some learners Fully identifying, understanding and overcoming potential shortcomings will require ongoing research

Table1

Summary of Participants by Condition

Condition	Participants (Females, Males)	Sample Size
Texting	F = 16, M = 5	n = 21
Email	F = 17, M = 3	n = 20
MSN	F = 16, M = 4	n = 20
Facebook	F = 18, M = 3	n = 21
Natural Use Control	F = 16, M = 5	n = 21
Word-processing Control	F = 18, M = 3	n = 21
Paper-and-pencil Control	F = 15, M = 6	n = 21

Table 2

Summary of Means and Standard Deviations for Multiple-choice Proportion Scores by Condition and Session

	Session 1		Session 2		Session 3	
	M	SD	M	SD	M	SD
Texting	57	17	75	11	56	16
Email	52	11	69	14	50	12
MSN	48	15	71	16	42	22
Facebook	50	19	68	17	43	18
Natural Use Control	50	15	78	24	58	17
Word-processing Control	55	15	75	12	57	21
Paper-and-pencil Control	60	16	74	17	53	20
Total	53	16	73	16	51	19

Table 3

Number of Non-compliant Participants by Condition for each Session

	Session 1	Session 2	Session 3	Average
Texting	4	6	3	4 33
Email	8	8	7	7 66
MSN	13	8	9	10
Facebook	14	11	10	11 6
Natural Use Control	-	-	-	-
Word-processing Control	6	6	5	5 66
Paper-and-pencil Control	4	5	5	4 66
Total of Non-Compliant Participants	49/144	44/105	39/103	

Note The "out of" number is the number of participants with available fidelity data for each session The dash indicates "not applicable"

Table 4

Most Frequent Multi-tasking Activities for Non-compliant Participants by Condition and Session

	Session 1	Session 2	Session 3
Texting	Internet for Entertainment (1) Games (1) -	Email (3) Internet for Entertainment (2) MSN (1)	Internet for Entertainment (2) Games (1) MSN (1)
Email	Checked Own Student Account (4) MSN (3) Facebook (3)	MSN (5) Texting (2) Internet for Entertainment (2)	Texting (3) Facebook (2) Checking Schedule Online (2)
MSN	Internet for Entertainment (5) Texting (4) Email (4) Facebook (4)	Internet for Entertainment (2) Texting (1) Facebook (1)	Internet for Entertainment (3) Email (3) Games (1)
Facebook	Texting (7) Internet for Entertainment (6) MSN (6)	Texting (5) Internet for Entertainment (4) MSN (3)	Texting (5) MSN (2) Email (2)
Natural Use Control	-	-	-
Word-processing Control	Texting (2) Facebook (1) MSN (1)	Texting (4) - -	Texting (3) Email (1) MSN (1)
Paper-and-pencil Control	Texting (4) MSN (1) Games (1)	Texting (5) - -	Texting (5) - -

Table 5

Correlation Matrix for 3 Factors in a Linear Regression for Individual Difference Variables

Coefficient Correlations

Model			Similarity of Experience	ADHD Scale	Attitudes Towards the Sessions
1	Correlations	Similarity of Experience	1 000	- 091	- 424
		ADHD Scale	- 091	1 000	- 037
		Attitudes Towards the Experimental Sessions	- 424	- 037	1 000
	Covariances	Similarity of Experience	5 722E-5	-4 295E-7	-6 586E-6
		ADHD Scale	-4 295E-7	3 934E-7	-4 754E-8
		Attitudes Towards the Sessions Scale	-6 586E-6	-4 754E-8	4 217E-6

a Dependent Variable TOTAL Proportion Score

Table 6

*Group Means, Standard Deviations and Ranges, According to Device and Length of Message (*Post hoc follow-up Study *1)*

		Cell-Phone	Laptop
Shortest message	M	24 27	12 87
	SD	11 91	4 32
	Range	11 – 55	7 - 21
Longest message	M	429 53	206 40
	SD	170 42	48 54
	Range	255 – 890	135 – 276

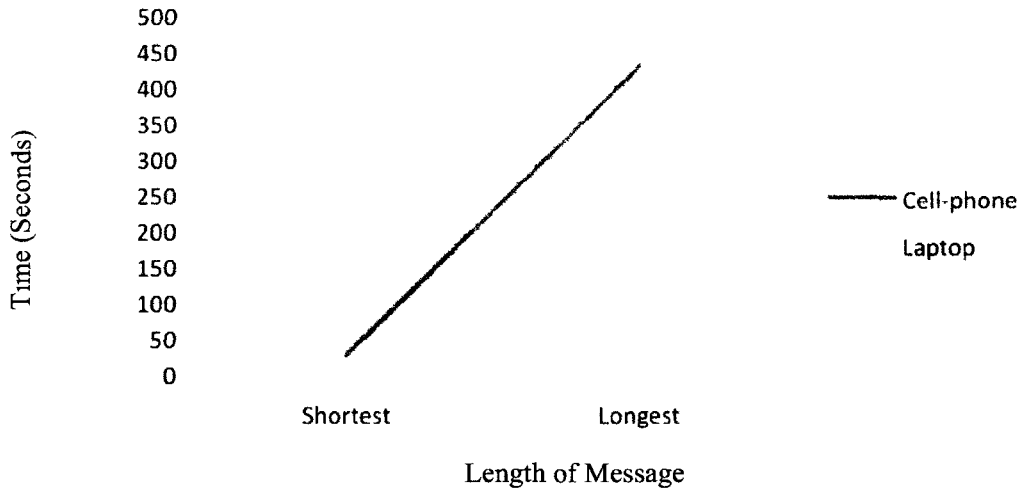

Figure 1 The interaction of device and length of message on time in seconds

Appendices

Appendix A. Pre-test Survey

In order to ensure confidentiality please create a user ID code by following the instructions below This code will be used to make the survey anonymous but will allow your instructor ad TA's to connect subsequent data with each participant For example, a completed ID code may be EIWOAN970

Fill in the boxes with the following information, in order

First two letters of your first name
First two letters of your last name
First two letters of the name of your street
Last three numbers of your phone number (your primary phone)

ID Code:									

Section A. Demographic Information *Please circle answer or fill in blank where applicable.*		
1.	**Age (in years)**	
2.	**Gender**	Male Female Other
3.	**Marital Status**	Married Common Law Divorced Single
4.	**Ethnic group with which you identify**	

Section B. Technology Experience *Please circle appropriate answer or fill in blank where appropriate.*					
1.	**How much do you use computers for school/work versus personal tasks?**				
	Much more for personal than work/school	A little more for personal than work/school	Equally for personal and work	A little more for work/school than personal	Much more for work/school than personal
	1	2	3	4	5
2.	**Frequency of Technology Use** ***How frequently do you use each of the following technologies:***				

		Never	Few times a year	Few times a week	Few times a day	Many times a day
a.	Computers (desktop)	1	2	3	4	5
b.	Laptop computers	1	2	3	4	5
c.	Cell-phones (no texting)	1	2	3	4	5
d.	Cell-phones (texting)	1	2	3	4	5
e.	Smartphone/Blackberry	1	2	3	4	5
f.	Internet	1	2	3	4	5
g.	Twitter	1	2	3	4	5
h.	Facebook	1	2	3	4	5
g.	MSN	1	2	3	4	5
h.	Skype	1	2	3	4	5
i	email	1	2	3	4	5
j.	Are there other computer based digital technologies with which you would consider yourself to be very familiar (i e , would rate as 4 or 5 on the above scale)? Please list					

3. Comfort with Technology

How at ease are you with each of the following technologies:

		Very *Ill* at Ease		Neutral		Very at Ease
a.	Computers (desktop)	1	2	3	4	5
b.	Laptop computers	1	2	3	4	5
c.	Cell-phones (no texting)	1	2	3	4	5
d.	Cell-phones (texting)	1	2	3	4	5
e.	Smartphone	1	2	3	4	5
f.	Blackberry	1	2	3	4	5
g.	Internet	1	2	3	4	5
h.	Twitter	1	2	3	4	5
i.	Facebook	1	2	3	4	5
j.	My Space or other personal profiles	1	2	3	4	5
k.	MSN	1	2	3	4	5
l.	email	1	2	3	4	5
m.	Skype	1	2	3	4	5

4. Affect/Enjoyment of Technology

How *much do you enjoy using* each of the following

	technologies:					
		Do not like using the technology at all		Neutral		Like using the technology a great deal
a.	Computers (desktop)	1	2	3	4	5
b.	Laptop computers	1	2	3	4	5
c.	Cell-phones (no texting)	1	2	3	4	5
d.	Cell-phones (texting)	1	2	3	4	5
e.	Smartphone	1	2	3	4	5
f.	Blackberry	1	2	3	4	5
g.	Internet	1	2	3	4	5
h.	Twitter	1	2	3	4	5
i.	Facebook	1	2	3	4	5
j.	My Space or other personal profiles	1	2	3	4	5
k.	MSN	1	2	3	4	5
l.	email	1	2	3	4	5
m.	Skype	1	2	3	4	5

5.	*How frequently do you use digital technology for the following tasks:*					
		Never	Few times a year	Few times a week	Few times a day	Many times a day
a.	**Communication**					
	i E-mail	1	2	3	4	5
	ii MSN	1	2	3	4	5
	iii Facebook	1	2	3	4	5
	iv Twitter	1	2	3	4	5
	v Skype	1	2	3	4	5
	vi Texting	1	2	3	4	5
	vii Other _____	1	2	3	4	5
b.	**Entertainment**					
	i Single player games	1	2	3	4	5
	ii Multi-player games	1	2	3	4	5
	iii Music	1	2	3	4	5
	iv Video (e g movie, Youtube)	1	2	3	4	5
	v Other _____	1	2	3	4	5

c.	**Office Tools**					
	i Word-processing	1	2	3	4	5
	ii Spreadsheets/Databases	1	2	3	4	5
	iii Presentations	1	2	3	4	5
	iv Other _____	1	2	3	4	5
d.	**Personal Financing**					
	i Banking/Paying bills	1	2	3	4	5
	ii Shopping	1	2	3	4	5
	iii Other _____	1	2	3	4	5
e.	**Studying (when taking courses)**					
	i On-line course work	1	2	3	4	5
	ii On-line research	1	2	3	4	5
	iii Other _____	1	2	3	4	5

6.	**Technology Attitudes and Beliefs.** ***Please rate the following on the 6-point scale provided.***						
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	***Not Applicable***
a	**I do not feel nervous about using**						
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
b	**I feel comfortable talking about _____with others**						
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
c	**I have never been frustrated with_____**						
	My Computer	1	2	3	4	5	0

	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
d	**I do not feel anxious when I use**						
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
e	**_____ does not threaten me**						
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
f	**I feel comfortable communicating with others using _____**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	***Not Applicable***
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
g	**I avoid using _____ whenever possible**						
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0

h	**I find _____ fun to use**						
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
i	**I do not think that having or using_____ is scary**						
	My Computer	1	2	3	4	5	0
	The Internet	1	2	3	4	5	0
	Facebook	1	2	3	4	5	0
	MSN	1	2	3	4	5	0
	Email	1	2	3	4	5	0
	Texting with a cell-phone	1	2	3	4	5	0
j	**I like surfing the Internet**	1	2	3	4	5	0
k	**I like experimenting with new computer hardware/software**	1	2	3	4	5	0

Section C. Attitudes Toward Courses

Please rate the following on the 5-point scale provided.

1.	**Please indicate your anxiety level to each of the statements on the 5-point scale below.**					
		No Anxiety				**Considerable Anxiety**
a.	Studying for an exam in a statistics course	1	2	3	4	5
b.	Interpreting the meaning of a table in a journal article	1	2	3	4	5
c.	Going to ask my statistics teacher for individual help with material I am having difficulty understanding	1	2	3	4	5
d.	Realizing the day before an exam that I cannot do some problems that I thought were going to be easy	**No Anxiety** 1	2	3	4	**Considerable Anxiety** 5
e.	Asking a private teacher to explain a topic that I have not understood at all	1	2	3	4	5
f.	Reading a journal article that	1	2	3	4	5

	includes some statistical analyses					
g.	Asking the teacher how to use a probability table	1	2	3	4	5
h.	Trying to understand a mathematical demonstration	1	2	3	4	5
i.	Doing the final examination in a statistics course	1	2	3	4	5
j.	Reading an advertisement for an automobile which includes figures on gas mileage, compliance with population regulations, etc	1	2	3	4	5
k.	Walking into the classroom to take a statistics test.	1	2	3	4	5
l.	Asking the teacher about how to do an exercise	1	2	3	4	5
m.	Getting to the day before an exam without having had time to revise the syllabus	1	2	3	4	5
n.	Waking up in the morning on the day of a statistics test.	1	2	3	4	5
o.	Realizing, just before you go into the exam, that I have not prepared a particular exercise	1	2	3	4	5
p.	Copying a mathematical demonstration from the blackboard while the teacher is explaining it.	1	2	3	4	5
q.	Trying to understand the odds in a lottery	1	2	3	4	5
r.	Trying to understand the odds in a lottery	1	2	3	4	5
s.	Walking into the classroom to take a statistics test.	1	2	3	4	5
t.	Going to a statistics exam without having had enough time to revise	1	2	3	4	5
u.	Asking a teacher for help when trying to interpret a results table	1	2	3	4	5
v.	Trying to understand the statistical analyses described in the abstract of a journal article	1	2	3	4	5
w.	Going to the teacher's office to ask questions	1	2	3	4	5
x.	Asking a private teacher to tell me how to do an exercise	1	2	3	4	5
2.	**How confident are you that....**					
		Not At All				**Very**

		Confident				Confident
a.	You will receive a final grade in this course that is comparable to your other math/statistics grades?	1	2	3	4	5
b.	You will receive a final grade in this course that is comparable to your other psychology grades?	1	2	3	4	5
c.	You will receive a final grade that is representative of the effort you will put into the course?	1	2	3	4	5

You are done. Thank you.

Hand in the survey to the Instructor.

Appendix B. Post-test Survey

In order to ensure confidentiality please create a user ID code by following the instructions below This code will be used to make the survey anonymous but will allow your instructor ad TA's to connect subsequent data with each participant For example, a completed ID code may be EIWOAN970

Fill in the boxes with the following information, in order

First two letters of your first name
First two letters of your last name
First two letters of the name of your street
Last three numbers of your phone number (your primary phone)

ID Code:									

Section A. Attitudes Toward the Three Experimental Sessions Conducted in your Class this Term
Please rate the following on the 5-point scale provided.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a.	Following the experimental instructions for my condition was easier to complete as the sessions progressed	1	2	3	4	5
b.	Following the experimental instructions for my condition was less distracting/disruptive as the sessions progressed	1	2	3	4	5
c.	The instructed activities (texting email, notetaking) in the later sessions took less time than the task in the first session	1	2	3	4	5
d.	Following the experimental instructions for my condition was more motivating and interesting/fun as the sessions progressed	1	2	3	4	5
e.	I felt that practice on multi-tasking had no impact on my performance on the tasks assigned in the later sessions	1	2	3	4	5
f.	The timing of the tasks felt consistent across sessions	1	2	3	4	5
g.	The timing of the tasks required for my condition was conducive to learning	1	2	3	4	5
h.	All things considered, the tasks I was asked to do in the later session were very comparable to the task I performed in the first session	1	2	3	4	5
i.	I felt that practice on multi-tasking had positively affected my performance on the	1	2	3	4	5

	tasks assigned in the later sessions					
j.	Following my instructions during the experiment did not affect my learning	1	2	3	4	5

Section B. Attitudes Toward Myself

Please rate the following on the 5-point scale provided.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I know that I am good because everybody keeps telling me so	1	2	3	4	5
2.	When people compliment me I sometimes get embarrassed	1	2	3	4	5
3.	I like to be the center of attention	1	2	3	4	5
4.	I prefer to blend in with the crowd	1	2	3	4	5
5.	I think I am a special person	1	2	3	4	5
6.	I am no better or nor worse than most people	1	2	3	4	5
7.	I like having authority over people	1	2	3	4	5
8.	I don't mind following orders	1	2	3	4	5
9.	I find it easy to manipulate people	1	2	3	4	5
10.	I don't like it when I find myself manipulating people	1	2	3	4	5
11.	I insist upon getting the respect that is due me	1	2	3	4	5
12.	I usually get the respect that I deserve	1	2	3	4	5
13.	I am apt to show off	1	2	3	4	5
14.	If I get the chance I try not to be a show off	1	2	3	4	5
15.	I always know what I am doing	1	2	3	4	5
16.	Sometimes I am not sure of what I am doing	1	2	3	4	5
17.	Everybody likes to hear my stories	1	2	3	4	5
18.	Sometimes I tell good stories	1	2	3	4	5
19.	I expect a great deal from other people	1	2	3	4	5
20.	I like to do things for other people	1	2	3	4	5
21.	I really like to be the center of attention	1	2	3	4	5
22.	It makes me uncomfortable to be the center of attention	1	2	3	4	5
23.	People always seem to recognize my authority	1	2	3	4	5
24.	Being an authority doesn't mean that much to me	1	2	3	4	5
25.	I am going to be a great person	1	2	3	4	5
26.	I hope I am going to be successful	1	2	3	4	5

27.	I can make anybody believe anything I want them to	1	2	3	4	5
28.	I hope I am going to be successful	1	2	3	4	5
29.	I am more capable than other people	1	2	3	4	5
30.	There is a lot that I can learn from other people	1	2	3	4	5
31.	I am an extraordinary person	1	2	3	4	5
32.	I am much like everybody else	1	2	3	4	5

Section C. My Habits: What I Am Like

Please rate the following statements on the 4-point scale provided.

In the past month, this was	**Never/ Seldom**	**Occasionally**	**Often**	**Very often**
I do what my parents or other adults ask me to do	0	1	2	3
I feel nervous or jumpy	0	1	2	3
I try to annoy other people	0	1	2	3
I blurt out the first thing that I think of	0	1	2	3
I lose stuff that I need	0	1	2	3
I interrupt other people	0	1	2	3
I am restless	0	1	2	3
I blurt out the answers before the question is finished	0	1	2	3
I enjoy myself when I do my favourite activities	0	1	2	3
I struggle to complete hard tasks	0	1	2	3
I have trouble finishing things	0	1	2	3
I am good at some things	0	1	2	3
I run and climb even when I am not supposed to	0	1	2	3
I have trouble keeping myself organized	0	1	2	3
I have trouble waiting for my turn	0	1	2	3
I can't do things right.	0	1	2	3
When I get nervous, things irritate me	0	1	2	3
I start lots of things but I don't finish them	0	1	2	3
It is hard for me to pay attention to details	0	1	2	3
I forget stuff	0	1	2	3
I skip classes	0	1	2	3
I talk too much	0	1	2	3
I am behind in my schoolwork	0	1	2	3
I feel worthless	0	1	2	3
I tell the truth, I do not even tell "little white lies"	0	1	2	3
I make mistakes by accident.	0	1	2	3
I am happy and cheerful	0	1	2	3
People like being around me	0	1	2	3
I have trouble keeping my mind on what people are saying to me	0	1	2	3
I lose track of what I am supposed to do	0	1	2	3
I don't feel like doing things that I used to enjoy	0	1	2	3
I have trouble with math	0	1	2	3

I have trouble controlling my worries	0	1	2	3
I act like an angel	0	1	2	3
I give up easily when I work on a hard problem	0	1	2	3
I have too much energy to stay still	0	1	2	3
I don't like doing things that make me think hard	0	1	2	3
I have trouble changing from one task to another	0	1	2	3
I am happy, even when I am waiting in a long line	0	1	2	3
I like to be on the go rather than being in one place	0	1	2	3
I have trouble with reading	0	1	2	3
I do things before I think what could happen	0	1	2	3
I need help doing my homework	0	1	2	3
It is hard for me to sit still	0	1	2	3
I have trouble following instructions	0	1	2	3
I blame others for things I do wrong	0	1	2	3
I have trouble keeping my mind on what I am doing	0	1	2	3
I have trouble with spelling	0	1	2	3
I feel like I am driven by a motor	0	1	2	3
I lose my temper	0	1	2	3
I feel sad, gloomy and or irritable for many days at a time	0	1	2	3
I have trouble understanding what I read	0	1	2	3
I have trouble getting started on tasks or projects	0	1	2	3
I am easily annoyed by others	0	1	2	3
I am perfect in every way	0	1	2	3
I forget things that I have learned	0	1	2	3
I get distracted by things that are going on around me	0	1	2	3
I can't pay attention for long	0	1	2	3
I feel like I don't have enough energy	0	1	2	3
I have trouble concentrating	0	1	2	3
People make me angry	0	1	2	3
I get really excited or hyper	0	1	2	3
I worry about lots of things	0	1	2	3
I go out at night even when I am supposed to be home	0	1	2	3
I make sounds without realizing it until someone tells me to be quiet.	0	1	2	3
I make mistakes	0	1	2	3
When I get mad at someone, I get even with them	0	1	2	3

Part D: Experiment

What Condition were you in? _____

Please describe your experiences for each of the days you participated on

Day 1

Day 2

Day 3

How similar was this experience in comparison to your usual use of technology in a lecture? Please rate this on the following 5-point scale

Very Dissimilar	Slightly Dissimilar	Neutral	Slightly Similar	Very Similar
1	2	3	4	5

Please describe your usual use of technologies in a lecture classroom in the space provided

Appendix C. Learning Tests for the Three Sessions

SESSION 1 TEST

ID CODE (NOT student ID) _____

(First two letters of your first name_____Then first two letters of your last name_____ Then First two letters of your street_____Then last three numbers of your primary phone number_____

Please circle the correct answer directly on the sheet

1 In a study of the credibility of eyewitness testimony, at least two independent raters view videotapes and make ratings What is the purpose of comparing these ratings?

A) To increase the internal validity
B) To aid in making operational definitions
C) To establish test-retest reliability
D) To establish inter-rater reliability
E) To evaluate the internal consistency of ratings within each observer

2 Which of the following impacts on reliability?

i) How well the researcher and RAs follow the operational definition
ii) The number of observations made by the researcher
iii) The kind of operational definition constructed
iv) The number of participants recruited for the study

A) All of the above
B) One of the above
C) Two of the above
D) Three of the above

3 In the development of a new measure of job satisfaction, the researchers give the measures twice to the same participants at 6-month intervals in order to establish

A) Test-retest reliability
B) Inter-rater reliability
C) Split half reliability
D) Convergent reliability
E) Internal consistency reliability

4 Which is the least important type of validity?

A) Criterion
B) Face
C) Content
D) Construct
E) Hypothetical

5 You know your measure is reliable if

A) Your measure seems to measure what you think it measures
B) You get consistent outcomes

C) You have enough variability to account for individual differences
D) Your measures are objective
E) All of the above

6 Which of the following statistics are used to calculate direct matches between raters?
A) Correlation coefficient
B) Percentage agreement
C) Cronbach's alpha
D) All of the above

7 Validity is evaluated in terms of
A) The repeatability of a measure
B) The ability of a measure to predict other variables
C) The number of times a variable is measured
D) The clarity of the measure

8 To test a measure's construct validity, researchers
A) Examine behavioral correlates of the measure
B) Conduct experiments to test hypotheses about it
C) Examine its correlations with measures of related constructs
D) Assess test-retest reliability
E) Ask experts for their opinions

9 A test shows split half reliability if
A) The test is split into small components and people respond similarly to each part
B) The test leads to similar results more than 50% of the time
C) The hypothetical constructs being tested have well-defined operational definitions
D) Participants take half the test in one sitting and then redo that half the test in a second session and the responses match

10 Construct validity refers to how well
A) Your operational definitions relate to the underlying concepts you are trying to measure
B) Your measurements concur with the measurements of others
C) Your measurements correlate with one another
D) Your measures predict the outcomes on other measures

11 For which type of reliability would you use a Cronbach's alpha statistic?
A) Inter-rater
B) Test-retest
C) Internal consistency
D) Split -half

12 If you ask a group of experts to review the items on your test to make sure that your test is valid in its coverage of the subject, you are most likely investigating your test's

A) Content validity
B) Criterion-related validity
C) Construct validity
D) All of the above

13 Reliability is to _____ as validity is to_____

A) Degree, Number
B) Believing, Seeing
C) Consistency, Accuracy
D) Accuracy, Consistency

14 Which form of validity takes the longest to establish?

A) Face
B) Content
C) Criterion
D) Construct

15 Which of the following are reliable measures?

A) A weigh scale that consistently measures a mouse as weighing 40 pounds
B) A thermometer that measures in standard Celsius units
C) A happiness scale that uses a 5-point likert-type design with stable anchors (not at all happy, and very happy)
D) Two of the above
E) All of the above

SESSION 2 TEST

ID CODE (NOT student ID) _____

1 The quiz has 15 questions What score do you think you will get out of 15? _____
2 On the 5-point scale provided please indicate your impression regarding today's session

In comparison to the previous session, the content covered today was

a) Very much easier	Easier	The same	Harder	Very much harder
1	2	3	4	5

In comparison to the previous session, following the conditions for my condition was

b) Very much easier	Easier	The same	Harder	Very much harder
1	2	3	4	5

Please circle the correct answer directly on the sheet

1 There were ____ threats to internal validity covered in the lecture and ___ threats to external validity

A) 9 internal, 3 external
B) 8 internal, 4 external
C) 3 internal, 9 external
D) 4 internal, 8 external
E) None of the above

2 If we wish to apply results of a study to a wider population, the type of validity that we would be concerned about would be

A) Convergent validity
B) Internal validity
C) External validity
D) Construct validity

3 A confounding factor that can be the result of naturally occurring improvement over time independent of the experimental manipulation is called

A) Maturation
B) Evolution
C) Regression
D) History

4 A confounding factor that can occur when observation procedures change during the study is called

A) Regression
B) Maturation
C) Selection
D) Instrumentation

5 When we can conclude that it was the independent variable and not some other variable that caused the change in the dependent variable, then the study has good

A) External validity
B) Conceptual validity
C) Internal validity
D) Inter-rater reliability

6 When there is a significant time lapse between pretest and posttest measures, the confounding variable most likely to affect results would be

A) History
B) Regression to the mean
C) Instrumentation
D) Selection

7 The effects of repeated testing represent a threat to internal validity primarily because

A) Participants get bored
B) The researcher gets tired of giving the same test over and over
C) Of regression to the mean
D) Participants may gain proficiency through repeated practice

8 Failure to rule out _____ results in threats to _____ validity

A) All independent variables, internal
B) Alternative explanations, internal
C) Alternative explanations, external
D) All dependent variables, internal

9 During an experiment looking at the relationship of walking on happiness, participants in one condition wore pedometers throughout the study to assess amount of walking In a typical population where people do not readily wear pedometers, less people walked This outcome is consistent with

A) The reactive effect of testing
B) Reactive effects of experimental environments
c) Selection biases
d) Experimental mortality

10 Which of the following is not a threat to external validity?

A) Selection biases
B) Reactive effect of testing
C) Reactive effect of experimental arrangements
D) Reactive effect of the experimenter

11 Which confounding factor is most likely to occur when participants are selected because their pretest measures were unusually high?

A) Regression to the mean
B) Testing

C) Mortality
D) Biases in selection

12 You are conducting a research experiment on sleep deprivation Your procedure involves playing loud noises while people are sleeping in your lab You notice that as they study goes on, people are dropping out of your study What is the most likely confound in this experiment?

A) Experimental Mortality
B) Instrumentation
C) Testing
D) History

13 If during testing it becomes apparent that participants in different groups are talking about the research procedure, the confounding variable to consider is

A) Selection
B) Mortality
C) Diffusion
D) Testing

14 When experiences with previous conditions affect responding to subsequent conditions

A) Instrumentation effects might occur
B) The possible confounding is called testing effects
C) Mortality is likely to be a confounding factor
D) Subject effects will be present

15 Which of the following threats is not specific to the participant?

A) History
B) Maturation
C) Mortality
D) Reactive effect of testing
E) All of the above are specific to participants

SESSION 3 TEST

ID CODE (NOT student ID) _____

1 The quiz has 15 questions, what score do you think you will get out of 15?
2 On the following 5-point scale provided please indicate your impression regarding today's session

In comparison to the first session on reliability and validity, the content covered today was

a) Very much easier	Easier	The same	Harder	Very much harder
1	2	3	4	5

In comparison to the second session on Internal and External Validity, the content covered today was

b) Very much easier	Easier	The same	Harder	Very much harder
1	2	3	4	5

In comparison to the previous sessions, following the instructions for my condition was

c) Very much easier	Easier	The same	Harder	Very much harder
1	2	3	4	5

Please circle the correct answer directly on the sheet.

1 Which of the following is NOT one of the three fundamentals of scientific thinking?
A) Manipulation
B) Comparison
C) Randomization
D) Control

2 In the case of Clever Hans the counting horse, it turned out that the horse really couldn't count but he could very easily detect subtle changes in behaviour To finally figure this out, an experimenter isolated each possible alternative and tested each one (e g , a stranger, only seeing the trainer behind a screen) This action is primarily consistent with
A) Manipulation
B) Comparison
C) Randomization
D) Control
E) Two of the above

3 Which of the following is NOT an issue for control for experiments?
A) Control over measures and instruments

B) General control procedures
C) Control over subject and experimenter effects
D) Control through participant selection and assignment
E) Control through particular experimental design

4 Control over the environment is often achieved through use of lab studies What shortcoming can lab studies yield?
A) Threats to internal validity
B) Threats to external validity
C) Greater experimenter effects
D) Greater subject effects
E) None of the above

5 Control procedures are used to enable researchers to
A) Be in perfect control of their research
B) Accurately control the amount of the independent variable
C) Accurately control the amount of the dependent variable
D) Confidently draw conclusions from research
E) Correspond with ethics requirements

6 Whenever we increase control, we
A) Prevent generalization
B) Increase the sample size
C) Rule out alternative explanations of the obtained results
D) Include alternative explanations of the obtained results
E) All of the above

7 Replication
A) Increases confidence in the validity of findings
B) Guarantees construct validity
C) Always shows the same results as the first study if the replication is carried out properly
D) Is best when the experiment is repeated by the same researcher
E) Is often the only way to confirm findings

8 In a single-blind, control-group procedure, the
A) Experimental group is blind to their assignment
B) Person testing the participants is blind to the hypothesis and assignment of participants to conditions
C) Receptionist is blind to the hypothesis and assignment of participants
D) Participants are blind to their assignment

9 In a study on hand-to-eye coordination, Dr Blink uses a computer to present stimuli and record participant responses This method of experimental control reflects which form of control?
A) Automation

B) Use of objective measures
C) Double-blind procedures
D) Single-blind procedure
e) All of the above

10 A researcher wants to do a study of pretest anxiety He devises two possible ways of measuring pretest anxiety (1) attaching electrodes to the palm and measuring the amount of sweat produced, (2) having observers rate participants on how anxious they look Which of the following is TRUE?

A) Both are subjective measures
B) Both are objective measures
C) #1 is objective, #2 is subjective
D) #1 is subjective, #2 is objective

11 In a random sample

A) Certain participants have a greater chance of selection, although selections are independent

B) Certain participants have a greater chance of selection, and the selections are dependent

C) Every member of population has equal chance of selection, although selections are dependent

D) Every member of population has equal chance of selection, and the selections are independent

12 Which of the following threats to internal validity is NOT a concern in the one shot case study design?

A) History
B) Maturation
C) Testing
D) Selection
E) Mortality

13 Sponge Bob Square Pants decides to do a study to see if he can teach his friend Patrick to count At the outset he checks to see how many numbers Patrick can put in order Then he spends two weeks counting every day with Patrick before he checks to see how many numbers Patrick can count Patrick can count one more number What is the design of this study and the most likely threat?

A) One- shot case study, history
B) One group pre-test posttest design, selection
C) Static group comparison, maturation
D) One- shot case study, instrumentation
E) One group pre-test posttest design, testing
F) Static group comparison, diffusion

14 All three pre-experimental designs experience concern in which of the following threats to internal validity?

A) History
B) Maturation
C) Testing
D) Instrumentation

15 A researcher believes that students acquire science facts better if they watch CSI than if they do not The researcher tested her idea by testing two groups of people, one that had watched CSI and one that had not The design is

A) One- shot case study
B) One group pre-test posttest design
C) Static group comparison
D) Randomized control group design

Appendix D. Fidelity Measure

What is your code? Fill in the boxes with the following information, in order

First two letters of your first name _____

First two letters of your last name _____

First two letters of the name of your street _____

Last three numbers of your phone number (your primary phone) _____

ID Code									

1. Please indicate how closely you adhered to the instructions given for the experimental condition to which you were assigned

Not at All	Slightly	Moderately	Mostly	Completely
0	1	2	3	4

2. Please indicate how closely you paid attention to the lecture

Not at All	Slightly	Moderately	Mostly	Completely
0	1	2	3	4

For the following statements, please indicate everything that you did with technologies during this lecture (Place a checkmark or X beside each statement that is true for you—you can check as many statements as are true)

3. □ I did not use any technologies throughout this lecture
4. □ I only used a word-processing application to take notes (e g Word/Word Perfect)
   *Estimated time of use_____minutes_*
5. □I only **received** text-messages but did not answer any
   Estimated number of messages received_____ number I read_____
6. □ I received and sent text-messages
   Estimated number both received and sent_____
7. □ I surfed the Internet for entertainment purposes
   Estimated amount of time I surfed the Internet for entertainment_____minutes
8. □ I played on-line games
   Estimated time of use_____minutes
9. □ I played other games from my application setting (ie Solitaire)
   Estimated time of use _____ minutes
10. □ I watched videos on YouTube
    Estimated time of use_____ minutes
11. □ I used MSN to communicate with my friends
    Estimated time of use_____ minutes
12. □ I used my Facebook to message my friends
    Estimated time of use _____minutes
13. □ I checked my own Facebook profile/ updated my wall
    Estimated time of use_____ minutes

14. □ I checked the Facebook profile of my friends/ others
Estimated time of use_____ minutes
15. □ I checked my email
Estimated time of use_____ minutes
16. □ I emailed my friends/others
Estimated time of use_____ minutes
17 □ I used the Word 97-2004 application to take notes on this lecture
Estimated time of use_____ minutes
18 □ I checked/ updated my WLU student account
Estimated time of use_____ minutes
19 □ I checked my class marks online
Estimated time of use_____ minutes
20 □ I checked my class schedule online
Estimated time of use_____ minutes
21 □ I dropped/added courses online
Estimated time of use_____ minutes
22 □ I checked my WLU financial account online
Estimated time of use_____ minutes
23 □ I checked a class syllabus for one or more of my courses
Estimated time of use_____ minutes
24 □ I checked my bank account
Estimated time of use_____ minutes
25 □ I searched for articles for an essay
Estimated time of use_____ minutes
26 □ I did other things using digital technologies during the lecture
Estimated time of use_____ minutes
*Please list*_____

Appendix E. Conversation Scripts for Multi-tasking Conditions for the Three Sessions

SESSION 1 SCRIPT TEXTING, EMAIL AND MSN CONDITIONS

1 RA I am an RA working on the multi-tasking study Hi!

Student Hi

2 RA What is your ID code?

Student Code
(if get only numbers prompt for following information 1 piece at a time,
a first two letters of first name
b first two letters of last name
c first two letters of street on which you live
d last 3 numbers of primary phone number)

3 RA We have scheduled make-up sessions in case you want to hear this lecture again OK?

Student Ok

4 RA So, would you like to book a make up time for this lecture material?

Student yes/no

- if "no" – then go directly to "continued conversation"
- If yes

5 RA These are the possible dates Today at 5 30, or Friday the 6th at 12pm Would you be free at any of these dates?

Student yes/no – (probably states which one they like best)

6 RA Actually we have 3-4 pm on Monday the 9th open also Would this be better for you?

Student Either wants the new date, or one of the old dates And will pick one

7 RA Okay so I'm going to book you for this day ____ OK?

Student Ok

8 RA It will be in room N2053 OK?

Student Ok

Continued Conversation

9 RA How are you liking this course so far?

Student It's hard/easy/okay

10 RA Oh I see Yeah I found it hard when I had to do it too

Student ____ (pause for 2 minutes)

11 RA (separate message) What is the hardest part about the course?

Student ____ (pause 2 minutes)

12 RA Did you do anything for Halloween?

Student yes/no (if no go to RA15)

13 RA What did you do?

Student _____

14 RA what did you dress up as?

Student ____

15 RA That's cool Did you see any other good ones?

Student _____

16 RA Do you have a lot of midterms coming up?

Student yes/no

If yes
17 RA Oh really, when?

Student ____

18 RA What class are they for?

Student _____

SESSION 2 SCRIPT TEXTING, EMAIL AND MSN CONDITIONS

1 RA I am an RA working on the multi-tasking study Hi!

Student Hi

2 RA What is your ID code?

Student Code
(if get only numbers prompt for following information 1 piece at a time,
a first two letters of first name
b first two letters of last name
c first two letters of street on which you live
d last 3 numbers of primary phone number)

3 RA We have scheduled make-up sessions in case you want to hear this lecture again OK?

Student Ok

4 RA So, would you like to book a make up time for this lecture material?

Student yes/no

- if "no" – then go directly to "continued conversation"
- If yes

5 RA These are the possible dates Wednesday the 11th at 1 30, or Thursday November 12th at 9 30am Would you be free at any of these dates?

Student yes/no – (probably states which one they like best)

6 RA Actually we have 5 30 on Thursday the 12th open also Would this be better for you?

Student Either wants the new date, or one of the old dates And will pick one

7 RA Okay so I'm going to book you for this day ____ OK?

Student Ok

8 RA It will be in room N2053 OK?

Student Ok

Continued Conversation

9 RA Classes are coming to an end soon, are you ready?

Student yes/no

10 RA Do you have many papers and tests?

Student ____ (pause for 2 minutes)

11 RA (separate message) Oh yeah? How many?

Student ____ (pause 2 minutes)

12 RA DO you have enough time to write them?/ study for them?

Student yes/no (if no go to RA15)

13 RA Can you ask for an extension?

Student yes/no

14 RA At least it will all soon be over Are you looking forward towards Christmas?

Student yes/no

15 RA Have you done your Christmas shopping yet?

Student yes/no

16 RA Do you have any good gifts ideas?

Student yes/no

If yes
17 RA Oh I like that Any other ideas?

Student ____

18 RA Do you know of any good deals?

Student _____

SESSION 3 SCRIPT TEXTING, EMAIL AND MSN CONDITIONS

1 RA I am an RA working on the multi-tasking study Hi!

Student Hi

2 RA What is your ID code?

Student Code
(if get only numbers prompt for following information 1 piece at a time,
a first two letters of first name
b first two letters of last name
c first two letters of street on which you live
d last 3 numbers of primary phone number)

3 RA We have scheduled make-up sessions in case you want to hear this lecture again OK?

Student Ok

4 RA So, would you like to book a make up time for this lecture material?

Student yes/no

- if "no" – then go directly to "continued conversation"
- If yes

5 RA These are the possible dates Monday the 16th at 3pm, or Thursday November 17th at 10 30am Would you be free at any of these dates?

Student yes/no – (probably states which one they like best)

6 RA Actually we have 1 30 on Wednesday the 18th open also Would this be better for you?

Student Either wants the new date, or one of the old dates And will pick one

7 RA Okay so I'm going to book you for this day ____ OK?

Student Ok

8 RA It will be in room N2053 OK?

Student Ok

Continued Conversation

9 RA How many classes do you have next semester?

Student _____

10 RA What are the classes
(pause for 2 minutes)

Student _____

11 RA (separate message) Do you think they are going to be easier than the classes from this Semester?

Student ____ (pause 2 minutes)

12 RA Why or why not?

Student _____

13 RA What discipline are you majoring in?

Student _____

14 RA That is cool, do you have a minor in mind as well?

Student _____

15 RA So what do you plan to do after you graduate, would you like to go to Master's?

Student _____

16 RA What would you like to do as a career?
Student _____

17 RA Oh I like that Is there any special reason why you chose this field?

Student ____

18 RA So if you decide later on that you are not interested in that, what else would you choose to do?

Student _____

Appendix F. Facebook Scavenger Hunts for the Three Sessions

SESSION 1 FACEBOOK SCANEVGER HUNT

ID Code (*NOT student ID*) _____
First two letter of your first name
First two letters of you last name
First two letters of the name of your street
Last three numbers of you phone number (should be the same # you wrote on the survey)

Facebook Scavenger Hunt Session 1

Log onto your Facebook account, and follow the instructions below in order Try to answer all questions

Please write the time that your started this scavenger hunt _____

Logging on

Open your web browser, and type in the webpage "Facebook com" Then click enter

Once on the Facebook site sign into your account by entering your email and password in the top right corner of the page (If you have Facebook)

If you don't have Facebook write this in the first box at the top right corner "laurierstudent@live ca"

Your password is "psychology"

Once on your own Facebook homepage, type in Petrice Gentile in the top right corner search box. Then click "enter". On this page look under the heading "people" and find Petrice Gentile's name. Click on it. This should bring you to Petrice Gentile's profile page.

1) At the top of the page under the name "Petrice Gentile" you will see a tab labelled "photos" Click on this Once on this page scroll down until you see "Petrice's Albums" Her third album is of a pet animal What animal is this (you don't have to click on it Stay on the same page)?

_____

2) Scroll up to the top of this page (the one with the albums) You should see a tab labelled "Info" Click on this Once on the "Info" page, look down at the section labelled "Personal Information" Then look at her favourite movies What is her favourite movie?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)

At the top right corner of the page you will see a search box. Click on this box and type in <u>Daniel Colangelo.</u> Then click "enter". On this page look under the heading "people" and find Daniel Colangelo's name. Click on it. This should bring you to Daniel Colangelo's profile page.

3) Look at the top left corner of his profile page You will see his profile picture Click on it What famous structure is he standing on in the last picture on the far right?

_____

4) Go back to his pain profile page At the top of his profile page under his name there is a tab labelled "photos" Click on it On this page you will see "Daniel's Albums" What topical location is his third album on?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)

At the top right corner of the page you will see a search box. Click on this box and type in <u>Aileen Coyle's</u>. Then click "enter". On this page look under the heading "people" and find Aileen Coyle's name. Click on it. This should bring you to Aileen Coyle's profile page.

5) At the top of her profile, under her name there are tabs There is a tab labelled "Info" Click on it Scroll down this page until you see the heading "Education and Work" Under "employer" it says who her employer is Who is Aileen's employer?

_____

6) Scroll back to the top of this page Beside the tab "Info" you will see a tab labelled "Photos" Click on this Once you are on this page, scroll down until you see "Aileen's Albums" Beside this there is a number indicating how many albums Aileen has How many albums does she have in total?

_____

(*What time is it right now _____*

(*What time is it right now _____*)

At the top right corner of the page you will see a search box. Click on this box and type in <u>Mimma De Pasquale</u>. Then click "enter". On this page look under the heading "people" and find Mimma De Pasquale's name. Click on it. This should bring you to her profile page.

7) Look at the top left corner of her profile page You should see her "profile picture" Click on this picture You will now be sent to a new page with more pictures What is the 3rd picture in the top row of?

_____

8) To answer this question you need to go to Mimma's profile page On the top left corner of this page there is a link called "Mimma's profile" Click on this to go back to her main page On her main profile page, what quote does she have under her picture?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)

At the top right corner of the page you will see a search box. Click on this box and type in <u>Matt Joyce.</u> Then click "enter". On this page look under the heading "people" and find Matt Joyce's name. Click on it. You should now be on his profile page.

9) Once on his profile page, scroll down to the very bottom On the left hand side of the page you will see a football helmet and above it a name of a football team What is this football team called?

_____

10) Scroll back to the top of this page Under his name you will see a tab labelled "Info" Click on it On this page you will see a heading labelled "Basic Information" Under this heading you will see the label "hometown" What is Matt's hometown?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)

At the top right corner of the page you will see a search box. Click on this box and type in <u>Cassandra Burns.</u> Then click "enter". On this page look under the heading "people" and find Cassandra Burns' name. Click on it. You should now be on her profile page.

11) You should now be on her profile page Look under her profile picture until you see the heading "Information" Under this heading you will find her birthday What is it?

_____

12) Stay on the same page Now click on her profile picture You should now be on a new page with more pictures of Cassandra Look at the last picture in the top row Two of her friends are wearing hats What color are they?

_____

(*What time is it right now _____*)

SESSION 2 FACEBOOK SCANEVGER HUNT

ID Code (***NOT*** *student ID*) _____
First two letter of your first name ___
First two letters of you last name ____
First two letters of the name of your street ___
Last three numbers of you phone number (should be the same # you wrote on the survey)
____

Facebook Scavenger Hunt Session 2

Log onto your Facebook account, and follow the instructions below in order Try to answer all questions

Please write the time that your started this scavenger hunt _____

Logging on

Open your web browser, and type in the webpage "Facebook com" Then click enter
Once on the Facebook site sign into your own personal account by entering your email and password in the top right corner of the page (If you have Facebook)
If you don't have Facebook write this in the first box at the top right corner "laurierstudent@live ca"
Your password is "psychology"

Once on your own Facebook homepage, type in Petrice Gentile in the top right corner search box. Then click "enter". On this page look under the heading "people" and find Petrice Gentile's name. Click on it. This should bring you to Petrice Gentile's profile page.

1) At the top of the page under the name "Petrice Gentile" you will see a tab labelled "Info" Click on this Once on this page scroll down until you see "Education and Work" What high school did Petrice go to?

_____

2) Scroll up to the top of this page Click on Petrice's profile picture This should take you to a screen with more photos of Petrice Look at the fifth picture from the top left What is she standing in front of in this picture?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in <u>Daniel Colangelo.</u> Then click "enter". You can refine your search by scrolling down to "all people results" clicking on it. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". You should now see Daniel Colangelo from Laurier on you page. Click on it. This should bring you to Daniel Colangelo's profile page.

3) At the top of the page under the name "Daniel Colangelo" you will see a tab labelled "Info" Click on this Once on this page scroll down until you see "Education and Work" What college did Daniel go to for his undergrad?

_____

4) Stay on the same page At the top of his profile page under his name there is a tab labelled "photos" Click on it On this page you will see "Daniel's Albums" What sport does he have an album on?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in <u>Aileen Coyle's</u>. Then click "enter". You can refine your search by scrolling down to "all people results" clicking on it. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". You should now see Aileen Coyle from Laurier. Click on it. This should bring you to Aileen Coyle's profile page.

5) At the top of her profile, there is Aileen's profile picture Click on it You should now see more pictures of Aileen Look at the third picture in the second row What is Aileen leaning against?

_____

6) Stay on the same page with all the photos Look at the 3rd row of pictures from the top What are Aileen and her friend standing in front of, in the 2nd picture from the left? (Remember this is on the third row from the top)

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in Mimma De Pasquale. Click the link "people" on the left side of the page. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". On this page you should see Mimma De Pasquale from Laurier. Click on her name.. This should bring you to her profile page.

7) Look at the top left corner of her profile page You should see her "profile picture" Click on this picture You will now be sent to a new page with more pictures Look at the last picture in the top row What is this a picture of?

_____

8) Stay on the same page with all the pictures Look at the last picture in the second row What is it an image of?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in Matt Joyce. Then click "enter". Click the link "people" on the left side of the page. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". On this page look click on Matt Joyce's name from Laurier. You should now be on his profile page.

9) Under his name you will see a tab labelled "Info" Click on it On this page you will see a heading labelled "Education and Work" Under this heading you will see the label "college" What program is Matt in?

_____

10) Scroll back to the top of the page Click on Matt's profile picture This should bring you to a page with more pictures What is the image on the second picture from the left?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)

At the top right corner of the page you will see a search box. Click on this box and type in <u>Cassandra Burns.</u> Then click "enter". Now click on the link "people" on the left hand side of the page. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". On this page you should see Cassandra Burns from Laurier. Click on her name.. You should now be on her profile page.

11) Now click on her profile picture You should now be on a new page with more pictures of Cassandra Look at the <u>second row</u> of pictures from the top Now look at the 4th picture from the left What are Cassandra and her two friends standing in?

_____

12) Stay on the same page with all the pictures What is Cassandra holding in the 1st picture in the second row?

_____

(*What time is it right now _____*)

SESSION 3 FACEBOOK SCANEVGER HUNT

ID Code (***NOT*** *student ID*) _____
First two letter of your first name ___
First two letters of you last name ____
First two letters of the name of your street ___
Last three numbers of you phone number (should be the same # you wrote on the survey)
____

Facebook Scavenger Hunt Session 3

Log onto your Facebook account, and follow the instructions below in order Try to answer all questions

Please write the time that your started this scavenger hunt _____

Logging on

Open your web browser, and type in the webpage "Facebook com" Then click enter

Once on the Facebook site sign into your own personal account by entering your email and password in the top right corner of the page (If you have Facebook)

If you don't have Facebook write this in the first box at the top right corner "laurierstudent@live ca"

Your password is "psychology"

Once on your own Facebook homepage, type in Petrice Gentile in the top right corner search box. Then click "enter". On this page look under the heading "people" and find Petrice Gentile's name. Click on it. This should bring you to Petrice Gentile's profile page.

1) Scroll up to the top of this page Click on Petrice's profile picture This should take you to a screen with more photos of Petrice Who is Petrice impersonating in the 4th picture from the top left?

_____

2) Look above the last photo in the first row You will see the word "next" Click on it You should now be on another page with pictures Look at the first photo in the second row What is Petrice sitting in front of?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in Daniel Colangelo. Then click "enter". You can refine your search by scrolling down to "all people results" clicking on it. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". You should now see Daniel Colangelo from Laurier on you page. Click on it. This should bring you to Daniel Colangelo's profile page.

2) At the top of the page under the name "Daniel Colangelo" you will see a tab labelled "Photos" Click on this On this page you will see "Daniel's Albums" Click on his ball hockey album Now click on the picture How many hockey players are on this team?

_____

3) Above the photo there is a link that says "Daniel's profile" Click on it Look at Daniel's profile picture What is he doing with his left hand?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in Aileen Coyle's. Then click "enter". You can refine your search by scrolling down to "all people results" clicking on it. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". You should now see Aileen Coyle from Laurier. Click on it. This should bring you to Aileen Coyle's profile page.

4) At the top of her profile, there is Aileen's profile picture Click on it You should now see more pictures of Aileen Look above the last picture in the top row You will see numbers (1, 2, 3, 4) Click on number "3" This will bring you to a new page of pictures Look at the 3rd row of pictures from the top Look at the 2nd picture in this third row What color liquid is in the two pitchers? (hint you should list 2 different colors)

_____

4) Look again at the numbers above the last picture in the top row Click on number "4" You should now be on another page with pictures What are the three girls holding in the 4th picture from the left in the top row?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in Mimma De Pasquale. Click the link "people" on the left side of the page. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". On this page you should see Mimma De Pasquale from Laurier. Click on her name.. This should bring you to her profile page.

5) Look at the top left corner of her profile page You should see her "profile picture" Click on this picture You will now be sent to a new page with more pictures Look above the last picture in the top row Click on "next" What is on Mimma's face in the last picture in the 3rd row?

_____

6) Stay on the same page Look at the 2nd picture in the first row What is Mimma sitting in?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)
At the top right corner of the page you will see a search box. Click on this box and type in Matt Joyce. Then click "enter". Click the link "people" on the left side of the page. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". On this page look click on Matt Joyce's name from Laurier. You should now be on his profile page.

7) Look under Matt's profile picture Click on the link that says "view photos of Matt" You should now be on a page with more pictures Click on the number '2' above the last picture in the first row (to bring you to the next page of pictures) Scroll down to the 1st picture in the last row What famous building is Matt standing in front of?

_____

8) Stay on the same page What is matt sitting on in the last picture?

_____

(*What time is it right now _____*)

(*What time is it right now _____*)

At the top right corner of the page you will see a search box. Click on this box and type in <u>Cassandra Burns.</u> Then click "enter". Now click on the link "people" on the left hand side of the page. Then go to "Filter" and type in "Wilfrid Laurier" in the "school" box. Then click "refine search". On this page you should see Cassandra Burns from Laurier. Click on her name.. You should now be on her profile page.

9) Now click on her profile picture You should now be on a new page with more pictures of Cassandra Look at the last picture in the second row What color t-shirts are the two girls wearing?

_____

10) Stay on the same page with all the pictures How many people are in the last picture?

_____

(*What time is it right now _____*)

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