5-24-2013

Investigating the Effects of Multitasking with Technology

Mehruz Kamal
The College at Brockport State University of New York, mkamal@brockport.edu

Gerardo Silva
The College at Brockport State University of New York, gsilv1@brockport.edu

Investigating the Effects of Multitasking with Technology

Mehruz Kamal
The College at Brockport
State University of New York
mkamal@brockport.edu

Gerardo Silva
The College at Brockport
State University of New York
gsilv1@brockport.edu

ABSTRACT

In today's digital world 'multitasking' has become a norm with all of us - especially college students across the world. Students in classes are seen to be checking their email, logging onto social network sites, playing online games, sending text messages, and "listening" to the in-class lectures. How effective are they at simultaneously managing all these activities? Is this hindering their ability to do their job well? The goal of this research was to investigate factors that impact multitasking with a focus on how information technology impacts this concept. Extant research regarding multitasking in the Information Systems and Psychology disciplines were reviewed and subsequently led to the development of a conceptual model outlining the factors influencing people and the effects produced when they multitask with information technology.

Keywords

Information technology, Multitasking, Information systems.

INTRODUCTION

In today's digital world 'multi-tasking', i.e., doing more than one thing at a time has become a norm with all of us and especially college-level students across the world. Students in classes are seen to be checking their email, logging onto social network sites, playing online games, etc. At the same time, they are also seen to be sending text messages on their hand-held devices, and "listening" to the in-class lectures. How effective are they at simultaneously managing all these activities? Is this really multi-tasking, are we really increasing efficiency? Or is this hindering our ability to do our job well? Is it changing our thinking, shortening our attention span? Many such questions arise and there are no simple answers.

Psychologists are of the opinion that it is not possible for the brain to focus on more than one activity at a time to be most effective and to perform at the person's full capability. There has been some preliminary research on the topic that shows that a person's effectiveness and productivity falls as they multi-task. We hope to extend such findings by studying and analyzing various real-world situations and in particular assessing student performance under such environments. The research will also investigate cognitive loads of students as it relates to differing user interfaces of a number of different technologies that are used by students within a multi-tasking environment. Findings from conducting such research projects will enable researchers to identify technology user interface factors that may impact multi-tasking.

Subsequently, this preliminary research project will be the first phase of addressing the above issues. At this firs stage, we reviewed relevant scholarly papers from the Information Systems field as well as from the Psychology discipline to build a repository of knowledge regarding this topic. The extensive review of extant literature regarding this topic is an instrumental step in helping us discover the challenges, benefits, and factors relating to multitasking with Information technology. We begin by first integrating the various definitions of the concept of multitasking and then move onto developing a conceptual model that integrates the factors influencing people as well as the effects produced when people multitask with technology.

DEFINING MULTITASKING

Over the years, numerous researchers have come up with their own definitions of multitasking. Burgess (2000) mentions that multitasking is the "ability to perform concurrent tasks by interleaving" which requires prioritization and planning skills, as well as remembering and/or recalling to be successful after he learned about Jerry Linenger, a US astronaut, and his experiences on his space station (Burgess, 2000). Other authors agree with Burgess, suggesting multitasking as the ability to handle multiple tasks by interleaving, task switching, or shifting attention (Bell, Compeau & Olivera, 2005; Spink, Park & Cole, 2006; Law, Logie & Pearson, 2006; Judd & Kennedy, 2011; Jez, 2011; Junco & Cotten, 2012; Adler, Benbunan-Fich, 2012). Another definition commonly seen across literature is that multitasking is the ability to perform or combine two or more tasks simultaneously or in parallel (Kenyon & Lyons, 2007; Rosen, 2008; Kirschner & Karpinski, 2010).

Sometimes technology is involved or preferred (Jeong & Fishbein, 2007; Rosen, 2008; Ophir, Nass & Wagner, 2009). As Jez (2011) observed, definitions mostly are divided between parallel or sequential processing of tasks (Jez, 2011). Other authors have come up with specific terms of multitasking. Spink, Ozmutlu & Ozmutlu (2002) came up with the term *multitasking information seeking and searching processes.* Spink, Park & Cole (2006) later updated the term to *multitasking information behavior* and defined it as the process of seeking multiple pieces of information concurrently in relation to a particular topic, or multiple related or unrelated topics (Spink, Ozmutlu & Ozmutlu, 2002; Spink, Park & Cole, 2006). They mention this behavior can occur when searching for information on the web, encyclopedias and/or databases.

Kenyon & Lyons (2007) mention natural multitasking and time driven multitasking. Natural multitasking are the types of tasks that can occur simultaneously without any noticeable change in performance such as driving a car while listening to music. Time driven multitasking involves task switching which can be triggered by deadlines or time pressure (Kenyon & Lyons; 2007). Kenyon & Lyons (2007) also stressed the need of each task to be physically close to each other. This need is slowly being erased with the aid of the internet. For our research, we have attempted to combine the definitions into one. We define multitasking as performing multiple interleaving, and/or parallel tasks driven by time pressure. The following section discusses factors impacting multitasking.

FACTORS IMPACTING MULTITASKING

The impact of multitasking is yet to be clear. There have been multiple studies that have investigated some of the positive and negative effects of multitasking across different fields.

In the field of education, Hembrooke & Gay (2003) performed a study on university students taking a lecture while using their laptops. Although the class they studied was able to use their laptops (as necessary) throughout the semester, for their purpose they divided the class into two for two lecture sessions. One group was allowed to use their laptops, while the other group did not. Students who were allowed to use their laptops during the lectures received lower scores on post-lecture examinations than participants that were not allowed to use their laptops. But, although specifically to their study, students who multitasked, received lower scores, end of semester results show multitasking can be effective. At the end of the semester, the class average was a B+ (Hembrooke & Gay, 2003). Researchers have attempted to understand which type of technologies can be successfully multitasked with schoolwork. Laptops, email, search engines, databases, and music have been considered beneficial for education since they promote good academic practices, or do not lower performance significantly (Jeong & Fishbein, 2007; Hammer et al., 2010; Junco & Cotten, 2012; Wood et al., 2012). Libraries have made efforts of integrating gaming and social networking sites in an attempt to engage students into learning (Hill, 2010). In other cases, surveys and experimental studies have been given to students which link low testing scores, longer completion times, sleep deprivation, and low studying time to multitasking schoolwork with technologies such as Facebook, instant messaging TV, computers, and texting (Rosen, 2008; Calamaro, Mason & Ratcliffe, 2009; Junco & Cotten, 2011; Junco & Cotten, 2012; Wood et al., 2012, Jeong & Fishbein, 2007; Kirschner & Karpinski, 2010). Undergraduates of a mean age of 22 and Graduate students with a mean age of 30, who were Facebook users, reported lower scores and lower studying times than non-users (Kirschner & Karpinski, 2010).

In the transportation field, the effects of utilizing technology while driving have been researched as well. Kenyon & Lyons (2007) suggest that using technology for travel leads to time well spent. Using the GPS while driving might minimize the number of wrong turns taken during a trip. The environment benefits from less gas emissions. Drivers can benefit as well - shorter trips result in less gas consumption (which saves money) and more time to enjoy other activities. Driving simulators and real time video/audio recordings have aided in the analysis of cell phone usage effects while driving. The effects seem to not have been completely understood. In a driving simulation study by Brumby, Salvucci & Howes (2007) participants were required to drive while concentrating most of their efforts into a primary task (dialing, or steering) at two different constant speeds of 35mph and 55mph (Brumby, Salvucci & Howes, 2007). When driving at lower speeds, performance did not deteriorate for any of the two tasks. At 55mph, they noticed driving accuracy was affected only when the primary task was to concentrate on dialing the cell phone. In 2010, an article by Kirschner & Karpinski was published which summarized the works of Austin (2009), Strayer, Drews and Crouch (2006), and Strayer et al. (2006). Reading and sending text messages resulted in slower reaction times similar to drinking and driving (Kirschner & Karpinski, 2010). Hands free devices did not make a difference (Kirschner & Karpinski, 2010). Junco & Cotten's (2012) publication mentions Strayer & Drews (2004) study in which they claim hands free devices cause more interruptions than riding with a passenger (Junco & Cotten, 2012) In fact, in 2010, Watson & Strayer showed that only a small percentage can successfully multitask while driving. The term they use to describe these individuals is "supertaskers" (Watson & Strayer, 2010).

In the workplace it has been noted that multitasking increases productivity and revenue although it lowers performance rates (Freedman, 2007; Bannister & Remenyi, 2009; Jez, 2011). Some researchers have mentioned that, for some tasks, the

negative effects can be minimized through practice (Law, Logie & Pearson, 2006; Rosen, 2008). Law, Logie & Pearson (2006) performed a study on psychology undergraduate students. The ages ranged from 18 to 26. The participants performed single and dual task assignments on virtual environments. The order in which they performed the single or dual tasks was random. They noticed that participants, who were able to perform the single task assignment first, were able to perform better on the dual task assignment (Law, Logie & Pearson, 2006). On two other occasions, research has found that practice does not increase performance. On both of these occasions, an increase in performance was seen on the second trial of the study but then decreased after the following trials (Neth, Khemlani, Opperman & Gray, 2006; Wood et al., 2012). Neth, Khemlani, Opperman & Gray (2006) wanted to demonstrate that with practice, maximum levels of multitasking can be achieved. They noticed that participants raised their performance on the second trial of their test but performance deteriorated on the third trial. Human results were mediocre when compared against an average computer agent (Neth, Khemlani, Opperman & Gray, 2006). Wood et al. (2012) also studied students, of a mean age of 20, to understand the effects of practice on school performance when multitasking with technologies such as Facebook and MSN. On a set of three trials, students only demonstrated an improvement on the second, while the first and third trial were similar (Wood et al., 2012).

In general, it has been mentioned that multitasking lowers IQ, gives symptoms similar to ADD, raises stress levels, slows down performance, and increases mistakes and fatigue (Freedman, 2007; Rosen, 2008; Bannister & Remenyi, 2009). Multitasking seems to impact accuracy negatively as the level of multitasking increases (Ophir, Nass & Wagner, 2009; Adler & Benbunan-Fich, 2012). Adler & Benbunan-Fich (2012) discovered that although accuracy diminished as the level of multitasking increased, productivity was the greatest at medium levels of multitasking. Finally, Carrier et al. (2009) provided a questionnaire to participants of three different generations (baby boomers (1946-1964), Generation X (1965-1979) and net generation (1980- present) to discover their behaviors. They concluded that multitasking grew across generations. Net generation reported highest multitasking occurrences. They also noticed a slight difference in difficulty perception (Carrier, Cheever, Rosen, Benitez & Chang, 2009). Baby boomers perceived multitasking as being more difficult than the net generation (Carrier, Cheever, Rosen, Benitez & Chang, 2009). A 2005 publication from Kushleyeva, Salvucci, and Lee performed a dual task study to understand when participants switched tasks. They noticed that university students switched tasks when they perceived the task was going to get more difficult or right after the task increased difficulty (Kushleyeva, Salvucci & Lee, 2005).

It is evident from the above studies that there is no consistency in the findings of factors and effects of multitasking. In trying to make sense of the conflicting results, we have categorized the findings into meaningful groups. This is outlined in table 1 below.

Factors	Publications
Technology Tools	Hembrooke & Gay (2003); Jeong & Fishbein (2007); Hammer et al. (2010); Junco & Cotten (2012); Wood et al. (2012); Rosen (2008); Calamaro, Mason & Ratcliffe (2009); Junco & Cotton (2011); Kirschner & Karpinski (2010); Kenyon & Lyons (2007); Brumby, Salvucci & Howes (2007); Watson & Strayer (2010); Haddington & Rauniomma (2011)
Number of tasks	Ophir, Nass & Wagner (2009); Adler & Benbunan-Fich (2012)
Age	Carrier, Cheever, Rosen, Benitez & Chang, (2009);
Related/Unrelated tasks	Wood et al. (2012)
Task Difficulty	Kushleyeva, Salvucci & Lee (2005)
Practice/Repeated tasks	Law, Logie & Pearson, (2006); Rosen (2008); Neth, Khemlani, Opperman & Gray (2006); Wood et al. (2012)
Perception	Carrier, Cheever, Rosen, Benitez & Chang, (2009); Hammer et al. (2010);
Free will/Forced	Wood et al. (2012); Hill, (2010); Hammer et al. (2010)
Individual/Groups	Haddington & Rauniomma (2011)

Table 1. Factors impacting Multitasking

CONCEPTUAL MODEL OF MULTITASKING

Jez (2011) pointed out that multitasking has been considered as interruptions but also as a necessary skill for the future. Subsequently, the insights gained from our analysis of extant literature enabled the development of a conceptual model of

multitasking shown in figure 1 below. We have integrated the factors from table 1 into a comprehensive model that will allow us to evaluate the effects of multitasking from a high level perspective.

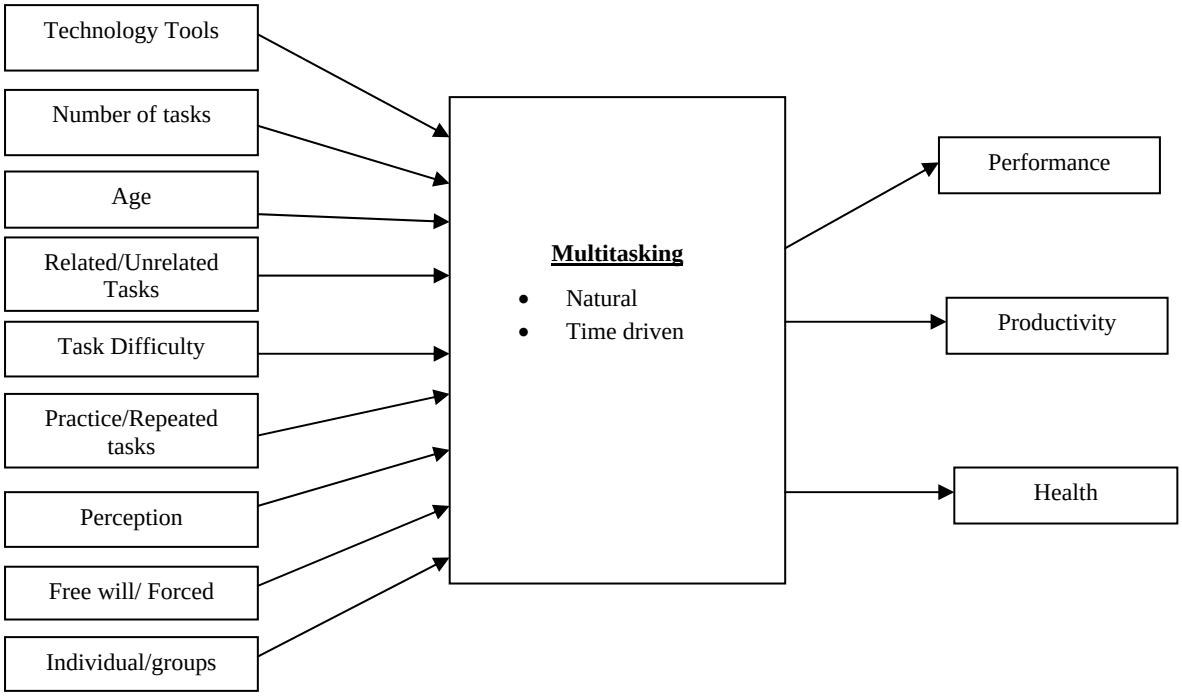

Figure 1. Conceptual model of Multitasking

The model integrates our findings from past literature by outlining the factors impacting multitasking – be it the specific use of a tool such as cell phone, or software applications such as online social networking sites; the number of tasks the person is involved in at any given time; whether the tasks are related or not; how complex or difficult the individual task may be; whether the same set of tasks were repeated or not; whether the person perceived they would be able to multitask successfully or not; whether participants were being forced to multitask or not; and finally whether the multitasking activities were being carried out by an individual or in a group setting. Each of these issues were either conducted in a natural setting, implying carrying out simultaneous tasks that were classified as being second nature to the participants. Or in settings that had controlled time limits during which all tasks needed to be completed. Results from these studies have either had outcomes in terms of improved or degraded performance, more or less productivity, or health issues.

CONCLUSION

The goal of this research was to investigate factors that impact multitasking with a focus on how information technology tools impact this concept. Extant research regarding multitasking in the Information Systems and Psychology disciplines were reviewed and subsequently led to the development of a conceptual model outlining the factors influencing people and the effects produced when they multitask with information technology. Future studies will use the conceptual model to derive propositions that we hope to investigate further. We believe findings will have implications for both academics and practitioners. For academics, it will help to shed light on how multitasking with technology can be effectively used within learning environments. And on the other hand, for Information Systems practitioners, it will help to guide better information technology applications and tools design.

REFERENCES

1. Adler, Rachel F., Raquel Benbunan-Fich. (2012). ”Juggling on a high wire: Multitasking effects on performance”, International Journal of Human Computer Studies, 70, 156-168

2. Bell, Caroline S., Deborah R. Compeau, and Fernando Olivera. (2005). "Understanding the Social Implications of Technological Multitasking: A Conceptual Model". HCI Research in MIS, 80-84.
3. Brumby, Duncan P., Dario D. Salvucci, and Andrew Howes (2007). "An Empirical Investigation into Dual-Task Trade-offs while Driving and Dialing". Proceedings of the 21st BCS HCI Group Conference, HCI.
4. Burgess, Paul W. (2000)."Real-World Multitasking from a Cognitive Neuroscience Perspective". Attention and Performance, 18, 465-472
5. Calamaro, Christina J., Thornton B. A. Mason, and Sarah J. Ratcliffe. (2009). "Adolescents Living the 24/7 Lifestyle: Effects of Caffeine and Technology on Sleep Duration and Daytime Functioning", Pediatrics.
6. Freedman, David H. (2007). "Taskus Interruptus: Why Interruption, distraction and multitasking are not such awful things after all", INC., 67-69
7. Haddington, Pentti, Mirka Rauniomma. (2011). "Technologies, Multitasking, and Driving: Attending to and Preparing for a Mobile Phone Conversation in a Car", Human Communication Research, 37, 223-254
8. Hammer, Ronen, Miki Ronen, Amit Sharon, Tali Lankry, Yoni Huberman, and Victoria Zamtsov (2010). "Mobile Culture in College Lectures: Instructors' and Students' Perspectives", Interdisciplinary Journal of E-Learning and Learning Objects, 6, 293-304
9. Hembrooke, Helene, and Geri Gay (Fall 2003). "The Laptop and the Lecture: The Effects of Multitasking in Learning Environments", Journal of Computing in Higher Education, 15(1).
10. Hill, Rebecca (June 2010). "The World of Multitasking Teens: How Library Programming is Changing to Meet these needs ", Young Adult Library Services, 8(4), 33-37
11. Jeong, Se-Hoon, and Martin Fishbeing (2007). "Predictors of Multitasking with Media: Media Factors and Audience Factors". Media Psychology, 10, 364-384.
12. Judd, Terry, and Gregor Kennedy (2011). "Measurement and evidence of computer-based task switching by 'Net Generation' students", Computers & Education, 56, 625-631
13. Junco, Reynol, Sheila R. Cotten. (2012). "Perceived academic effects", Computers & Education, 56, 370-378
14. Kenyon, Susan, and Glenn Lyons (2007). "Introducing multitasking to the study of travel and ICT: Examining its extent and assessing its potential importance". Transportation Research Part A, 41, 161-175.
15. Kirschner, Paul A., Aryn C. Karpinski. (2010). "Facebook and academic performance", Computers in Human Behavior, 26, 1237-1245
16. Law, Anna S., Robert H. Logie, David G. Pearson. (2006). "The impact of secondary voluntary tasks on multitasking in a virtual environment". Acta Psychologica, 122, 27-44.
17. Neth, H., Sangeet S. Khemlani, Brittney Opperman, and Wayne D. Gray. (2006). "Juggling multiple tasks: a rational analysis of multitasking in a synthetic task environment". Proceedings of the 50th the annual meeting of the Human Factors and Ergonomics Society.
18. Ophir, Eyal, Clifford Nass, and Anthony D. Wagner. (2009). "Cognitive control in media multitaskers", Proceedings of the National Academy of Sciences of the United States of America.
19. Rosen, Christine (2008). "The Myth of Multitasking", The New Atlantis, 105-110
20. Salvucci, Dario D. (2005). "A multitasking General Executive for Compound Tasks". Cognitive Science, 29, 457-492.
21. Spink, Amanda, H. Cenk Ozmutlu, and Seda Ozmutlu (Jan 2002). "Multitasking Information Seeking and Searching Processes". Journal Of The American Society For Information Science And Technology, 53(8), 639-652.
22. Truemper, Jacob M., Hong Sheng, Michael G. Hilgers, Richard H. Hall, Morris Kalliny, Basanta Tandon (2008). "Usability in Multiple Monitor Displays". The Database for Advances In Information Systems, 39(4), 74-89.
23. Watson, Jason M., David L. Strayer (2010). "Supertaskers: Profiles in extraordinary multitasking ability", Psychonomic Bulletin & Review, 17(4), 479-485
24. Wood, Eileen, Lucia Zivcakova, Petrice Gentile, Karin Archer, Domenica De Pasquale, and Amanda Nosko (2012). "Examining the impact of off-task multi-tasking with technology on real-time classroom learning", Computers & Education, 58, 365-374