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ABSTRACT

The presence of multitasking has become more and more prevalent in most if not all aspects of today's society. This reoccurring display of multitasking is extremely prominent within the classrooms of our nation's colleges and universities. While supposedly paying attention to lectures and taking efficient notes, students can be seen texting and using social media on their phones, or having a wide variety of possible tabs and windows pulled up on their laptops or tablets. This apparent habit of almost every higher-education level student has raised a multitude of questions in various fields of study over the years. It has also provided professors with yet another obstacle that they must overcome to effectively teach their students. In this study, we explore these issues and develop an extensive conceptual model outlining the factors that may impact multitasking with technology in academic settings.

Keywords

Technology, multitasking, academia, information systems, learning

INTRODUCTION

In our current modern "high-tech" world, people can do everything on their phone, laptop, or tablet. Multitasking while using electronics gradually has become a central part of our daily life. People can be seen paying bills while watching a movie, checking their email while driving, shopping online while cooking, making appointments while walking, and doing homework while chatting with friends on online social networks. Multitasking has become more and more tightly integrated into our lives - people subconsciously assume that we have the ability to do more than one thing at a time. People also believe that connecting with technology helps their lives become richer and simpler. However a previous study found that multitasking affects a person's effectiveness and productivity (Kamal & Silva, 2013).The field of psychology has provided a significant number of studies dealing with multitasking, its possible causes, and the effects it has on the people doing it, mainly students. A common theory that repeatedly shows up in psychological studies on multitasking is that 'true multitasking' is impossible. This theory comes from the basis that, according to psychologists, the brain is unable to focus on more than one thing or activity at the same time. According to them, what is actually happening is that our brains are rapidly switching back and forth between the various tasks that a person may be performing, and this rapid switching happens so fast that it just seems like you are doing everything simultaneously (Judd & Kennedy, 2011; Jez, 2011).

Another field that has provided a rather large number of studies on multitasking is the broad field of education. These studies dealt mainly with the academic consequences that students face as a result of multitasking, and the effects it has on professors' teaching methods and styles. There are some cases and studies where professors across the country seem to think that they have successfully developed a solution or multiple solutions to overcome this ever-trending obstacle of multitasking. Studies on multitasking are becoming more prevalent in the field of technology and information systems. These studies mainly look at how technologies and software are playing a factor into the whole multitasking epidemic.

In the college classroom, it is very common to see students checking their email, texting, tweeting, or playing games while listening to the professor. Some students take notes on their laptops, while others may research the information being taught if it remains unclear (as opposed to simply asking the professor for more information). However, the question then arises as to how does this sort of multitasking affect their learning? Do students realize that these sorts of activities are distracting them and decreasing their learning efficiency? How much negative influence does multitasking have on learning? Scientists believe that multitasking is much more complex than most people believe. It may be possible for our brains to process more than two general things at once, such as visual information, acting audition, or auditory information. However, when the brain needs to

process information, such as when one is attempting to arrive at a conclusion, witness creativity, or produce language, it is not possible to attend to two tasks at the same time. According to Terry Doyle, "Our brain works hard to fool us into thinking it can process information from more than one source at a time. It cannot. " (Doyle & Zakrajsek, 2013). In his research, Doyle indicates that our brain will shut down one task in order to complete the other task. Learning is a complex process - it involves listening, reading, reacting, and comprehension abilities. It then appears that learning efficiency may be impacted as the number of tasks that an individual has to carry out simultaneously increases. This research study explores these issues further by building on a previous study carried out which investigated the factors that impact multitasking with a focus on how technologies impact the overall concept of multitasking. The previous study investigated the general impact of multitasking in various fields of context such as education, transportation, and the workplace (Kamal & Silva 2013). In this current study, however, we are focusing solely on the higher-lever academic context by exploring factors (both causal and resultant impact) of multitasking. Although our primary focus is on technology multitasking in academic settings, we have intentionally attempted to be more broad and comprehensive in our research exploration by investigating relevant extant studies that draw on non-technology factors that may impact multitasking in the same context as well. Therefore our research question for this study is two-fold: *What are the factors that cause, and, are impacted by multitasking in academic settings? What role does technology-based factors have to play in the same context?* The next section outlines relevant extant research on this topic and then is followed by our integration of the factors identified from past research into a comprehensive conceptual model of multitasking in academic settings.

MULTITASKING IN ACADEMIC SETTINGS

Among the various papers related to the topic at hand, many seem to agree that multitasking can adequately affect an individual's ability to retain information and learn effectively in an educational environment. Various researchers have attempted to set up experiments that could identify the possible causes of these lapses in information retainment and while many have found some predominant factors, results are skewed across the board due to the sheer amount of variables present. One such study attempted to test their theory by administering an activity to two different class sections, one being given near the end of the class and another during the beginning. This tested whether students were actively engaged throughout the class or simply at the beginning (Rekart 2011). Extant research has also shed light on the fact of emotional needs and how they affect our multitasking behaviors. The need for social support or emotional support during other tasks, or simply a belief in one's ability to multitask also plays a powerful role on their decision to multitask during the primary task (Wang & Tchernev 2012).

Role of Technology in Multitasking

Various researchers have tended to focus on variables such as devices around the student or distractions that would cause a lack of information retention (Sana, Weston & Capeda 2013). Student motivation seems to be another prominent factor when choosing to multitask. It is noted that when students tend to get bored during lecture, it leads to the use of laptops or mobile devices (dependent on availability) to provide ample distraction (Hammer, Ronen, Sharon, Lankry, Huberman & Zamstov 2010). Hembrooke and Gay studied whether or not the length of the distraction had any impact on the student's retention in one of their papers which lead to the result that the amount of time spent on the opposing task directly correlated with how "distracted" the individual was on the focused material (Hembrooke & Gay 2003). They also conducted another study on the use of laptops with their university students, allowing one of the two sections to utilize laptops while the other was barred from it. In result, the section with their laptops received lower grades than the latter (Hembrooke & Gay 2003). A more recent study by Ophir, Nass, and Wagner (2009) also looked at information retention by heavy multitaskers. The study by the group proved that multitasking individuals have a more difficult time retaining information and filtering out unnecessary data due to their multitasking behaviors. We can also see some other effects that are related to multitasking which involves the quality of the work produced when multitasking is present in certain scenarios (Judd & Kennedy 2011). To further cement Hembrooke and Gay's argument, Conrad and Marsh also found during their research that interruption complexity, the similarity of the interruption, and control over the interruption play a major role on the impact the distraction has (Conrad and Marsh 2014). Another study was conducted within a 75 minute class following students who had their laptops open. Between taking notes and interactions on social media, the students spent around 34 minutes of the 75 multitasking. On average, the students with the laptops spent 27 minutes sending or receiving emails (D'Agostino 2010). A similar study found that within another 75 minute class period experiment, multitasking with an off topic nature was heavily existent as well. Of the 137 individuals, 64.3% stated they used their laptops in at least one class period. During that time, the users who reported multitasking did this for approximately 17 of the 75 minutes, mostly spending their time either checking e-mail, instant messaging or surfing the web (Fried 2008). Some other interesting thoughts explored were the differences between task switching and multitasking, how each affects the individual differently. It was found that task switching is actually becoming increasingly more existent than

multitasking itself (Judd 2014). Another particular study by a group of researchers following the Cognitive Load Theory (CLT) found that during a study in which two groups of individuals were given a passage to read while the other was given a passage and a video to watch simultaneously, the group who read only performed significantly better than the other group. No difference in comprehension existed but the former group scored better than the latter. The performance of the main task at hand was affected when the second task required a higher level of cognitive load than just basic attention. This in turn showed that multitasking has a negative effect on the retention of information (Lee, Lin & Robertson 2012). To affirm this finding, Sana, Weston and Cepeda conducted a study with students using laptops to see if it would hinder their performance on a comprehensive exam. What was found was that if an individual performs multiple tasks alongside the learning target task, comprehension is affected. Those in view of the individuals utilizing technology were also affected by their peers who were multitasking around them. The degree at which the attention is shifted plays a major factor in the comprehension of the material and they even noted the individuals multitasking were "aware' that it could hinder their knowledge acquisition. What was also interesting was that they did not believe their peers would be affected or wouldn't be noticeably distracted by their actions (Sana, Weston & Capeda 2013). In table 1 below, the various factors that serve as the primary driver or trigger for multitasking in academic settings are provided.

Triggering Factors	Publications
Age	Eidman-Aadahl & O'Donnell-Allen (2011); Hammer, Rosen, Sharon, Lankry, Huberman, & Zamtsov (2010)); Judd (2014); Judd & Kennedy (2011); Junco & Cotten (2011);
Motivation and Intention	Conrad & Marsh (2014); Hammer, Rosen, Sharon, Lankry, Huberman, & Zamtsov (2010); Hembrooke & Gay (2013); Judd & Kennedy (2011); Junco (2012);
Similarity of Tasks	Conrad & Marsh (2014); Hembrooke & Gay (2003); Rosen, Carrier, & Cheever (2011); Rosen, Lim, Carrier, & Cheever (2011); Vega (2009)
External Distractions	Bowman, Levine, Waite, & Gendron (2010); Calderwood, Ackerman, & Conklin (2014); Fante, Jacobi, & Sexton (2013); Fried (2008); Jarmon (2008); Levine, Waite, & Bowman (2007)
Practice/Training	Conrad & Marsh (2014); Hembrooke & Gay (2003); Judd (2014); Judd & Kennedy (2011); Junco & Cotten (2012); Levine, Waite, & Bowman (2007); Lien, Robertson, & Lee (2009)); Rekart (2011);
Social Factors	Judd & Kennedy (2011); Junco & Cotten (2011); Junco & Cotten (2012); Kirschner & Karpinski (2010); Wang & Tchernev (2012)
Time Factors	Hembrooke & Gay (2003); Judd & Kennedy (2011); Junco (2012); Junco & Cotten (2011); Lee, Lin, & Robertson (2012)
Availability of Media	D'Agostino (2010); Hembrooke & Gay (2003); Judd (2012); Rosen, Carrier, & Cheever (2011); Sana, Weston, & Capeda (2013);
Number of Tasks or Media	Fried (2008); Judd (2012); Judd (2014); Judd & Kennedy (2011); Rekart (2011);
Difficulty of Tasks	Fante, Jacobi, & Sexton (2013); Hembrooke & Gay (2003); Judd (2014); Judd & Kennedy (2011); Sana, Weston, & Capeda (2013); Wood, Zivcakova, Gentile, DePasquale, & Nosko (2011)
Unstructured vs. Structured Use of Technology	Fried (2008); Hammer, Rosen, Sharon, Lankry, Huberman, & Zamtsov (2010); Hembrooke & Gay (2003); Junco (2012); Rekart (2011)
Metacognition	Hembrooke & Gay (2003); Junco (2012); Rosen, Lim, Carrier, & Cheever (2011); Sana, Weston, & Capeda (2013)
Mental Factors	Lee, Lin, & Robertson (2012); Logie, Trawley, & Law (2011); Neth, Khemlani, Oppermann, & Gray (2006); Parry (2013); Rosen (2008);
Types of Software Technologies	Bowman, Levine, Waite, & Gendron (2010); Wood, Zivcakova, Gentile, DePasquale, & Nosko (2011)

Table 1. Triggering factors of Multitasking in academic settings

In table 2 below, the various factors that serve as the outcomes for multitasking in an academic settings are provided.

Outcome Factors	Publications
Performance (Number of Errors, Accuracy, GPA/Grades, Academic Goals and Achievements)	Bowman, Levine, Waite, & Gendron (2010); Conrad & Marsh (2014); Fante, Jacobi, & Sexton (2013); Hammer, Ronen, Sharon, Lankry, Huberman, & Zamtsov (2010); Junco (2012); Karpinski, Kirschner, Ozer, Mellot, & Ochwo (2013)
Processing of Information (Recall, Retention, & Memory; Effectiveness of Study method by individuals)	Hembrooke & Gay (2003); Jarmon (2008); Junco & Cotten (2011); Rosen, C. (2008).

Teaching Methods	Eidman-Aadahl & O'Donnel-Allen (2011); Lowther, Ross, & Morrison (2003); Prentice (2009)
Learning/ Learning Processes	Fante, Jacobi, & Sexton (2013); Hammer, Ronen, Sharon, Lankry, Huberman, & Zamtsov (2010); Junco (2012); Sana, Weston, & Capeda (2013)
Attention/ Level of Focus	D'Agostino (2010); Lee, Lin, & Robertson (2012); Parry (2013); Sana, Weston, & Capeda (2013); Wood, Zivcakova, Gentile, Archer, DePasquale, & Nosko (2011)
Relationships (Communication skills)	Fante, Jacobi, & Sexton (2013); Junco & Cotten (2011); (2008); Qua-Haase (2008); Vega (2009)
Productivity (Speed/ Duration (Time), Efficiency)	Kirschner & Karpinski (2010); Lin, Robertson, & Lee(2009); Rosen (2008); Vega (2009); Wang & Tchernev (2012)
Satisfaction	Fried (2008)
Health	Junco & Cotten (2011); Kirschner &Karpinski (2010); Parry (2013); Rosen (2008)
Assessing Importance of Information	Vega (2009)
Distractibility	D'Agostino (2010); Fante, Jacobi, & Sexton (2013); Hammer, Ronen, Sharon, Lankry, Huberman, & Zamtsov (2010); Levine, Waite, & Bowman (2007); Moreno, Jelechick, Koff, Eikoff, Diermyer, & Christakis (2012)

Table 2. Outcome factors of Multitasking in academic settings

CONCEPTUAL MODEL

The insights gained from our extensive analysis of extant literature enabled the development of a conceptual model of multitasking shown in figure 1 below.

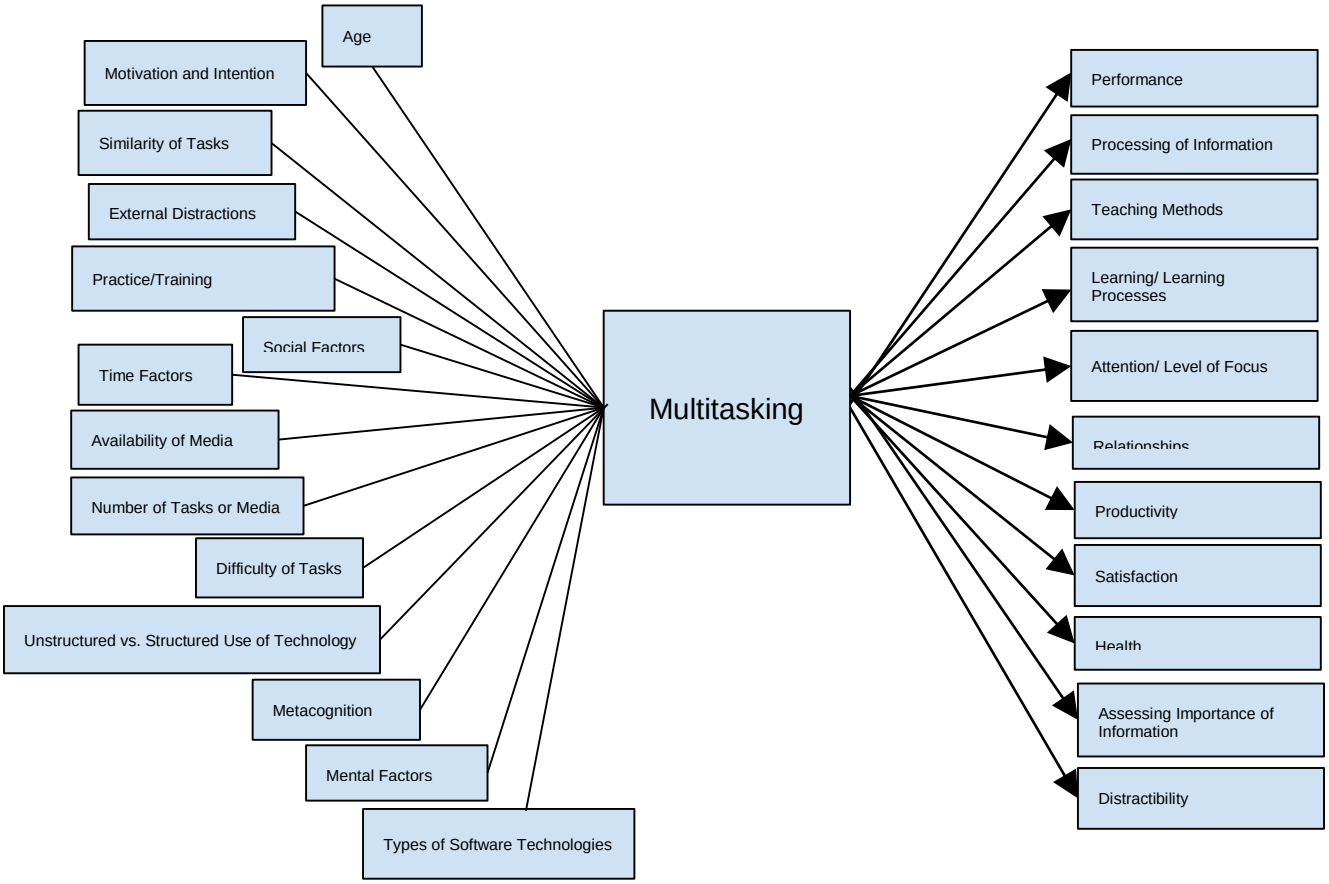

Figure 1. Conceptual Model of Multitasking in academic settings

We have integrated the factors from tables 1 and 2 into a comprehensive model that will allow us to evaluate the effects of multitasking in an academic setting. The boxes on the left of figure 1 represent the triggering factors from table 1 that serve as independent variables impacting a student's ability to multitask. On the other hand, the boxes listed on the left of figure 1 represent the outcome factors from table 2 that serve as the dependent factors. This comprehensive model serves as a solid base foundation from which we may select independent and dependent factor(s) to develop propositions and hypotheses that can be tested out and analyzed to help us better understand the true benefits of multitasking in academic settings.

We note that out of the thirteen independent factors (the boxes on the left-hand side) in the model, four of the factors relate directly and indirectly to the role that technology may play in triggering/impacting multitasking behavior in an academic setting. These are specifically, *External distractions*, *Availability of Media*, *Unstructured vs. Structured use of technology*, and *Types of software technologies*. External distractions refers to whether other students around a given individual in the same classroom is using a technology device that may cause distraction and hinder the individual's ability to pay attention in class. Availability of Media refers to whether a given student has specific technologies (e.g. laptop, tablet computer, smartphone, e-reader, etc.) with him/her during the class and whether that triggers him/her to use it just because he/she has readily access to it thereby creating a scenario where they may then attempt to both use the particular device and at the same time attempt to pay attention to material being presented in class. Unstructured vs. Structured use of technology refers to whether students are asked to perform a task using a given technology e.g. they may be asked to take an online quiz or work on an assignment electronically – this would depict an example of a structured use of technology. By contrast, unstructured use of technology is defined as students using technologies of their choice when doing assignments or tasks related to the class that did not mandate that they need to use technology to complete them. The last technology-based factor relates to Types of software technologies. This factor refers to the nature of the actual software applications that the student may be using at any given time. Certain applications may require less skill to operate and thereby may facilitate the use of that application while trying to do other tasks at the same time. Future studies will take the factors, primarily the ones relating to technology that have been identified in the conceptual model in figure 1, and carry out experiments to determine the role and to what extent they play out in either facilitating or hindering multitasking in the classroom. Contributions from such experiments will shed light on how lesson planning and delivery are carried out to deal with the students of today who are constantly tied to their gadgets.

CONCLUSION

The goal of this research was two-fold – first to investigate factors that impact multitasking in higher-level academic settings and second, to identify the technology-based factors that may affect multitasking in the same context. A very comprehensive extant literature research regarding multitasking in academic settings, from the disciplines of Information Systems as well as Psychology were carried out. This led to the subsequent development of a conceptual model. We believe that this model will help formulate propositions and their eventual testing through carefully designed experiments. We believe that findings from these studies 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.

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