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The impact of media multitasking on learning

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While multitasking is not a new concept, it has received increasing attention in recent years with the development of new media and technologies. Recent trends appear to suggest that multitasking is on the rise among the younger generation. The purpose of the study is to determine if students obtain more or less information in multitasking conditions. We examined the relationships of multitasking to attention, cognitive load and media with 130 college student participants. In this study, participants were given a timed (16 minutes) reading comprehension test in three conditions: Silence (only reading), Background multitasking (reading with a non-tested video shown simultaneously), and Test multitasking (reading with a tested video shown simultaneously) conditions. Our findings indicated that: (1) participants in the Background condition performed as well as those in the Silence condition, and (2) when participants were tested on their video comprehension, the group in the Test condition performed significantly better than the group in the Background condition. The results of this study suggest that cognitive load plays an important role in determining how much information is retained when students perform more than one task at a time.

Keywords: multitasking; cognitive load theory; schema construction; interactivity; learning

Introduction

In libraries and classrooms across the many college campuses, it is common to see students performing multiple tasks at the same time while completing their assignments or studying for a test. Some claim that multitasking does not interfere with students’ studying habits (Jenkins et al. 2006; Prensky 2006; Small and Vorgan 2009). ‘Millennials’ might even argue that multitasking actually helps them to concentrate (Roberts, Foehr, and Rideout 2005). Others believe that we cannot perform more than one task at a time. Since multitasking with technology is a fairly recent phenomenon, researchers are still trying to determine its impacts on learning. Gardner (2008, 3) notes that multitasking...
Media multitasking

Foehr (2006, 2) observes that, ‘much of the multitasking young people do revolves around media use.’ Vega (2009, 3) defines media multitasking as ‘engaging in multiple media activities simultaneously, including multiple windows on a single media platform and/or multiple media.’ According to the Kaiser Family Foundation (2010), 8- to 18-year-olds in the United States spend 7.5 hours on media daily. The researchers found that young people packed a total of 10 hours and 45 minutes worth of content media into 7.5 hours of media use.

Young teens seem to embrace multitasking as a way of life (Foehr 2006). For example, many teenagers send text messages throughout the day while they are engaged in school and social activities. American teens sent an average of 3146 text messages a month in 2009 (Entner 2010). According to Madden and Lenhart (2009), one in three teens between the ages of 16 and 17 admitted to texting while driving. It is not surprisingly that ‘activities that require focused attention, such as reading, are declining among American youth’ (Levine, Waite, and Bowman 2007, 560). While society in general appears to have embraced the necessity of multitasking, the cost of multitasking remains unclear. Gardner (2008, 3) noted that the phenomenon of multitasking appears to be counter-intuitive to the principles of information processing. Do we acquire more or less information in a multitasking learning environment? Do we learn better by focusing on one task at a time?

Cognitive load theory

Psychologists and neuroscientists have long been interested in the limits of human information processing in terms of attention. The issue has generated more interests recently because multitasking has dominated many facets of our lives. We are particularly interested in the multitasking practice among the younger generation. Foehr (2006, 2) observes that ‘although no research has focused specifically on the effects of media multitasking on teens and on their environment, conventional wisdom and brain research support the idea that there are limits to how much our brains can process at once.’

In 1956, George Miller conducted various experiments on how accurately people remembered numbers. Miller (1956, 95) found that his subjects generally remembered seven digits when tested on their working memory. He
believed that his subjects were limited in the amount of information that they were ‘able to receive, process, and remember.’ Miller’s theory on how our brains handled information paved the way for other researchers who were interested in the limitations associated with human cognitive processing abilities and the effects on learning. From 1960s to 1990s, various models of the working memory were proposed including Atkinson and Shiffrin’s multi-store model (1968), Baddeley and Hitch’s model of working memory (1975) and, more recently, Sweller’s cognitive load theory (1988).

Cognitive load theory emerged in the instructional design community to address the limitations of our cognitive processing abilities when it comes to learning. *Cognitive load* is defined as a ‘multidimensional construct representing the load that performing a particular task imposes on the learner’s cognitive system’ (Paas and van Merriënboer 1994, 122). Paas, Renkl and Sweller (2003, 2) describe cognitive load theory (CLT) as focusing on ‘techniques for managing working memory load in order to facilitate the changes in long-term memory association with schema construction and automation.’

Cognitive load theorists believe that we store knowledge as schemas in our long-term memory (Sweller, van Merriënboer, and Paas 1998; van Merriënboer and Ayres 2006). Schema construction plays an important role in freeing up the limited resources in our working memory. van Merriënboer and Ayres (2006) suggest that we can reduce highly complex schemas to simpler elements through practice and repetitions. Over time, familiarity with a task through repetition helps lessen the cognitive load (Sweller, van Merriënboer, and Paas 1998, 252–3). On the other hand, learning a new task has the opposite effect. It places additional load on the working memory.

We employed two assumptions from the CLT to design experiments that allowed us to investigate whether students obtain more or less information in multitasking conditions. First, CLT assumes that we can only process a limited number of elements in our working memory. Second, every task generates a cognitive cost on the working memory in terms of cognitive load. Sweller (1988) believes that problems that require ‘a large number of items to be stored in short-term memory may contribute to an excessive cognitive load’ (265).

A complex task places a heavier cognitive load on the working memory than a simple task. When multiple tasks compete for the same resources, we strain the limits of our working memory.

Sweller, van Merriënboer and Paas (1998) noted that the ease with which information is processed is a primary concern for working memory. There are three types of cognitive load that affect learning: extraneous, germane and intrinsic (Paas, Renkl, and Sweller, 2003, 2). Extraneous cognitive load interferes with learning since it places additional burden on the working memory that does not contribute to knowledge acquisition. Intrinsic cognitive load is a part of the learning material or activity that cannot be altered. It is the amount of working memory required for the learner to interpret the learning material or activity that is presented. Paas, Renkl and Sweller (2003, 2) describes
intrinsic cognitive load as ‘a base load that is irreducible’ and it gets allocated before the other two categories of cognitive load.

Sweller, van Merriënboer and Paas (1998) believe that germane cognitive load contributes to the schema construction. It plays a critical role in the learning process. Paas, Renkl and Sweller (2003, 1) argue that, ‘information varies on a continuum from low to high interactivity.’ Low interactivity elements are ‘materials that can be understood and learned individually without consideration of any other elements.’ When we learn a new task, we have to process the information consciously. For example, a teenage driver who is learning how to drive a car behaves differently than an experienced driver. We expect the young driver to focus his sole attention on driving and thus expend more cognitive resources than an older driver with decades of experience. As we gain more driving experience, driving becomes more automated and thereby allowing us to use less cognitive resources.

Paas, Renkl and Sweller (2003) believe that we can learn high interactivity elements individually. Unlike low interactivity elements, they argue that we have to master high interactivity elements together to understand the information. For example, air traffic controllers provide instructions to pilots, clear flights, monitor flight conditions and track multiple flights at the same time. While it is possible to understand the different elements of the job, traffic controllers must master all the elements in order to ensure the safety of the commercial and private planes.

Despite the growing body of research and attention on multitasking, studies on how it impacts learning habits have been far and few in between. Fried (2008) found that the level of laptop use in the classroom correlates negatively to student learning and overall course performance. Levine, Waite and Bowman (2007) reported that the amount of time students spent using instant messages was significantly related to more distractibility for academic reading, while amount of time spent reading books was negatively related to distractibility. Kirschner and Karpinski (2010) found that students, who spent more time on Facebook, have lower grade point averages than non-users. In another study, Fox, Rosen and Crawford (2009) examined the reading comprehension scores of students who were using instant messaging and reading at the same time. They reported that participants who spent more time on instant messaging scored lower on their reading scores.

**Methods**

**Participants**

We invited undergraduate students from eight courses in the College of Education at a major southern university in the United States to participate in the study. A total of 137 students volunteered to participate in the study. Seven responses out of the 137 responses (137 participants) were not used
because of incomplete answers. Therefore, data analysis was based on responses from 130 participants. The majority of the participants were female (90.7%) while the rest (9.3%) were male students. The large number of the female participants in the study represents proportionately the large number of female students in the College of Education. The mean age of the participants was 23.9 years.

**Design and procedures**

In our experiment, we selected two reading sets and developed questions based on them. In each reading set, we selected one article on the subject of science, history and politics. In the first reading set (Reading Set 1), we included an article about dinosaur discovery (science), a civil war prisoner camp (history) and the 2008 presidential nominee, Barack Obama (politics). In the second reading set (Reading Set 2), we included an article on an astronomical event (science), the prosecution of an American spy (history) and the 2008 presidential nominee, John McCain (politics). We used articles that were of similar length, format and level of difficulty. The articles were college-level texts that students would typically read in their core education courses.

We created six questions for each article with varying levels of difficulty to accompany the text. We recruited a small group of students to read the articles and answer the questions before we used them in the study. In addition to the articles, we also selected two short videos for the study. The first video was a documentary on drunk-driving, while the second video was a situational comedy (sitcom). We edited both videos so that they were 16 minutes in length and developed a set of questions for each video presentation.

In the study, we setup three conditions. The conditions were: (1) reading in silence (Silence), (2) reading with informational video playing in the background (Background), and (3) reading with informational video playing that contains testable information (Test). Table 1 describes the setup for each of the three conditions.

Participants were randomly assigned two out of three experimental conditions so that no one condition was favoured. Participants in Group A were tested under two conditions: Silence and Background. Participants in Group B were tested under Silence and Test conditions. In Group C, participants were tested under Background and Test conditions. In each of the conditions, they were instructed to read three articles and answer six questions at the end of article. Those in the Background and Test conditions had to answer questions related to the videos that were shown. Table 2 shows the configuration of the experiments.

At the beginning of each session, we distributed the reading materials and instructed the participants on what they needed to do. Each session contained two experimental conditions (Table 2). We employed the same data collection procedure for both experimental conditions.
First, we collected demographic information from them. Next, we gave the participants Reading Set 1 or Reading Set 2 and asked them to answer 18 (six for each article) multiple-choice questions related to the articles, under one of the three conditions – Silence, video Background or video Test condition. If it was a video condition, we asked the participants to answer six questions on the video. At the end of each experiment, we debriefed the participants. The entire procedure took approximately 50 minutes. The order of the set of reading materials (Reading Set 1 or 2) was systematically randomized, as were the order of the videos (documentary first, sitcom second, or vice versa) so as to not privilege any one format.

### Results and findings

We awarded participants three points if they answered a question correctly. We deducted one point for an incorrect answer. We did not award any point to questions that were unanswered. We timed the tests so that participants would have to deal with the time constraint as a limiting factor. In each reading

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**Table 1. Experiment descriptions for the three conditions.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Experiment description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silence</td>
<td>Participants were instructed to read and answer 18 multiple-choice questions regarding the three articles.</td>
</tr>
<tr>
<td>Background</td>
<td>Participants were instructed to read and answer 18 multiple-choice questions regarding the three articles. In addition to the reading task, the group was assigned a second task. The group watched a video while they performed their reading tasks. A situational comedy or a documentary was shown to the participants to mimic a scenario where a student would read and watch TV or video at the same time. The participants were told that they could ignore the video if they chose to do so, although they were asked to answer six questions related to the video afterwards.</td>
</tr>
<tr>
<td>Test</td>
<td>Participants were instructed to read and answer 18 multiple-choice questions regarding the three articles. A situational comedy or a documentary was shown to this group. Unlike under the Background condition, the participants were instructed that they would be tested on the information related to the video.</td>
</tr>
</tbody>
</table>

**Table 2. Number of participants by paired conditions.**

<table>
<thead>
<tr>
<th>Participants and session groupings</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A – Silence and Background</td>
<td>30</td>
</tr>
<tr>
<td>Group B – Silence and Test</td>
<td>35</td>
</tr>
<tr>
<td>Group C – Background and Test</td>
<td>65</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
</tr>
</tbody>
</table>
set, participants could score up to 54 points with the three articles (a total of 18 questions). If a video was shown, an additional 18 points (six questions for a video) could be scored. We only compared participants’ reading comprehension performance under three different conditions. Scores for the video condition were excluded to prevent score inflation for that group. Table 3 provides a summary of how participants performed under each condition.

We used paired $t$-tests to determine if the mean scores of the reading tests given under each of the three conditions differed significantly. First, we found that there was no significant difference in reading scores for students who were in the Silence and Background conditions (Group A). There did not appear to be any significant difference in the participant scores in the Silence and Background conditions, $t(29) = -0.611, p > 0.05$.

Next, we compared the scores for participants who were in Group B (Silence and Test conditions). There did not appear to be any significant difference in the participant scores in the Silence and Test conditions, $t(34) = 1.142, p > 0.05$.

Lastly, when we compared how participants scored in the Background condition against the Test condition (Group C), there was a significant difference in the reading scores of the two groups. We found that participants scored better in reading comprehension under the Background condition ($M = 13.55, SE = 0.448$) than in the Test condition ($M = 12.48, SE = 0.388$), $t(64) = 2.168, p < 0.05, r = 0.26$.

**Discussion**

In a multigenerational study conducted by Carrier et al. (2009), the researchers found that Millennials (born between 1982 and 2001) were spending more time than Generation X (born between 1965 and 1976) and Baby Boomers (born between 1946–1964) on media-related activities like web surfing, texting and video games. Millennials were more likely to multitask compared with the previous generations. This phenomenon has led some researchers to suggest that the brains of our current generation are adapting to the technology revolution in ways that are different than Baby Boomers and Generation X (Small and Vorgan 2009).

Whether we agree or disagree with the idea that the technology has transformed the brains of our youths, one pivotal issue has emerged: How do we...
teach a generation of technologically savvy students that has a distinct preference for media multitasking? If anything, the innocuous sight of students surfing the web on their laptops with music playing in the background while working on their assignments appears to reinforce the notion that we can do many things at the same time. However, the findings in this study paint a more complex picture of the multitasking behaviour in the learning environments.

Our findings support the argument that we retain less information when we perform more than one task at a time. Participants in the Silence condition performed significantly better than the participants in the Test condition. Researchers have long argued that our ability to perform simultaneous tasks is limited (Broadbent 1957; Pashler 1994; Fisch 2000; Lang 2001; Kirschner and Karpinski 2010). Kirschner and Karpinski (2010) believe that we can only perform multiple tasks when these tasks are automated. Tasks that require focused attention like studying suffer when students engaged in other activities at the same time.

We expected similar results in the Silence versus Background conditions. Interestingly, the reverse was true. There was no significant difference in reading comprehension scores among participants in the Silence condition and Background condition. More recently, some researchers have argued that new media and technology have changed the way we retain and process information (Small and Vorgan 2009). Small and Vorgan (2009, 25) believe that ‘the bombardment of digital stimulation on developing minds has taught them to respond faster, but they encode information differently than the older minds do.’ Technology may very well be the catalyst in changing our ability to handle multiple source of information.

When we compared the reading scores of those in the Background–Test condition, we found that participants scored better in the Background condition rather than the Test condition. We hypothesize that the Test condition carried a greater cognitive load than the Background condition. As a result of higher cognitive load, participants likely used greater cognitive resources in order to perform the primary and secondary tasks simultaneously. The increased consumption of cognitive resources may have attributed to the lower reading test scores for those in the Test condition. In other words, the performance of the primary task (reading) suffered when the secondary task required higher cognitive load than just casual attention. This finding is consistent with the work of Yeung, Jin and Sweller (1998) who found that extraneous cognitive load can and do interfere with learning.

How does this impact academic performance, which we are interested in? Sweller, van Merriënboer and Paas (1998) believe that low-element interactivity tasks consume less cognitive capital than high-element interactivity tasks because they involve fewer elements in working memory. Based on our findings, we hypothesize that multitasking is possible when a low-element interactivity task is coupled with another low-element interactivity task or a high-interactivity task with a low-interactivity task (as in Background multitasking condition). It
is far easier for a student to listen to a lecture with low interactivity elements in the background (soft music or chatting) as opposed to sitting in one with high interactivity elements (solving complex mathematical equations at the same time). However, these configurations need to be further tested in future studies before any claim of effectiveness can be levied.

One of the limitations of the study was the fact that our participants were recruited from the pre-service teacher population. We cannot generalize the findings to a broader population without replicating the study with other groups of students. Since over 90% of the participants were females, future studies should include a more balanced gender representation because of possible gender differences in multitasking habits. Moreover, in real life, students are free to select their preferred media while completing a reading activity assigned by their instructors. In contrast, the media selection for this study was predetermined.

**Conclusion**

In the study, we examined if students acquired more or less information in a multitasking learning environment. Our findings have important implications for students and educators alike. We believe that multitasking interferes with knowledge acquisition. It generates extraneous cognitive load that burdens the working memory. Students perform better when they focus on one task at a time especially when they are learning new materials inside and outside the classroom. For students with a strong preference for multitasking outside the classroom, coupling media use with activities that are considered low interactive elements may help reduce extraneous cognitive load. Educators should consider limiting student media use when introducing new materials in class. There is an unquestionable (and even urgent) need for more studies to be conducted as we deal with the impact of multitasking habits on our society. This research gap is especially critical as schools and colleges find ways to work with students whose multitasking behaviours are both voluntary and prized.

**Notes on contributors**

Jennifer Lee is a doctoral candidate at the Department of Learning Technologies, University of North Texas. Her research interests include distributed learning, new media and technologies, and the scholarship of teaching and learning.

Lin Lin is an Assistant Professor in the Department of Learning Technologies, University of North Texas. Her research interests include instructional technology, cognition, psychology, and new media.

Tip Robertson recently received his PhD from the Department of Learning Technologies, University of North Texas. His research interests include individual and team
performance improvement, dyadic and small-group relationships, and the cognitive
and learning processes of young adults, particularly within the context of work/life
and school/life balance.

References
control processes. In The psychology of learning and motivation: Advances in
Academic Press.
Broadbent, D. 1957. A mechanical model for human attention and immediate
across generations: Multitasking choices and difficulty ratings in three generations
ielsenwire/online_mobile/under-aged-texting-usage- and-actual-cost/ (accessed
March 16, 2010).
Fisch, S.M. 2000. A capacity model of children’s comprehension of educational
messaging affect college students’ performance on a concurrent reading compre-
Education 50, no. 3: 906–14.
Virginia Polytechnic Institute and State University.
Confronting the challenges of participatory culture: Media education for the 21st
Kaiser Family Foundation. 2010. Generation M2: Media in the lives of 8- to 18-year-
Computers in Human Behavior 26, no. 6: 1237–45.
Lang, A. 2001. The limited capacity model of mediated message processing. Journal of
Communication 50, no. 1: 46–70.
Levine, L.E., B.M. Waite, and L.L. Bowman. 2007. Electronic media use, reading,
and academic distractibility in college youth. CyberPsychology & Behavior 10,
no. 4: 560–6.
Madden, M., and A. Lenhart. 2009. Teens and distracted driving. Pew Internet &
Teens-and-Distracted-Driving.aspx (accessed September 17, 2010).
Miller, G. 1956. The magical number seven, plus or minus two: Some limits on our
tions of the interaction between information structures and cognitive architecture.
Instructional Science 32, nos. 1–2: 1–4.


