THE DIRECT AND INDIRECT EFFECTS OF LAPTOP MULTITASKING IN HIGHER EDUCATION

Forget about notepads and pencil cases. As students returned to classes this fall, their knapsacks may have carried only one essential back-to-school item: their laptop. Educators can attest to the ever-increasing presence of laptops on college campuses. In a sample of 1,200 university students in 2010, 83% owned a laptop (Elmer-DeWitt, 2010), with numbers today likely higher. Estimates are that at least 65% of students bring their laptop to class (Fried, 2008). Laptop students are able to access class materials (e.g., lecture slides posted online) and type additional notes to a professor's lecture. But a laptop in class, which provides easy access to a multitude of websites, social media, videos and games, might also tempt serious distraction.

Students can easily switch back and forth between academic and non-academic activities on their laptops during class time (what we, the authors, refer to as "laptop multitasking").

Checking the odd email or sending a quick instant message to a friend doesn't seem like a threat to learning. However, the actual estimated rates of laptop multitasking are worse than you'd think. One study found that students with laptops spent 42% of class time multitasking (Kraushaar & Novak, 2010). Surprisingly, little research has addressed the question of whether laptop multitasking during class is a significant threat to student learning. The existing data is largely self-report, noting that students enjoy the freedom and novelty of laptops in class but also that they consider laptops to be distracting (Barak, Lipson, & Lerman, 2006; Wurst, Smarkola, & Gaffney, 2008). One empirical study has tested the distracting effect of laptops on test performance but with notable methodological limitations (Wood et al., 2012).

To contribute to this important literature, we designed two psychology experiments investigating the effects of laptop multitasking in a simulated college classroom environment. Our two primary goals were to investigate the direct effects of laptop multitasking (i.e., on the user) and to investigate the indirect effects (i.e., on a nearby paper-and-pencil student).

LAPTOPS AND DIVIDED ATTENTION: TWO SCHOOLS OF THOUGHT

Cognitive psychologists have studied how performance changes when attention is divided between two tasks. Attentional resources are finite. If these resources must be split between two or more tasks at the same time, performance on both tasks will suffer (Pashler, 1994)—in quality (accuracy) and efficiency (completion time). When we perceive we are "multitasking," our brains actually are performing rapid shifts of attention from one task to another that result in regular downtime from each task. For instance, if one person is telling us a phone number and we are simultaneously scheduling an appointment via text message, we might mix up the numbers from the two streams and remember an incorrect phone number as well as schedule the appointment at the wrong time.

When it comes to student laptop use and divided attention, two schools of thought emerge in the popular media. Some individuals (e.g., parents, students, educators) feel as though laptop multitasking surely must impair students' learning, just as research consistently demonstrates. Other individuals reason that since today's youth are so accustomed to living in the digital age – where information is constantly flowing from one of several sources at any given moment – they have become multitasking experts. The debate reached the pages of a 2006 *TIME* magazine article in which prominent psychologists and neuroscientists quoted research showing that young people are not immune to the detrimental effects of multitasking (Wallis, 2006). A final goal of our experiments was to shed light on the rift between anecdotal and experimental evidence of multitasking effects in young people, at least as they pertain to laptop use in the classroom.

THE EMPIRICAL EVIDENCE

In our first classroom experiment, 40 undergraduate university students attended a 45- minute, live lecture on meteorology and were instructed to take notes on the lecture using their personal laptops. The setting was just like any traditional college classroom. Half of the students received additional instructions to complete a series of online tasks at any convenient point during the lecture. These were our "laptop multitaskers." An example of a task was "What is on channel 3 tonight at 10 pm?" The online tasks were meant to mimic typical student browsing and could be completed within 15 minutes (without interruption). After the lecture, all students completed a surprise 40 question multiple-choice quiz on the lecture content. We found that laptop multitaskers

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scored, on average, 11% lower than non-laptop-multitaskers on the quiz (55% vs. 66%, respectively).

In our second classroom experiment, a new group of 38 students attended the lecture and was instructed to write out lecture notes using paper and pencil. Some students were strategically seated throughout the classroom so that they were in-view of our "experimenter allies" who were multitasking on laptops, while other students had a distraction-free view of the lecture. After the lecture, students completed the surprise multiple-choice quiz. We found that students in-view of a laptop multitasker scored, on average, 17% lower than students with a distraction-free view of the lecture (56% vs. 73%, respectively).

In response to the first two goals of our experiments, our results show that laptop multitasking leads to impaired learning in a classroom setting. In response to our third goal, we challenge the belief that today's generation of students has mastered a multitasking lifestyle. The most astonishing finding was the indirect effect of multitasking on students seated nearby a laptop user. These are the students who come to class prepared and ready to learn, but inadvertently, they are distracted by others' laptop activities.

Students seem unaware of the impact laptops can have on their learning. Using a 7-point Likert scale, multitaskers judged that peers' learning would be "barely hindered" by their choice to multitask, and those in view of multitaskers (who were not multitasking) thought their peers' actions would "barely hinder" their own learning. On both the giving and receiving end, laptops have a far more profound impact than students realize.

▶ SUGGESTIONS FOR STUDENTS AND TEACHERS

Laptops will of course remain a tool of the modern day student, so the question should not be to ban or not to ban, but how we can use this type of technology to actively progress learning rather than distract it. Indeed, the results of our research suggest that it is *off-task* laptop use in class that is harmful to learning; *on-task* laptop use actually may improve learning outcomes. We offer a few suggestions for teachers and students.

For teachers, you might consider first opening up a class discussion on laptop multitasking and its effect on learning.

You might see first hand that many students conform to the myth that they are "multitasking specialists". Challenge their thinking with the scientific evidence. Make them aware that their own learning choices in class will inevitably affect the abilities of their peers.

To encourage on-task laptop use in your class, consider incorporating e-learning methods that allow students to use their laptops for class-related purposes. For example, students could search the Internet for related course content and videos, answer questions in an Internet poll, participate in an online demonstration, or post thoughts on a discussion forum. Every day students and teachers are devising new ways of creatively using technology to assist learning.

We encourage post-secondary teachers to share best practices with their colleagues. Furthermore, make lecture design be a priority. Interactive and engaging lectures are the ones that will be able to compete for students' attention amidst other distractions. Offering one or two "off-task multitasking" breaks during class time may also curb students' temptations to stray away from your lesson.

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An instructor's pedagogical choices have a significant influence on classroom learning; yet, at the end of the day, the choice to stay focused in class is up to the individual student. If off-task multitasking is necessary (e.g., studying for an exam in the next period), we suggest that off-task students sit at the back of the classroom so at least other students' learning is not hindered.

We are often asked whether the results of our work apply to students using tablets or smartphones in the classroom. In terms of tablet use, we speculate that a tablet might be less distracting than a laptop (although we are not aware of any data testing this hypothesis). Many tablets currently on the market are designed to have only one application open at a time, making it more difficult to engage in direct multitasking. Moreover, unaccessorized tablets sit flat on a desktop and are therefore less likely to be visible by nearby peers. When it comes to smartphones, however, it is more than likely

that students are off-task while using these devices (e.g., social media apps, text messaging, games). The size of a smartphone screen makes it less than ideal for typing class notes and seeing the entirety of a website page. In terms of peer distraction, research suggests that cell phone sounds interrupt and disturb classroom learning (Shelton et al., 2009); therefore, every effort should be made to have students set their cell phones to silent mode.

As the school year continues, we hope our findings encourage teachers and students to consider the pros and cons of laptops in the classroom, to open up dialogue on the effects of off- task laptop multitasking, and to remain on-task with laptops through some of our suggested activities. Laptops may be the tool of 21st century learning, but let us all ensure they are used constructively. ◑

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