Impact on advanced tax class as a result of electronic device usage

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ABSTRACT

The literature shows that unguided device use in the classroom decreases academic outcomes for a broad range of students. However, the literature does not address potential harms to graduate students. We investigate where highly motivated graduate students in a professional MPA program would be vulnerable to the same device distraction effects as undergraduate and grade school students. Four sections of Advanced Taxation were assigned to either "device-prohibited" or "device-permitted" (natural use). Those assigned to the device-prohibited sections earned 17% higher course grades, an effect size greater the undergraduate studies. Surprisingly, GPA and device use interacted, with those at the *high* end of the GPA showing the greatest disadvantage from device use. The evidence indicates that it is not the least academically prepared students who are the most vulnerable to device distractions, but rather the more accomplished students, although the declines were found for all levels of academic achievement.

Keywords: devices, distractions, learning, assessment, divided attention

INTRODUCTION

Recent articles in both trade publications and the popular press have explored the increasing problem of digital distractions in the workplace. A 2014 *Entrepreneur* headline screams "PAY ATTENTION" in huge font (Robinson, 2014), while the *Wall Street Journal* taunts its readers with the headline, "Here's Why You Won't Finish This Article" in a piece describing what some employers are doing to minimize distractions and keep workers focused (Silverman, 2012). Another business journalist has even coined a name for the phenomena—The Distraction-Industrial Complex (Mims, 2014), noting that companies producing digital devices and services have powerful financial incentives to capture our attention. Mims claims that some studies suggest that workers lose as much as 40% of their productive time when they are regularly interrupted. Companies such as eBay, Intel, and Microsoft have identified the problem with their own workers and instituted various solutions. Several years ago, eBay adopted a no-device policy during some team meetings (Silverman, 2012), while Intel set aside four hours of "think time" per week with no interruptions for its software and services group (Silverman, 2012).

Whether in the workplace or in the classroom, it is clear that the effect of constant interaction with digital devices on our cognitive abilities must be better understood in order to address potential positive and negative effects. Clearly, cell phones, laptop computers, tablets and smart devices, all part of the world for professionals and students, can be a mixed blessing. Some crafty educators have found innovative ways to use these devices to take attendance, survey the class, give pop quizzes and engage students outside the classroom in a myriad of ways. These devices, however, can also distract students from learning, cause distractions to other students and increase educator angst. Syllabus policies go from ignoring devices to prohibiting devices to fining students for each cell phone ring tone heard. Since devices are both a potential tool for learning and a temptation to take a mental vacation from the class activity, educators struggle with the policy to require, ignore or prohibit them.

The purpose of this paper is to extend the research on the impact of digital device use on academic performance to a different population of students, high-performing graduate students whose enrollment in a difficult program of study, graduate accounting, is self-selecting for higher achievers (admission to graduate school) and motivation to learn the subject (desire to pass the national Uniform CPA Exam that has a 50% failure rate). The effect of digital device use (cell phones and laptops), was measured in advanced tax classes at a large public university in Georgia. We found not only that unrestricted device use was associated with a large decrease in course grades but that the strongest achievers were harmed the most.

HYPOTHESIS DEVELOPMENT

Divided Attention

Cognitive science has a long history of understanding how divided attention hurts learning and memory (Craik *et al.*, 2000, Naveh-Benjamin *et al.*, 2015). It appears in all of us. Younger and older adults have trouble encoding to memory when their attention is divided, for example, when distracted (Craik *et al.*, 2000). Some have dubbed it the bottleneck theory because attention resources are limited (Welford, 1967, Wickens, 2002). When distractions drain away mental resources, there are fewer available for the encoding (learning) process (Park *et al.*, 1989, Craik *et al.*, 2000, Naveh-Benjamin *et al.*, 2015). Requiring more effort during learning, such as mixing up question types, can increase learning and retention, however, divided attention has consistently been shown to be detrimental to learning and memory (Gaspelin *et al.*, 2013). So, if the brain science literature is clear, distractions hurt learning, the practical question about the wonder of these new technology devices is: Is the harm to the average student enough to be a concern? Alternatively, is the upside of engaging and using these tools more powerful than the distraction they provide?

Student Impression of How Device Use Impacts Learning

A 2008 study found that about 65% of students brought laptops to class (Fried, 2008), while a 2009 survey of 693 college students at seven colleges across the U.S. revealed that 75% of students take their cell phones to class "always" and another 16.4% take cell phones to class "most of the time" (Froese *et al.*, 2012). In a marketing class, 90% of the students reported receiving text messages during class (Clayson and Haley, 2013). Do students believe this pervasive use of devices is a problem? In a science class where students were surveyed about device use, students reported believing that cell phones help their learning, and the more they used their phones, the higher they rated phone usefulness (Tessier, 2013). Further, not even ***one*** of Tessier's students rated the level of distraction of their phones higher than 2 out of 5. Even if students recognize the fact that digital activities distract the user, they may disagree that they themselves are distracted very much (Dietz and Henrich, 2014). This may be because they underestimate their use of cell phones in class. Undergraduates have been shown to underestimate the frequency of their in-class use of digital devices (Kraushaar and Novak, 2010, Duncan *et al.*, 2012). In Duncan's study, 75% of the students reported regular cell phone use during a lecture, but estimated that they only used cell phones three times per class period. However, observation data gathered in the same study found that the average frequency of cell phone use of these students was closer to seven times per class period (Duncan *et al.*, 2012).

Improvements to learning from device use

Studies have shown that active learning strategies, such as using clickers to quiz students on lecture material, can produce a positive effect on student learning (Crossgrove and Curran, 2008). Using laptops in the classroom can result in the benefits of an increase in student spreadsheet skills and the ability to take notes electronically (Skolnik and Puzo, 2008). Another study looked at the use of student response systems in an accounting classroom and found a high degree of student satisfaction and engagement with device use, although only a small improvement in actual learning was noted (Carnaghan *et al.*, 2011). As Walsh and Borkowski (2014) point out in their guide to using linked databases in an introductory business course, most first-year business students arrive on campus with greater technical skills than their predecessors. They explain that it is important to leverage technology to support the learning process of these "tech-savvy" students (Walsh and Borkowski, 2014). Elder's (2013) study indicated that free use of digital devices during a short video followed by a test on the content did not reduce scores below those of a control group without access to their devices, although the results are tempered by the low overall scores (below 50%) and the brief duration of the experiment.

The key, however, is that for the students to benefit, digital devices must be used for academic purposes rather than nonacademic purposes in the classroom, and this is hard to control. Academic purposes include online research and communication with other students and the professor. Nonacademic purposes include internet access of entertainment and other nonacademic sites, communication with friends and playing games. Even studies showing a positive effect on student learning and engagement cite the distracting influence of digital device use (Skolnik and Puzo, 2008). As Skolnik and Puzo point out, pedagogy influences the effectiveness of laptops, and actively engaging students in the class can help minimize the potential distraction created by access to the Internet. “Guided use” of these devices in the classroom should be distinguished from “free use” of digital devices. Guided use involves providing students with well-defined academic tasks to perform on their computers while free use is when students use their computers or mobile devices for their own, personal purposes, which can distract students from learning (Lam and Tong, 2012).

Decreases to learning from device use

If “guided use” justifies digital devices in the classroom, do students restrict themselves to the beneficial academic uses? One study found that students engaged in substantial multitasking with their laptops in class and had non-course-related applications open for about 42% of the time (Kraushaar and Novak, 2010). A later survey of 777 undergraduate and graduate students at six U.S. universities determined that students used a digital device an average of 10.93 times each class day for non-class activities (McCoy, 2013). Undergraduates used the device 11.16 times per day while graduate students’ use was less, at 3.90 times per class day (McCoy, 2013). Just availability of computers in the classroom lowered scores 10 points compared to a matching group in classrooms without computers (Martin, 2011), showing that students find it difficult to restrict themselves to academic use of technology. Froese et al. (Froese *et al.*, 2012) found that students expected a 33% decline in their post-lecture quiz if asked to text during the lecture. Further, students report that when fellow students use devices, it interferes with their ability to pay attention and learn the material (Fried, 2008). So, while students under report their device use, they generally agree that device use hurts learning. The question is not whether learning is compromised, but by how much?

The studies about the degree of harm from digital devices in academic settings differ in their methodology, their outcome measure, and their effect sizes, but they all send the same message: device use decreases performance. In an undergraduate psychology course, students reported non-academic uses of their laptop for an average of 17 out of 75 minutes of class time, and the more minutes they used their laptops, the lower their performance on exams (Fried, 2008). In eight science classes, student grades were 9% lower when students used their phones during lecture (Duncan *et al.*, 2012). Sana et al. took a bolder step and actually *required* some students to perform unrelated, online tasks during the lecture and found that those assigned the unrelated task scored 11% lower on a post-lecture test than those using a laptop but without such a task. Undergraduates in an introductory Psychology class assigned to the texting group scored 18.3% lower on the recall test than the participants in the non-texting group (Dietz and Henrich, 2014).

Some studies tried to tease out which device attractions were the most harmful to learning. Kraushaar & Novak (2010) used spyware to track use of digital devices in their study of laptop use during a lecture-style management information systems class, finding that non-course-related applications were active and open about 42% of the time and that the degree of non-course-related use predicted course grades, with text messaging lowering performance the most. Wood, et al. (2012) compared four device groups (Facebook™, texting, email and MSN Messenger) to three non-device control groups (no devices, pencil and paper note-taking, word processing note-taking, and a "natural use" control group that had complete discretion to use or not use their devices. Wood found that the participants who did not use any technologies in the lectures outperformed students who used some form of technology, and that Facebook™ and MSN Messenger were more likely to hurt learning than others conditions. The only study using accounting students and the only study to control for GPA found that students told to text the teacher during class scored significantly lower than students that did not text during class (Ellis *et al.*, 2010).

Finally, Kuznedkoff & Titsworth (2013) suggested one mechanism through which texting disrupts learning, in this case, effective note-taking. The study gauged the effect of text messages and Facebook™ posts using cell phones on note-taking during a simulated class lecture by undergraduate students in Communications courses at a large Midwestern university. The participants were split into three groups, a control group with no cell phone use, a group with low distraction and usage from cell phones, and a group with high usage/distraction. The researchers used free-recall and multiple choice tests to evaluate the students' knowledge of the lecture content. The study revealed that students who were not using their cell phones wrote down 62% more information in their notes, took more detailed notes, and were able to recall more detailed information from the lecture. They also scored a full letter grade and a half higher on the multiple choice test than the students actively using their cell phones. The high distraction group had the most negative effect from texting as compared to the no cell phone use control group, and the researchers identified a linear trend. Kuznedkoff concluded that texting/posting diminished the number of notes recorded by students during lectures, which impaired performance on tests of the lecture content. The literature consistently documents, across varied student populations, types of outcome measures, and types of devices, that devices distract from learning.

What is not clear from this literature is this: are the harms cited in the above studies reserved for the less experienced students who do not know their limits and have weaker academic habits? To date no work has been done on highly motivated and successful students: graduate students. McCoy (2013) finds, albeit with a small sample, that graduate students are less likely to use digital devices for non-class purposes than undergraduates, hinting that they may not be as vulnerable to device temptation as undergraduate students. Weighing on the other side, however, is that graduate level work is more complex and rigorous, requiring more intensive concentration. Given the more difficult subject matter, device distractions may, in fact, be even more harmful. Since graduate students have not been participants in this literature, the direction of device impact on academic outcomes is not clear.

This work takes a look at the least vulnerable and most accomplished students, those admitted to a competitive highly rank graduate program and who have paid considerable sums to attend the school. Does use of digital devices also hurt learning for this population of students, and, if so, is it just the weakest students with less developed academic habits who cannot orchestrate devices and mental processes in synchrony? Given that our sample is not using devices as an instructional tool and that weaker students are likely more vulnerable than stronger ones, we hypothesize:

H1: Students prohibited from using devices will earn stronger exam grades than students permitted to use devices.

H2: Students with lower GPAs will be hurt more from device use than those with higher GPAs

METHOD

Participants

This study was a quasi-experiment with non-equivalent control group design without pre-test (Campbell and Stanley, 1963) conducted with students enrolled in a Masters of Accountancy program Advanced Tax course taught by the first author (N = 99) at a large urban public university in the southeastern United States with a diverse student body and an average SAT of 1027, just above the national high school average for the SAT of 1010. Participant attributes and exam scores are summarized in Table 1 (Appendix). There were no significant differences between cumulative GPA and masters level credit hours completed among students who were permitted to use their devices and those prohibited from doing so.

The first author taught four evening sections of Advanced Tax, two in Fall 2014 and two in Spring 2015. One section in each term was used as the control section and the other section was the intervention section. The instructor, lecture, book, assignments and exams were identical across all four sections. The advanced tax course is a rigorous course in the one-year masters of accountancy program. All students were accounting majors hoping to pass the tax section of the CPA exam so learning the content was a strong goal. Nearly all students are paying for the program themselves and are working full-time so they are motivated and diligent in completing coursework. All students completed a consent form during the first week of class to comply with the institutional review board practices.

For the two intervention sections, the instructor indicated that all devices of any kind would be off and stored out of sight during the class period. Students were to give their undivided attention to the class activities. About once an hour the class would take a break for five minutes and students could use their devices outside the classroom.

The intervention sections were taught in video-equipped rooms that taped and stored the class lecture (all classes in those rooms were automatically taped and available for later viewing). Although students were not aware of this, the course management software recorded the number of minutes viewed for any student that watched the videos. In order to control for those that viewed the taped lectures, who may have been absent or highly motivated, and therefore somehow different from the other students, we tracked the “video viewers” as a separate self-selected group.

For the two control sections, device use was “natural use.” That is, students were free to use their phones, their tablets, their laptops or smart devices during class if they chose without comment from the instructor. There was no video of the lecture.

Materials

The course had a mid-term and final exam. The midterm was 40 true/false, 60 multiple-choice and ten matching of tax cases with issues central to the tax case. The final exam was 25 true/false, 50 multiple-choice and six matching of cases with tax issues. All exams were graded by a graduate student with no partial credit awarded. The study used the raw points (even though the scores were curved for course credit) and the maximum score was 400 points.

Measures dependent variable

The average raw points, adding the midterm and the final exam scores and dividing by two, was the outcome measure. This measure of achievement reflects the concepts learned during the course.

Independent variable and covariates

Device "prohibited" (vs device "permitted") was the independent variable. We used three co-variates to control for other factors that can influence exam grades. We controlled for prior academic achievement (cumulative GPA), because that reflects academically relevant habits, motivation and subject matter achievements. We included a covariate for amount of college experience, reflected by total credit hours earned, presuming that more experienced students would have more developed understanding of when device use helps or hurts their performance.

The third covariate was to track video use (yes or no). Of the 44 students in the intervention class that had access to videos, 15 students (34.09%) watched the videos, on average, viewing 459 minutes of lecture, a significant amount of time. As shown in Table 1, the cumulative GPA and credit hours earned were nearly identical between students in prohibited sections who watched the videos and those that chose to ignore them, indicating that neither the high achievers nor the struggling students were video users. Those that used the videos had nearly identical exam scores, indicating that video use did not contribute to any increase in exam scores compared to the control group. Our software did not permit us to know if the video, once launched, was actually watched during the full playing time and therefore these minutes may not be fully reflective of extra instructional time.

RESULTS

In an ANCOVA with exam average as the dependent variable, device policy (prohibited or permitted) as the independent variable, and cumulative GPA, total credit hours earned and video use (yes or no), cumulative GPA and device policy were significant predictors of exam average (Table 2, Appendix). Further, interaction of cumulative GPA x device policy indicated that the effect size of device prohibition was uneven across levels of academic achievement. Figure 1 (Appendix) illustrates the interaction, showing that higher achieving students benefitted most from the policy to put devices away.[1]

DISCUSSION

Our work adds a new population, graduate students, to the literature showing the detrimental effect of multitasking and digital distractions in the classroom and supports the finds of many studies that non-academic use is pervasive and harmful (Duncan et al, 2012; Froese, et. al, 2012; Ellis, Daniels, and Jauregui, 2010; Kraushaar & Novak, 2012; Wood, et. al., 2011; Dietz & Heinrich, 2014; Kuznetkoff & Titsworth, 2013). The effect size was even larger than

[1] Pearson Partial Correlation, holding GPA and video use constant, shows video use and scores significantly correlated (Pearson R = -.477, *p*<.001).

found for undergraduates, approximately 69 points out of 400 or about 17% of the course grade. Further, GPA and device use interacted, signaling that the most successful students, potentially those with the greatest capacity to benefit from class activities, were hurt the most.

Clearly students find it difficult to resist device use. Only 57% of the participants adhered to instructions to use only the assigned device during lecture (text, MSN Messenger, Facebook™ or email) when participating in a short term study (Wood *et al.*, 2012). What's worse is that offering anytime access to the lecture does not bridge the gap created by device distractions.

The potentially most serious aspect of our finding is that those harmed generally dismiss the problem as belonging to others (Duncan *et al.*, 2012, Tessier, 2013, Dietz and Henrich, 2014). Policing device use may not be the professor's first choice, although our evidence suggests that helps substantially. Alternatively, instructors could make a serious effort to educate the students about the potential harm. Of course, because students think this applies mostly to others, it may take a little mini-experiment to awaken self-reflection on the realities of device distractions. For instance, one professor at the University of Colorado in Boulder, Diane Sieber, did just that, watching students who used laptops frequently and showing them how their test scores were negatively impacted (Tompkins, 2010). Alternatively, instructors may consider incorporating a classroom exercise on digital device distractions, making students read and discuss some of the research papers on the topic or actually have the students do a mini-research exercise in class to demonstrate digital distraction.

We warn students of the dangers of excessive drinking and illegal drugs. To discourage unhealthy behavior, most campuses are smoke-free. We urge students to walk in pairs after dark, and we widely broadcast information on the negative consequences of academic dishonesty. Why not warn students systematically of another insidious danger in our midst? Allowing digital device use but consciously informing students of the potential harm strikes the right balance between a no-device mandate and the laissez-faire approach of tolerating students' unrestricted device use. The evidence provided here sends a strong message: this is not just a problem for the weak.

This work makes several important contributions. First, it is the first to introduce the harmful effect of device use by graduate students and for students in an upper level accounting topic course. Second, the strongest students lose the most from device distraction. The presumption that the weak and less academically proficient will be harmed the most needs rethinking. We offer this evidence to share with students as support for a no-device policy or as encouragement to enlighten students as to their own self-deception about the impact of devices in academic settings.

LIMITATIONS AND FUTURE WORK

The device-prohibited group had access to lecture videos, and a portion of the cohort repeated the lecture, without any apparent impact on exam average. The lecture views could have been from students that missed class periods (attendance was not taken so this cannot be verified). Future work might offer lecture videos to both cohorts and see if the effect size of the learning differences grows over that found here.

This work and most of the literature is based on how device use hurts during lecture style classrooms. Increasingly instructors are trying a "flipped" classroom, where lectures are delivered outside of class and discussions, problems and activities occur during class. Device use may have different impact on course outcomes in these non-lecture-style classes.

CONCLUSIONS

This study found that even the most sophisticated students, highly motivated graduate students, succumb to the temptation to use devices during class to their academic detriment. Students permitted to use devices performed substantially below those prohibited from using devices during class. The effect size was substantial: 17% of the course grade, and high achievers, those presumably with the best academic skills, suffered greater learning shortfalls over device-deprived peers. This sends a chilling message: the harms are substantial, even for the strongest students who may feel overconfident about their ability to manage device use in an academically neutral way. Well-staged academic use of laptops and digital devices engages students in learning and can be an important learning tool if guided effectively by the professor (Skolnik and Puzo, 2008). Clearly, the use of digital devices in schools and in the workplace is here to stay. Prohibiting devices may not be appealing to instructors. Presenting the evidence about the degree of harm, even for the superstars, at a minimum, seems wise.

APPENDIX

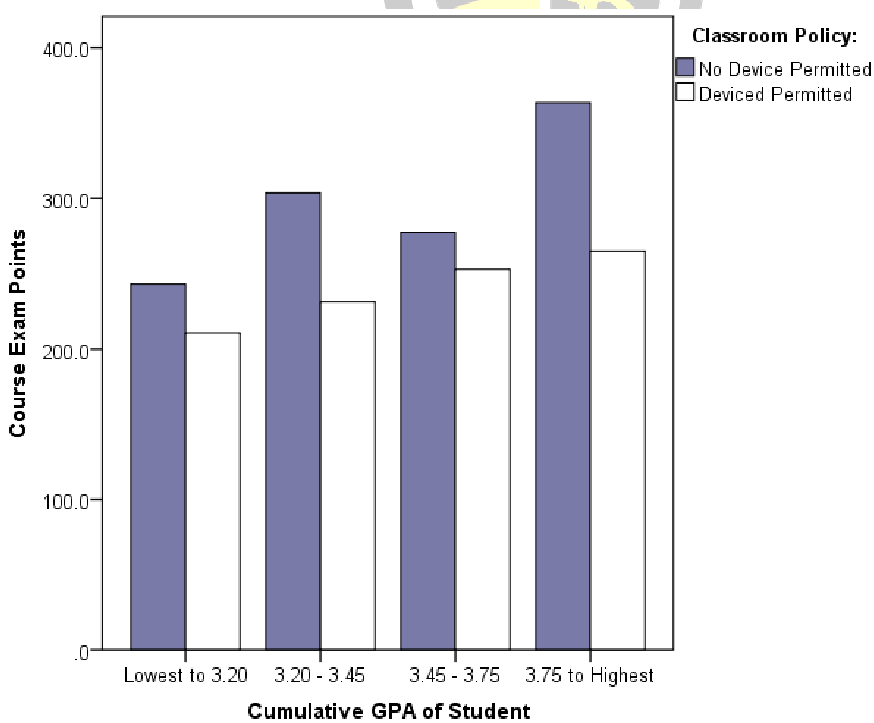
TABLE 1 - Participant Attributes and Exam Scores: Mean (Std. Dev.)

Attribute	Device Prohibited		Device Permitted	All Participants
	Video Use	No Video		
Number of participants	15	29	55	99
Cumulative GPA	3.58	3.58	3.40	3.48
Masters Credit Hours	33.50	34.31	34.03	33.82
Exam points	302.47 (52.17)	305.95 (75.42)	237.19 (42.21)	267.22 (64.31)

TABLE 2 - Analysis of Covariance on Exam Averages

	Type III Sum of Squares	Df	Mean Square	F	Signif.	Partial Eta Squared
College Credit Hours Earned	2574.017	1	2574.017	1.315	.255	.015
Cumulative GPA	40535.878	3	13511.959	6.902	.000	.194
Device Prohibited	63417.622	1	63417.622	32.396	.000	.274
Video Used	67.287	1	67.287	.034	.853	.000
GPA x Device Prohibited	33095.747	3	11031.916	5.635	.001	.164

FIGURE 1 - Interaction of GPA and Device Use on Exam Scores



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