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Are Students Self-Regulating Their Device Usage? The Effects of Off-Task Device Usage in a Classroom Setting

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ABSTRACT

Although previous research indicates a negative relationship between personal device usage and classroom performance, how students self-regulate the use of these devices has not been explored. This study investigated a) the influence of off-task device usage in class on subsequent exam performance, and b) whether students self-regulate their device usage throughout the semester. Results indicated that off-task device usage was associated with lower performance on exam one, but not the last regular exam. Findings suggest that off-task device usage may impact students' grades in a class; however, when their grades are negatively impacted, students appear to self-regulate their device usage.

KEYWORDS

Academic performance; classroom behavior; device usage; self-regulation

The integration of technology and electronic devices in the classroom has greatly impacted the way students learn and interact with information. With the advent of laptops, tablets, and smartphones, students now have access to a wealth of information at their fingertips. This can have a profound effect on academic performance and has led to a new set of challenges and opportunities for both teachers and students. Over the past decade, interventions have been developed that would encourage a more attention-aware classroom (e.g., Bunce, Flens, and Neiles 2010; Burke and Ray 2008; Schacter and Szpunar 2015). However, before interventions can be effectively developed, it is important to understand how students use electronic devices across a semester long course and whether the frequency of usage changes throughout the semester.

Researchers have noted that the use of electronic devices has the potential to both support and hinder academic performance. One of the most significant advantages of electronic devices in the classroom is the ability for students to access information quickly and easily. This can lead to greater engagement and motivation in the learning process. For example, students can use online resources to conduct research, access educational videos and simulations, and collaborate with peers on projects. These opportunities allow students to connect with the material on a deeper level, which can lead to improved understanding and retention of information (Day, Fenn, and Ravizza 2021). However, while electronic devices can have a positive impact on academic performance, they can also lead to distractions and decreased attention in the classroom. With the rise of social media, students may be tempted to use their devices for nonacademic purposes, such as texting, browsing the internet, or playing games. This can lead to decreased focus and attention, which can negatively impact academic performance (Uzun and Kilis 2019).

Of the many electronic devices available to students, laptops and cellphones are perhaps the most widely used in a college setting. Morehead et al. (2019) found that approximately half of the college students surveyed preferred taking notes on a laptop as opposed to longhand writing. In addition to laptops, cellphones are always on-hand and allow users to instantly connect to social sites, the internet, and to friends, thus providing the user with a constant stream of information at any time and place. When asked, 70-90% of college students reported that they texted on their cellphones during class (Parry and Le Roux 2018), with anywhere from 15-20 messages sent during class (Dietz and Henrich 2014).

There are numerous reasons why students check their cellphones during class. Oulasvirta et al. (2012) found that such factors included boredom, a need for information, or simply taking a small attention break. They also found that these checking habits were

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typically short, but that such checking behaviors could facilitate more task-irrelevant behaviors. Moreover, students may be aware that checking their cellphones during class can negatively impact their learning, yet they continue to engage in these behaviors (Harrison and Gilmore 2012). One possible explanation for this disconnect between students' perceptions and their actual behavior in the classroom could be attributed to misplaced confidence. Students believe that they are good multitaskers and can overcome distractions that might be caused by engaging in task-irrelevant behaviors on their devices (Finley, Benjamin, and McCarley 2014; Ophir, Nass, and Wagner 2009).

Students' awareness of the challenges presented by device usage may also be a function of self-regulatory skills. According to Zimmerman (2002), self-regulation of learning is not tied to a single trait, rather it involves an awareness of the various processes and strategies that impact one's learning. This awareness eventually leads the learner to modify their behavior in an attempt to successfully execute each learning task. Students who possess high self-regulation skills understand the parallel between their own behavior and the ramifications of that behavior. Thus, they are able to control and modify their own behaviors (e.g., putting away their cellphones) in a way to optimize their learning environment. When students can regulate their own behavior and use electronic devices effectively, they are more likely to stay focused and engaged in the learning process, which could ultimately enhance academic performance.

Before a decision can be made about interventions, more research is needed to better understand how students use electronic devices for off-task activities during class. Much of the research conducted thus far has focused on the immediate and short-term impact of off-task device usage on learning outcomes. Very few studies have continuously measured such device usage over an entire semester and compared that usage to the students' overall grade in the class (Bjornsen and Archer 2015).

Another limitation of previous research is that most of the data was collected in a simulated classroom setting. For example, some studies would have students interact with short, prerecorded lectures or reading passages while having them engage in distracting behaviors like texting or accessing the internet (Dietz and Henrich 2014; Risko et al. 2012). Their level of recall would then be measured by administering an exam on the covered information. Such methodologies lack the ecological validity afforded by collecting data in an actual classroom during a regular semester. In a laboratory type setting, students might not be as invested in the simulated lecture and more inclined to use their devices, thus obscuring their off-task device usage behaviors.

Present study

The current study examined the long-term effects of off-task device usage on students' overall performance across different exams given throughout a semester. Unlike previous research, students in the current study were surveyed once a week for 15 wk about their off-task device usage during class. In addition, rather than just collecting a single exam score, we collected multiple exam scores to assess the impact of device usage throughout the semester. The two main objectives of the current study were to examine off-task device usage in a non-simulated classroom setting and to determine whether students self-regulate their device usage throughout the semester. Given the growing body of research on the relationship between electronic device use and academic achievement, we hypothesized that there would be a negative association between electronic device usage and subsequent exam performance. Finely et al. (2014) found that individuals can, to some degree, predict their performance deficits from multi-tasking, thus we also hypothesized that students would be able to self-regulate their device usage after receiving feedback (i.e., knowing their grades) on course assessments.

By utilizing a class for which the students earn course credit, our design captures authentic and typical student behaviors in the classroom. The motivation of students in an actual classroom likely differs compared to those in a laboratory setting. Similarly, the amount and type of off-task device usage of students in an actual classroom are certainly different from those in an experiment whereby they are instructed to engage in a specific off-task device usage behaviors (e.g., being told to send emails when prompted). In sum, results from our study may aid scientists in understanding the role of more organic levels of device usage on exam grades, as well as practitioners seeking to incorporate interventions and/or policies that enhance learning in the classroom.

Method

Participants

A total of 106 students (81 females; 25 males) participated in the study. We selected this sample size because an a priori power analysis conducted using G*Power software (Faul et al. 2007) indicated that 84

participants were needed to achieve sufficient power (.80) for a bivariate correlation, with a moderate effect size (.30) and .05 alpha level.

All students were enrolled in an upper-level Psychology course at a medium sized liberal arts university in the Southeast during the Fall 2019 semester. The students were enrolled in one of the following upper-level courses: Learning and Memory ($n = 25$), Cognitive Psychology ($n = 54$), or Sensation and Perception ($n = 27$). The average age of participants was 22.2 years, and the sample was racially diverse (White/Caucasian = 43, Black/African American = 46, Asian = 4, Hispanic = 9, Other = 4). Students earned extra credit for their participation, which was determined by the instructor of the course, and the study was approved by the University of South Carolina Institutional Review Board.

Measures

The device usage questionnaire consisted of three items and was adapted from Bjornsen and Archer (2015). The first two items instructed participants to (1) rate their understanding of today's class content and (2) rate their interest in today's class content. These two items were on a 4-point Likert scale ranging from 1= very low to 4 = very high. The last item instructed participants to report how many times they used an electronic device (e.g., laptop, tablet, cellphone, smart watch, etc.) during today's class, irrespective of checking the time and taking notes to: (a) read or send an email; (b) read or reply to a text message; (c) check social media (Facebook, Instagram, Twitter, Snapchat, etc.); (d) play a game; and (e) shop online. This third item was on a 6-point Likert scale ranging from 1 = never to 6 = very frequently. Finally, the questionnaire asked participants to report their demographic information, including gender, age, and race.

Course descriptions

Of the three courses used in the study, two upper-level psychology classes met for 50 min three times a week (Learning and Memory, Cognitive Psychology) and one upper-level psychology class met for 75 min twice per week (Sensation and Perception). Two of the classes consisted of a single section (Learning and Memory, Sensation and Perception) and one class consisted of a double section (Cognitive Psychology), hence why there were more students enrolled in Cognitive Psychology. Although the courses were taught by different instructors, each instructor primarily used the lecture format during instruction.

Procedure

On the first day of class, students were told that once a week they would be asked to respond to a series of questions regarding their electronic device usage for that class period. Students were also made aware that they could decline participation without penalty; however, all students consented to participate in the study. Each instructor emphasized that the devices used could be laptops, cellphones, tablets, smart watches, and other similar devices. The students were told that all responses were confidential. A unique numeric identifier was assigned to each student so that their data could be paired with their responses and grades at the end of the semester. Lastly, they were told to feel free to use or not use their devices during class, as participation in the study would not affect their grades in any way.

Each week (not including the first week of classes and Thanksgiving break) for a total of 13 weeks, the instructor distributed the questionnaire with approximately 10 minutes remaining in the class period. Weekly administration of the questionnaire was determined by the instructor; thus, the questionnaires were not given on the same day each week. Students remained seated until all questionnaires were completed.

All course exams were held in-person, worth 100 points each, and included multiple choice and short answer questions. Two of the courses (Cognitive Psychology, Sensation and Perception) had a total of four exams given throughout the semester, while the Learning and Memory course had three exams given throughout the semester. For comparison purposes, we chose the first regular exam ($n = 106$) and the last regular exam ($n = 103$). We chose the last regular exam as opposed to the final as we believed final exam performance may be influenced by more external factors (e.g., some finals are optional, some are cumulative). Additionally, student motivation and intentions may differ qualitatively for the final exam (Gray and Bunte 2022).

Results

Scoring

Descriptive statistics for our study variables are shown in Table 1. Prior to testing our hypothesis, device usage for the weeks preceding the first exam (two weeks for Cognitive Psychology and Sensation and

Perception, three weeks for Learning and Memory) were averaged within person to provide a mean score for each off-task device usage item. Preliminary results indicated that courses did not differ for any device usage behavior (all $p > .40$) or for grades ($p = .58$).

Primary analyses

First, bivariate correlations were calculated to test our prediction that device usage would have a negative relationship with the student's first exam performance. As shown in Table 2, results demonstrated that several device usage behaviors in class preceding the first exam contributed to lower exam one performance. Specifically, email use ($r = -0.33$, $p < .01$), texting ($r = -0.24$, $p < .05$), and social media use ($r = -0.29$, $p < .01$) shared statistically significant negative relationships with exam one performance.

Next, we explored whether off-task device usage contributes less to exam grades as the semester progressed. We examined bivariate correlations between off-task device usage for the weeks preceding the last regular exam (LRE variables in Table 2) and grades on that exam, thereby isolating the effects of off-task device usage that were most proximal to this final regular exam. As shown in Table 2, none of the off-task device usage variables were significantly correlated with performance on the last regular exam. Therefore, it is possible that students changed their behavior as a result of receiving feedback on their performance.

To further clarify whether the decline in predictive validity of off-task device usage was due to students' self-regulation of their device usage, we chose to compare the relative levels of early semester off-task device usage to later semester usage. We hypothesized that students may engage in fewer such behaviors during the semester, particularly following feedback (e.g., knowing exam one grades). We conducted a series of paired t-tests comparing usage behaviors prior to exam one to usage behaviors prior to the last regular exam. Results found that all the device usage behaviors declined except for social media use; however, only texting behaviors were statistically significant, $t(95) = 2.91$, $p < .01$. When all items were combined into a single device usage score, the results revealed a significant decline in device usage from the weeks preceding the first exam ($M = 1.76$, $SD = .90$) to the weeks preceding the last regular exam ($M = 1.64$, $SD = .94$), $t(95) = 2.12$, $p = .04$, $d = .56$.

Supplemental analyses

To test whether there was within-person decreases in texting for students performing poorly on exam 1, we conducted a 2 Texting (prior to Exam 1, prior to LRE) X 4 Grade (A, B, C, Fail) mixed ANOVA. Congruent with our hypothesis, students changed their behavior following feedback from exam 1, with students exhibiting fewer texting behaviors leading to the final regular exam (see Figure 1). The interaction between texting and grades was also significant, $F(3, 92) = 2.88$, $p = .04$. Specifically, students that failed exam 1 showed the largest decrease ($M_{difference} = .764$, $p = .004$), students with a "B" or "C" grade on exam 1 decreased similarly ($M_{difference} = .524, .576$ respectively, $p = .048$), and students with an "A"

Table 1. Descriptive statistics.

Variables	E1 *Mean (SD)*	LRE *Mean (SD)*
Grade	0.78 (.15)	0.80 (.13)
Interest	3.19 (.52)	3.15 (.52)
Understanding	2.92 (.66)	3.03 (.60)
Emailing	1.76 (1.14)	1.64 (1.12)
Texting	2.64 (1.46)	2.23 (1.38)
Social Media	1.72 (1.12)	1.74 (1.37)
Playing Games	1.18 (.73)	1.17 (.77)
Shopping	1.24 (.74)	1.21 (.82)

Note. E1 refers to data collected for exam 1 analyses. LRE refers to data collected for the last regular exam analyses.

Table 2. Correlations for study variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Exam 1	–											
2. Last Exam	0.53**	–										
3. (E1) Email Use	−0.33**	−0.24*	–									
4. (E1) Texting	−0.24*	−0.20*	0.53**	–								
5. (E1) Social Media	−0.29**	−0.24*	0.61**	0.66**	–							
6. (E1) Play Game	−0.10	−0.10	0.52**	0.38**	0.52**	–						
7. (E1) Shopping	−0.15	−0.15	0.51**	0.53**	0.60**	0.84**	–					
8. (LRE) Email Use	−0.06	−0.09	0.56**	0.44**	0.51**	0.45**	0.42**	–				
9. (LRE) Texting	−0.02	−0.14	0.53**	0.58**	0.59**	0.37**	0.44**	0.61**	–			
10. (LRE) Social Media	−0.05	−0.18	0.51**	0.54**	0.66**	0.46**	0.53**	0.60**	0.72**	–		
11. (LRE) Play Game	−0.12	−0.07	0.50**	0.40**	0.53**	0.84**	0.68**	0.66**	0.49**	0.58**	–	
12. (LRE) Shopping	−0.13	−0.14	0.56**	0.45**	0.52**	0.78**	0.69**	0.57**	0.49**	0.52**	0.88**	–

Note. *$p < .05$. **$p < .01$.

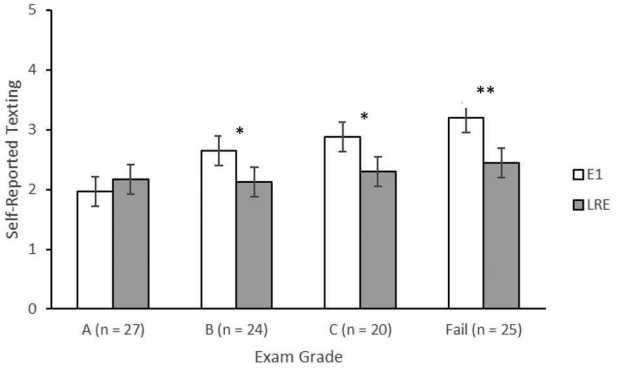

Figure 1. Changes in texting behavior as a result of Exam 1 grade performance.
Note. E1 = Exam one; LRE = Last Regular Exam; *$p < .05$, ** $p < .01$

demonstrated little change in texting behaviors ($M_{\text{difference}} = -0.205$, $p = .408$). This finding further supports the notion that students self-regulated their texting behavior based on feedback from the first exam.

Discussion

The purpose of the current study was to investigate a) whether off-task device usage was related to exam performance, and b) whether students self-regulate such task irrelevant behavior as the semester progresses. As predicted, off-task device usage adversely influenced performance on the first exam. However, the results also revealed that some device usage behaviors did not significantly impact exam one performance; playing a game and shopping were not correlated with exam one performance. These results may be complementary to findings reported by Patterson (2017), which revealed that media multitasking had negative effects on test performance, especially when considering the combination of many unrelated tasks while studying. In the current study, playing a game and shopping had the lowest reported frequency of use and smallest variance among the off-task behaviors. Additionally, these behaviors may be the most egregious in the eyes of students and teachers, thereby prompting more socially desirable responding especially when compared to texting, which has become rather ubiquitous in many classrooms. Taken together, it is possible that the range restriction and skewness in these behaviors' frequency led to an attenuation of the effect.

Previous studies on the relationship between device use and academic performance have been limited to mainly cellphones and laptops. These studies have provided evidence that self-reported device usage often negatively impacts academic performance in the short-term and long-term (Gingerich and Lineweaver 2014; Junco and Cotten 2012; Junco 2015; Lepp, Barkley, and Karpinski 2014). Findings of the current study both replicate and extend prior work by demonstrating a negative relationship between electronic device usage and academic performance. Implications from these findings raise the following two important points: (1) engaging in any off-task device usage during a lecture-based class has deleterious effects on initial exam performance; and (2) students seem to become more metacognitively aware that their device usage may be impeding their learning, especially after the first exam.

In addition to examining the effects of device usage on exam one performance, we also wanted to determine what impact device usage would have on the last regular class exam. We hypothesized that students would change their device usage throughout the semester as a reflection of course performance. Aligned with this hypothesis, our results indicated that device usage did not significantly impact performance on the last regular exam in each course. This finding provides evidence that students were engaging in some self-regulatory monitoring as the semester progressed.

Although we did not ask participants to report their metacognitive beliefs about using electronic devices during class, many are probably aware of its consequences. For example, Rosen, Carrier, and Cheever (2011) found that nearly three-fourths of participants felt that receiving and sending text messages during class was disruptive to learning. In the context of the current study, this awareness became salient after exam one. Overall, there was a significant decline in device usage from exam one to the last regular exam (see *t*-test results). While this finding included the combination of all device usage behaviors, our results also revealed that texting behavior had the most significant decline from the first exam to the last regular exam. While there was an overall reduction in the amount of engagement with device usage, texting showed the greatest reduction perhaps due to its ubiquitous nature. Our findings indicated that students were more inclined to text than engage in any other off-task device usage behavior; therefore, texting had the greatest room to decline. It is possible that students may not believe that their learning is impaired when texting during a lecture until they are required to retrieve the material later during course assessments.

As noted by Forsythe and Johnson (2017), feedback increases student's metacognitive awareness which should translate into some meaningful behavior change.

In the current work, it appears that performance feedback led to behavior changes (i.e., less device usage) among students, perhaps in hopes of achieving better results on subsequent assessments. In particular, supplemental analyses revealed that students who failed the first exam reported far fewer texting behaviors prior to the last regular exam, students with a "B" or "C" first exam grade reported fewer texting behaviors as well, and students with an "A" on the first exam did not meaningfully change their texting behaviors. Collectively, these findings suggest that students were monitoring and adjusting their discretionary behavior in class (e.g., texting) to some extent based on their initial performance in class.

While our findings have important educational implications, there are limitations that must be addressed. One factor that might impact students' performance in class could be mind wandering. For example, Wammes et al. (2016) examined the influence of unintentional and intentional mind wandering on immediate and long-term performance. They found that intentional mind wandering was more strongly linked to poor short-term performance, while unintentional mind wandering was more strongly linked to long-term performance. The use of electronic devices for nonacademic related activities could be more strongly associated with intentional mind wandering than unintentional mind wandering. Other factors that might affect exam grades beyond device usage include out-of-class study time, fixed versus growth mindset, different instructors, and teaching styles, etc.

It is not plausible to hold all these factors constant in a single study, thus future research should include other types of assessments such as quiz grades. It may also be prudent to get a measure of students' pre-course GPA as some studies have indicated a negative relationship between device use and GPA (Bjornsen and Archer 2015; Lepp, Barkley, and Karpinski 2014). In the future, obtaining students' GPA will allow us to examine any possible moderating effects on the relationship between off-task device usage and exam grades.

Another limitation of the current work is that there were no other methods utilized to record device usage besides a self-report measure. Although most studies examining the relationship between student device usage and academic achievement rely on self-report, we suggest that future studies not only record how students use their devices, but how long they engage in those off-task device usage behaviors. This would allow for a more accurate and nuanced assessment of the impact of such behaviors on academic performance.

Lastly, we must also acknowledge that data from the current work was gathered one semester before widespread effects of the COVID-19 pandemic. During the pandemic, many instructors were forced to adapt their teaching methods to incorporate more digital technologies. Future research should examine how students engage with different electronic devices as they return to campus and the classroom setting following a global pandemic.

Conclusion

The availability and capability, as well as the potential benefits and drawbacks, of technological devices have increased over the past few decades, particularly in educational settings. While students have always engaged in some off-task behaviors in the classroom, technology has expanded the range and engagement of those behaviors. As devices continue to become increasingly integrated in the classroom, often in a mandated fashion (e.g., requirements to bring laptops to class), the influence of their on-task and off-task use will also be of increasing importance. Before making decisions about whether to ban (or mandate) electronic devices like cellphones and laptops in the classroom, researchers should continue to focus on how self-regulation interacts with electronic device usage and classroom performance. Although there has been increasing interest in studying metacognition and its impact on students' performance, the majority of this research has been conducted in laboratory settings (Tauber and Ariel 2023). The current study elected to utilize real college classes that were semester long in length, which would afford greater generalizability to authentic and typical educational environments. While this is a strength of the current work, future studies examining electronic devices in a classroom setting should consider utilizing mixed-methods approaches. After all, electronic devices are not going anywhere anytime soon.

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