

SÃO PAULO, JUNE 2017

Cell Phone Usage And Academic Performance: An Experiment

DANIEL DARGHAN FELISONI ^a and ALEXANDRA STROMMER GODOI, Ph.D. ^b

^a Student, FGV/EAESP, Rua Itapeva, 474 – 11o andar, Sao Paulo, Brazil (e-mail: dfelisoni@gmail.com)

^b Department of Economics, FGV/EAESP, Rua Itapeva, 474 – 11o andar, Sao Paulo, Brazil (e-mail: alexandra.godoi@fgv.br)

ABSTRACT

This paper makes use of an experiment to test the relationship between the actual average time students spend using their cellphones per day and academic performance. Differently from previous studies that rely on self-reporting cell phone usage data, which tends to significantly underestimate the time spent by students at their cell phones, we employed an App to effectively measure actual usage. Collecting data from students at FGV, a business school from São Paulo, Brazil, our analysis yielded a significant negative relationship between total time spent using cellphone and academic performance, after controlling for demographic information and other known predictors of performance. Each 100 minutes spent using the device on average per day reduced a student's position in the school's ranking by 6.3 points, in a range from 0 to nearly 100. Moreover, if we consider usage during class time only (as opposed to during free time and weekends), the effect is almost twice as high. The extent of this effect is alarming, the highest among all variables contemplated: each 10 minutes of usage during class time is equivalent to a decline of almost 19 positions at the entrance exam ranking (ranging from 1 to 350), a thorough test on all major academic subjects for which students prepare along their whole school lives. Thus, this study brings new evidence of the potential harm of excessive cellphone use and should be useful for educators and other academic stakeholders interested in the subject of the impact of technology on students' performance.

Keywords: cellphone use and academic performance, cellphone usage in college, influence of technology on college grades, experiment, actual cellphone usage, cellphone in class

INTRODUCTION

In recent years, specifically from 2000 onwards, access to affordable digital devices rose substantially, as cellphones, tablets and laptops became part of the academic life from elementary school to graduate courses. Nowadays, in every campus worldwide, cellphones and tablets are ubiquitous and their use becomes everyday more frequent, not only in spare time, but also during class. In fact, cellphone usage is so frequent among students that they tend to underestimate the number of times they access their phones. Duncan, Hoekstra & Wilcox (2012) suggest that, on average, students report an access rate of three times per class while the actual observed rate is close to stunning twenty-one times.

Even though the use of technology, especially portable devices, may provide a set of tools that potentially leverage learning, research (e.g., Barkley & Lepp, 2013) has shown that these technologies are primarily perceived as a leisure tool, not as an educational one. Therefore, if cellphones are commonly used in class for purposes unrelated to the discipline, it is likely that students may be distracted during lectures or activities, as they often overestimate their ability to multitask (Ophir, Nass & Wagner, 2009), which eventually leads to academic underperformance.

In this context, it is reasonable to question whether the benefits of cellphone usage are overcome by the harm of distraction and misuse of time, leading to academic underperformance. Therefore, it is necessary to understand if students, particularly heavy cellphone users, get worse academic results when compared to those who use it in moderation. Thus, the purpose of the present study is to investigate whether there is any negative implication of high cellphone usage in academic performance and, if any correlation is found, in what intensity does the cellphone usage impact student's results.

Survey-collected vs actual observed data

Previous studies that investigated the relationship between cellphone usage and academic performance relied on self-reported cellphone usage time, which carries significant bias for two main reasons. Firstly, most people give imprecise information, because it is rather difficult in practice to estimate how much of one's day was dedicated to any particular activity. In fact, comparing self-reported cellphone usage time assessed in the questionnaire we applied to our sample of 44 students to the actual usage time obtained through the monitoring applications, the latter was on average 48.5% higher, which indicates that not only people are imprecise, but also tend to significantly underestimate this variable. Secondly, when self-reporting usage time, there is little assurance that the concept of usage is the same

among participants. While one may believe that only calling and texting amount as cellphone usage, for instance, another may consider only gaming, or surfing the internet.

In order to attempt to eliminate the above-mentioned bias of self-reporting data, cellphones from students at Fundação Getúlio Vargas, a business school in São Paulo, Brazil, were monitored through downloaded applications (Apps) which retrieved data of each cellphone's actual daily usage. This data was then voluntarily shared by students with the experiment's developers, and was used, together with demographic and official academic performance information, to assess the relevance and impact of cellphone usage in academic results.

The available literature points to a negative correlation between digital portable devices usage and academic performance: the more frequently students use their cellphones, the lower their position in academic rankings, indicating that cellphone usage is generally a focus of diversion to students rather than a content contribution tool. Our regression model, based on a sample of 43 students, yielded a expressive and statistically significant negative relationship between cellphone use and student's official accumulated college's average grade ($\beta = -0.063$). This relationship was twice as high when we considered usage during class time only ($\beta = -0.120$), suggesting that students might be getting distracted by technology and loosing focus on the disciplines they are supposed to be learning.

LITERATURE REVIEW

Despite increasing penetration of technology across universities around the world in the last decade, its academic effects, particularly over students' learning, have been scarcely tested or documented. Whenever applied, surveys oriented to understand the impacts of cellphone usage over academic performance have either failed to involve all possible applications of current smartphones – meaning that they have focused on traditional uses only, such as texting and calling –, or have lacked appropriate methods to accurately quantify the actual amount of time spent on smartphones during classes. For instance, Jacobsen and Forste (2011) studied the impacts of texting and calling in self-reported GPA scores in a sample of North American students. Even though the study found a negative relationship between the variables, it failed to acknowledge that social medias, web surfing and gaming, for example, might have similar or worse effects compared to texting and calling. Hong, Chiu and Hong (2012) found similar conclusions when analyzing texting and calling effects among Taiwanese female students.

Isolated effects of uses other than texting and calling have been analyzed, however. Most conclusions, especially when testing for social media and gaming impacts, have pointed to a negative correlation between their use and academic performance. Jackson et al (2011) associated lower GPAs with heavy gaming while Chen & Peng (2010) related lower levels of internet use with better academic performance.

Furthermore, the impact of social media has been extensively documented across the world. In every case, the amount of time spent on social media was negatively related to academic performance. Many studies have tested for the same variables in a variety of social media settings (Facebook, Twitter, Whatsapp), but we highlight Kirschner and Karpinski (2010), which notably found that heavy Facebook users had a lower self-reported GPA, and Junco (2012a, 2012b), which concluded that Facebook usage contributed to lower actual GPA.

Predictors of Academic Performance

Several past studies have established predictors of academic performance which must be used as control variables in this study, such as the “self-efficacy” beliefs (Pajares, 1996), which portray one’s belief in his or her ability to plan and execute the necessary tasks to perform well and succeed in whichever goals him or her might have. As a consequence of this belief, students reporting higher self-efficacy scores are usually more perseverant and more inclined to learn (Schunk, 1984, 1989). Hence, self-efficacy measures are positively correlated to most academic performance results, such as grades, homework, assignments, and class positioning (Multon, Brown & Lent, 1991; Pajares, 1996).

Two frameworks of self-efficacy have become notorious because of their predicting accuracy (Pajares, 1996). The first is the self-efficacy for self-regulated learning (SE:SRL), which describes a student's ability to regulate his own path towards academic success, which includes avoiding distractions, overcoming obstacles, accomplishing necessary tasks and creating appropriate learning environments. The second is the self-efficacy for academic achievement (SE:AA), which involves one's ability to learn contents from specific fields of knowledge, such as science and math.

Lepp, Barkley and Karpinski (2015) have published the only study so far that sought to relate cellphone usage and academic performance while controlling for known predictors such as SE:SRL and SE:AA. After sampling 536 undergraduate students and controlling for demographic variables, self-efficacy for self-regulated learning (SE:SRL), self-efficacy for academic achievement (SE:AA) and actual high school GPA, the study concluded that there

was a negative relation between cellphone use and college GPA (proxy for academic performance), with $\beta = -0.164$ and $R^2 = 0.449$.

Finally, some research has also been conducted on multitasking and task-switching in order to identify their effects on academic performance. It is imperative to notice that technology use is highly related to multitasking, particularly for students, once they often keep connected to social media and their friends through texting apps while studying and doing homework. Indeed, several studies (notably Jacobsen & Forste, 2011 and Junco & Cotton, 2012) have confirmed that students report being connected to more than one social media while performing academic tasks. Notwithstanding, Wood et al (2012) found that multitasking in any of the analyzed technologies (emailing, texting and Facebook) was negatively correlated to the capability to learn effectively, demonstrated by lower test scores. Junco & Cotton (2011) also found that multitasking between Facebook and academic tasks as well as between texting and academic tasks was prejudicial to college GPAs, after controlling for variables such as sex and high school GPA.

In sum, while the available literature surrounding the effects of technology over academic performance offers some guidance towards the expected results for the present study, it is clear that some specific gaps have not been filled yet. First, it is necessary to address the cellphone as an integrated platform for a variety of applications, extending beyond traditional uses such as texting and calling. Moreover, even though several analyses have come to a common conclusion determining the negative impact of isolated uses, it might be that, as they coalesce, influence is even more harmful. Lepp, Barkley and Karpinski (2015) began to close this gap, analyzing the cellphone platform as a whole. However, their study was based on surveys to determine the intensity of cellphone usage, which according to their own data collected from a group of 21 students, had only a moderate correlation (50%) to actual cellphone usage obtained through their cellphone's records.

Second, all available literature is based on surveys to quantify the amount of time spent on cellphones and GPA to determine academic performance. Even though surveys are valuable tools, the present study will address the direct impact off cellphone usage by observing *actual time spent* using smart, integrated devices, without relying on student's own perceptions. An experimental method such as the one proposed in the present study is necessary to adjust to inherent biases present on surveys as a metric for understanding the cellphone's influence.

Table 1 – Summary of Literature

Author	Main Conclusion	Sample	Limitation
Lepp, Barkley and Karpinski (2015)	Negative relation between cellphone use and college GPA ($\beta = -0.164$ and $R^2 = 0.449$), after controlling for demographic variables, SE:SRL, SE:AA and actual high school GPA	Sample of 536 North American undergraduate students	Uses self-reported cellphone usage data (survey completed during class)
Hong, Chiu and Hong (2012)	Negative relationship between texting and calling	Sample of Taiwanese female students	Uses self-reported data; fails to acknowledge other uses
Junco (2012a)	Negative relationship between Facebook usage and actual GPA scores	Sample of 2368 US college students	Uses self-reported Facebook usage data (online questionnaire) and actual GPA data; fails to acknowledge uses other than Facebook
Junco (2012b)	Negative relationship between Facebook usage and actual GPA scores ($\beta = 19.530$, $p < .001$, adjusted $R^2 = 0.208$)	Sample of 1839 US college students	Uses self-reported Facebook usage data (online questionnaire) and actual GPA data; fails to acknowledge uses other than Facebook
Wood et al (2012)	Multitasking in any of the analyzed technologies (emailing, texting and Facebook) was negatively correlated to test scores	Sample of 145 North American students (116 females and 29 males)	Intends to evaluate the effectiveness of multi-tasking, not cellphone usage
Jacobsen and Forste (2011)	Negative relationship between usage of electronic media and GPA scores; social networking and cell phone/texting being the most significant	1,026 first-year North American university students	Uses self-reported data (logs in a time diary)
Jackson et al (2011)	Negative relationship between heavy gaming and self-reported GPA scores	Sample of North American students	Uses self-reported data; fails to acknowledge other uses
Junco & Cotton (2011)	Found that multitasking between Facebook ou texting and academic tasks was prejudicial to college GPA	Sample of North American students	Uses self-reported data; does not focus on cellphone usage
Chen & Peng (2010)	Related lower levels of internet use with better academic performance	49,609 junior students from 156 universities	Uses self-reported data (online questionnaire); fails to specify different uses
Kirschner and Karpinski (2010)	Negative relationship between heavy Facebook usage and self-reported GPA scores	102 undergraduate and 117 graduate students at a large, public Midwestern (US) university	Uses self-reported data; considers only Facebook usage

METHODOLOGY

As previously discussed, all past studies that investigated the implications of cellphone usage in academic performance were based on surveys, questioning each participant about the amount of time they had spent on their cellphones during a given period. However, Duncan, Hoekstra & Wilcox (2012) found that, on average, the difference between reported access rate and the actual rate among students might be as high as sevenfold. Thus, to capture the real and indisputable influence of cellphone usage on students' performance, it is necessary to observe their natural behavior during a typical day and collect data that is unrelated to each student's own bias. Therefore, the current experiment was designed to extract information automatically from the student's regular routine, with the least intervention possible from the research team or from the subject of the study.

Sample

All 250 students (of the 5 different classes) enrolled in 4th semester of the undergraduate course in Business Administration of Fundação Getúlio Vargas (FGV-SP) were invited to participate in an experiment and offered, as a reward for participation, a credit of 10 hours of "complementary activities"¹. The 4th semester was chosen because FGV students, in their first four semesters at school, are required to complete a series of common mandatory disciplines. After their 5th semester, they are allowed to "customize" their curriculum by choosing elective disciplines, which would compromise comparability in our analysis of grades.

Invitations took place during class time. The presentation from the experiment's developers to the students took, on average, 10 minutes and exhaustively explained all the steps of the experiment. However, in order to avoid any bias, the final purpose of the study was not revealed. Students were informed only that the experiment intended to study their cellphone usage habits, but the possible effect on academic performance was not mentioned. The invitation was reinforced by an email to all students, which once again detailed all procedures of the experiment.

Since the experiment involved sensitive data, students were assured that every shared information would be kept anonymous and under no circumstance would be sent to other

¹ Students at FGV must have completed 300 hours of complementary activities by the end of the 8th semester in order to graduate.

parties. To ensure secrecy to students, a confidentiality letter was signed by the investigators and the Undergraduate Dean at FGV and delivered to all participating students.

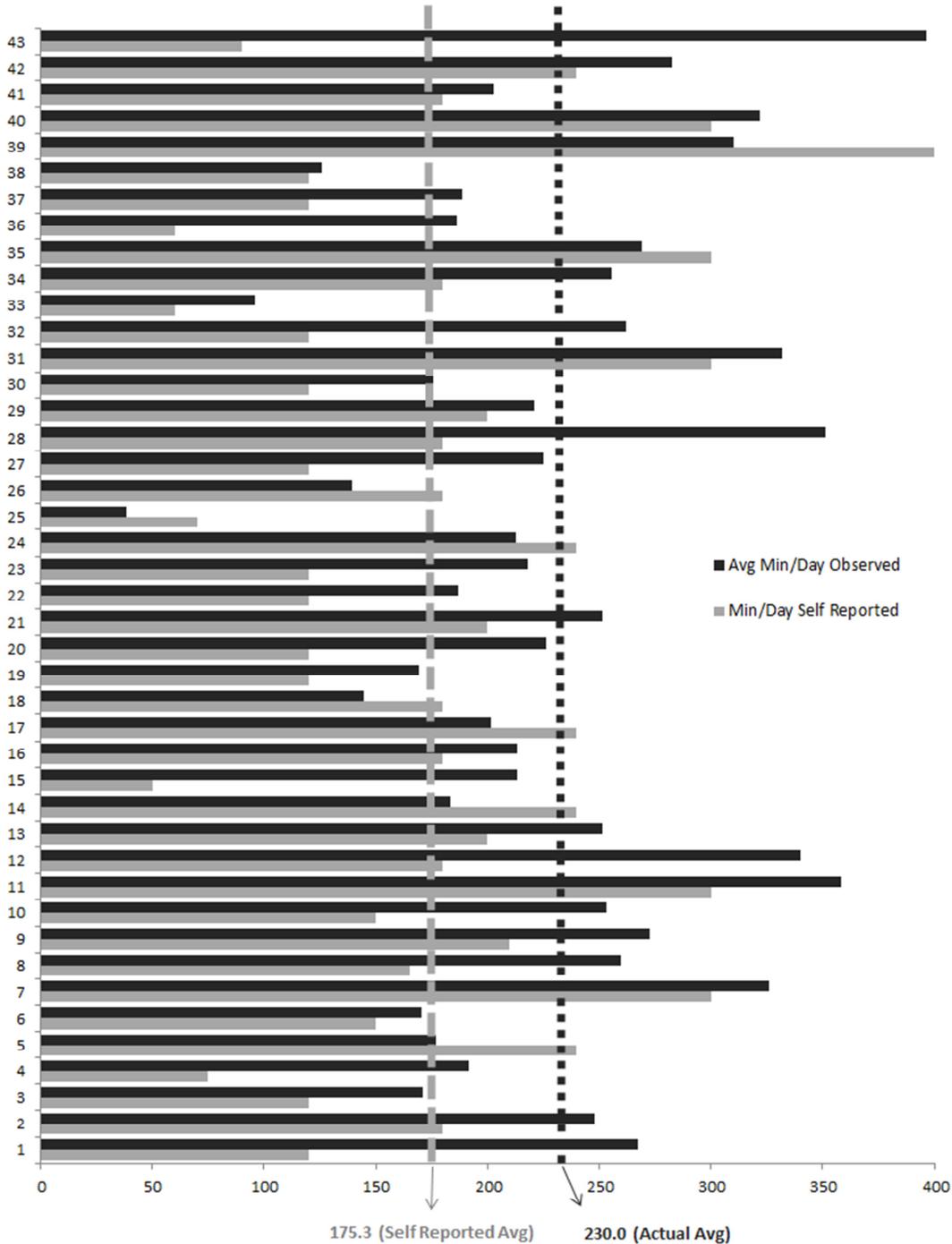
Out of the 250 recruited students, 54 sent their cellphone data to the experiment's investigators, but only 43 of those contained full two-weeks of data, which was the minimum required by the investigators to complete the study. Therefore, the final sample of the experiment was 43 students ($N = 43$) from 5 different classes, where men accounted for 46.5% and women for 53.5% of the total.

Independent variables

Participating students were asked to install monitoring applications in their cellphones and let them running for two weeks. By the end of that period, they were asked to export the data and send it through email to the developers of the experiment. Those applications, namely "Moment" for iPhone users and "App Usage Tracker" for Android users, have the one functionality of monitoring how much time one spends using his cellphone (usage time is computed only when cellphones are unlocked and thus discarding time spent checking the time or notifications, for instance).

The data received by the investigators contained the total of minutes that each participant spent using his or her cellphone for each day from 4/4/2016 to 4/18/2016. The average usage time was then calculated by adding total minutes for that period and dividing by 14. Hence, the average usage time per day was calculated in minutes for each student. Results varied from 38.4 minutes per day (sample minimum) to 396.5 minutes per day (sample maximum) and the standard deviation (σ) for the sample ($N=43$) was 73.4 minutes per day. The average cellphone usage time of the sample was 230.0 minutes per day.

Chart 1 –Cellphone Usage – Actual vs Reported



Source: Students' reports; compiled by authors

Students were also asked to fill a questionnaire with personal information, such as gender, smoker/nonsmoker, high school average grades and their estimate of how much time they spend on their cellphones on a typical day. The questionnaire also contained the

validated SE:SRL scale (Zimmerman et al., 1992), which is an 11-item scale designed to assess student's ability to self-regulate learning related activities, such as delivering homework, participating in class, studying in appropriate distraction-free environments. Students were given a seven-point Likert scale to appoint their perception on how frequent they engaged in each self-regulation activity (i.e., 1=never to 7=always). All responses were summed so each student had a score ranging from 11 to 77 where higher scores indicated higher self-efficacy. As previously mentioned, this scale has been shown to be a reliable predictor of academic performance (Pajares, 1996).

Finally, the actual academic performance of each student in the college's entrance exam (or "*vestibular*") was obtained anonymously through the Undergraduate's Office. As this exam comprehends subjects learned in high school with considerable level of difficulty, how well students performed can be considered a solid proxy of how dedicated academically they were in the past and thus a reliable predictor for academic performance in college. The entrance exam performance variable could range from 1, which would be the top performer, to approximately 350, which would indicate the worst performer in the exam. In this study's sample, the best performer ranked 4th in the entrance exam and the worst performer ranked 270th.

Dependent variable

As academic performance allows several interpretations, the official standardized weighted average calculated by FGV (G-MNPS) was used as an objective proxy to assess and compare each student's performance. As published by the Undergraduate's Office of FGV, the G-MNPS score is calculated as follows: for each semiannual subject, students are ranked in an ascending order relatively to their final grade, usually composed by one or two intermediate tests, one academic assignment and one final test. For instance, for a subject with 50 enrolled students, the one with the highest final grade would be ranked number 1 and the worst performer would be ranked number 50. Whenever there are two equal grades, every student with the same grade receives the same higher ranking. In the hypothetical class of the example above, if there were 5 students with a final grade equal to 10 (i.e., the maximum grade) and one with the final grade equal to 9.5, all of the first five would be ranked number 1 while the student with the 9.5 final grade would be ranked number 6.

The standardized average is computed dividing the attributed ranking by the total number of enrolled students in each subject. Following the example above, a student ranked 30 in that class, would have a standardized average of 0.6 (30 divided by 50). Finally, the

weighted standardized average is calculated using credit hours of each subject (ranges from 2 to 6 hours in mandatory subjects) as weight. The final average is given in percentage points. Since it is more intuitive for the better performing students to have the higher average, the published G-MNPS is the subtraction of the calculated weighted average (as shown above) from 100%. For instance, if the hypothetical student above was enrolled in that subject only, his final G-MNPS would be 40% (100% minus 60%). Therefore, values of the dependent variable in the sample used for the present study could range from 0 to nearly 98.4 (since most subjects have 60 enrolled students at most). From the study's sample, the minimum G-MNPS observed was 24.1 and the maximum was 91.8. The sample's standard deviation (σ) was 17.9.

As participating students were enrolled in 4th semester of the Business Administration course, the study used the accumulated G-MNPS from the first to the third semester as dependent variable. Since students at FGV are only allowed to enroll in non-mandatory (elective) subjects from the 5th semester onwards, the accumulated G-MNPS used is comparable between students, given that all went through the same disciplines, tests and activities, and thus, higher scores mean better academic performance. The investigators obtained the participants' information through the Office of Undergraduate Courses of FGV.

DATA ANALYSIS

All analyses were made using Minitab Statistical Software for Windows (version 17, State College, Pennsylvania). First, in order to find significant differences between the average G-MNPS of subgroups of the sample, independent t-tests and ANOVA analyses were performed. Subgroups of men versus women, smokers versus non-smokers, as well as subgroups of different classes (the sample contained students from five different classes) were analyzed. Second, Pearson's correlation was calculated between the independent variables in order to illustrate the relationship between them. The previously mentioned variables were considered: G-MNPS, SE:SRL, entrance exam performance and cellphone usage.

A hierarchical regression was performed next to verify if there is any statistically significant relationship between cellphone usage and academic performance. This method grants an easy observation of whether the addition of a new variable (cellphone usage) to a regression model which already contains well-known predictors (gender, smoker versus nonsmoker, SE:SRL and entrance exam performance) results in a more precise model with a higher R^2 but still significant p-value (below 5%). Therefore, if the addition of the cellphone

usage variable increases the R^2 of the regression model, it would be possible to assert the relationship of this variable to the independent variable (G-MNPS) and the coefficient (β) of that variable would indicate the extent of its impact.

Finally, the sample was divided in two subgroups relatively to the average cellphone usage time per day of each student. Students with an average usage time higher than 300 minutes per day were considered "heavy users" and the ones with an average usage time lower than 300 minutes per day were labeled "light users". Heavy users accounted for 35 students and the average G-MNPS of that cluster was 45.4 ($\sigma = 16.9$) while the remaining 8 were light users and had an average G-MNPS of 59.5 ($\sigma = 17.3$). An ANOVA analysis was conducted to determine if there was any statistical significance in the difference between the average G-MNPS between the two clusters.

RESULTS

Descriptive Statistics

Assuming outliers as observations above or below three standard deviations from the sample's mean (Rosen et al, 2013), none of the observations of the experiment's sample should be removed, once the minimum value of the initial sample was 38.4 minutes per day and the maximum was 396.5 minutes per day, while outliers would be observations above 450.2 or below 9.8. Thus, the final sample size of the study is 43. The average cellphone usage time of the sample was 230.0 minutes per day with a standard deviation of 73.4 minutes per day. As for G-MNPS, the sample averaged 56.8 and the standard deviation was 17.9. Table 2 provides a summary of the descriptive statistics for all variables.

Table 2 - Descriptive Statistics

	Minimum	Maximum	Average	Standard Deviation
G-MNPS	24.1	91.8	56.8	17.9
SE:SRL	3.0	5.0	4.7	0.8
Entrance Exam	4.0	270.0	133.2	76.6
Cellphone Use	38.4	396.5	230.0	73.4

Note. G-MNPS = standardized cumulative weighted average; SE:SRL = self-efficacy for self-regulated learning

The sample was evenly distributed among men and women as well as between classes. Men comprised 46.5% of the total sample of 43 students while women represented 53.5%. The sample of 20 men spent on average 217.7 minutes per day using their cellphones and had an average G-MNPS of 54.8, while women spent on average 240.7 minutes per day and had

an average G-MNPS of 58.6. Meanwhile, classes 1 to 5 sampled 12, 10, 1, 10 and 10 students, respectively.

Independent sample t-tests were performed and showed no significant difference in the average G-MNPS between males and females (p-value = 51.3%). Likewise, an ANOVA test showed no significant difference in the average G-MNPS between all 5 classes (p-value = 38.7%) and therefore, both of these variables (gender and class) were excluded from further analyses. Moreover, none of the participants declared to be smokers and, as such, no comparison could be made between smokers and nonsmokers.

Table 3 summarizes the correlation coefficients between the resulting variables, and their interpretation ensures their consistency as predictors of academic performance. As expected, there was a positive and high correlation between G-MNPS and the self-efficacy measure (SE:SRL). That same measure has a negative and high correlation with the entrance exam because of the inverted scale of the latter variable (better students have lower rankings), which is the same reason for a negative correlation between the entrance exam and G-MNPS. Moreover, cellphone usage was negatively correlated both with G-MNPS and SE:SRL. All correlation coefficients were statistically significant (p-value < 5%).

Table 3 - Pearson Correlation Coefficient

	G-MNPS	SE:SRL	Entrance Exam
SE:SRL	81.6%		
Entrance Exam	-31.9%	-52.2%	
Cellphone Use	-30.1%	-63.6%	-6.7%

Note. G-MNPS = standardized cumulative weighted average; SE:SRL = self-efficacy for self-regulated learning. Entrance Exam has inverted scale (better students have lower rankings).

Hierarchical Regression

In order to conclusively answer the central question of this study, which is to state the extent of the impact, if any, of cellphone usage in academic performance, a hierarchical regression analysis was conducted, by progressively adding the variables that were shown to be statistically significant in the previous descriptive analysis. If adding the cellphone usage variable to a regression model already composed of other significant and predicting variables makes the output even more precise (higher R^2), it would be safe to claim that there is indeed a relationship between that explanatory variable and the dependent variable (G-MNPS, as a proxy for academic performance).

As shown in Table 4, each variable added to the model contributed to a more precise prediction of the dependent variable with statistical significance (p-value < 5%). The first

regression model was composed only by the SE:SRL variable as predictor of G-MNPS. As previously mentioned, SE:SRL has been found, in previous studies, to be a solid predictor in a variety of settings, including academic, since it assesses an individual's capacity to proactively organize and schedule the activities necessary to a more efficient content absorption, which likely results in better academic performance, regardless of the measure considered.

The R^2 of this first model was 30.4%, illustrating the significant (p -value < 0.00) and positive ($\beta = 10.89$) relationship between the variables. Sequentially, the entrance exam variable was added and a significant (p -value < 0.026) negative relationship ($\beta = -0.065$) was revealed. It is important to note, however, that the negative coefficient is a result of the computation method for the entrance exam variable. The best performing student is ranked 1 while subsequent worse students will receive higher rankings. Therefore, the lower the entrance exam ranking, the better the student performed and the higher is his or her G-MNPS. Finally, the cellphone usage variable was added to the regression model and the output was a significant (p -value < 0.04) negative relationship with G-MNPS ($\beta = -0.063$). The analysis of the final regression model shows that 43.6% of the sample's variance is explained by the three independent variables mentioned above ($R^2 = 43.6\%$), including the observed average cellphone usage time per day.

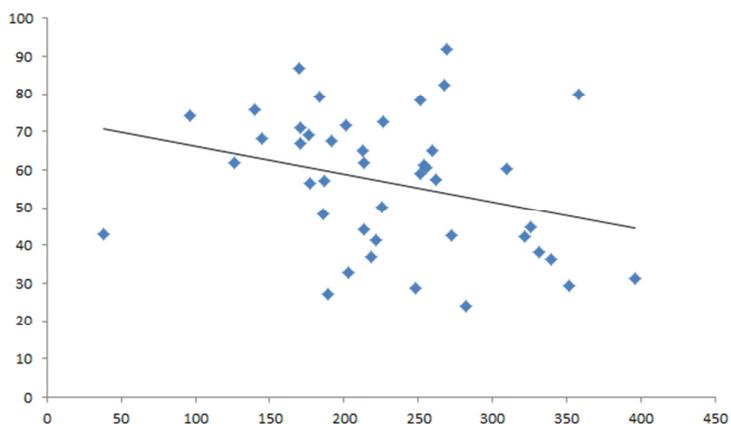
Table 4 - Hierarchical Regression Outputs

	SE:SRL	Entrance Exam	Cellphone Usage
R^2	30.4%	37.1%	43.6%
ΔR^2	-	+6.7pp	+6.5pp
Regression p-value	0.00	0.00	0.00
Variable p-value	0.00	0.026	0.040
Regression Coefficient (β)	10.2	-0.065	-0.063

Note. G-MNPS = standardized cumulative weighted average; SE:SRL = self-efficacy for self-regulated learning; Entrance Exam has inverted scale (better students have lower rankings).

Therefore, the regression equation that explains 43.6% of the variance of the academic performance, measured as the cumulative standardized weighted average of 43 sampled students, considering the exposed independent variables, would be the following:

$$G - MNPS = 34.7 + 10.2 SE: SRL - 0.065 Entrance Exam Rank - 0.063 Average Cellphone Usage Time per Day$$

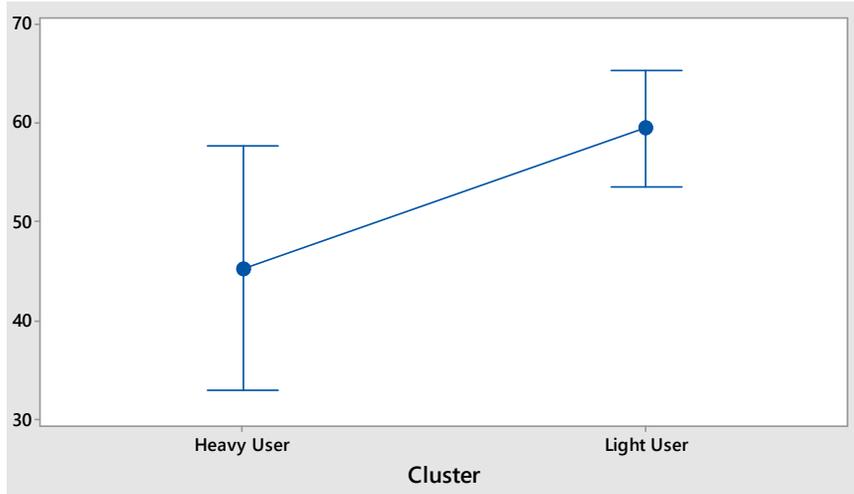
Chart 2 – Average Usage/Day vs Position in Ranking

Source: FGV and students' reports; compiled by authors

The regression's equation reveals the magnitude of the cellphone's use impact. Each 100 minutes spent using these devices on average per day is likely to reduce a student's G-MNPS by 6.3 points, in a range from 0 to nearly 100. The extent of this effect is alarming. First, it is equivalent to a decline of astounding 96,4 positions at the entrance exam's ranking (ranging from 1 to 350), which comprehends the performance on a long and thorough test, assessing a series of specific knowledges. Second, it is a variable fully under control of each student, which suggests that a more disciplined behavior is enough to bring very positive results, since the G-MNPS is the criteria of prioritization for the enrollment in a range of courses at FGV, as well as for acceptance in exchange programs abroad.

A final ANOVA test was performed to compare the average G-MNPS of the heavy users' subgroup with the average of the light users' subgroup, as previously described. A significant difference between the average of the subgroups was found (p-value < 0.043). As illustrated by the chart below, the heavy users G-MNPS average is only 76.2% of the light user's average.

Chart 3 - Average G-MNPS distribution by cluster

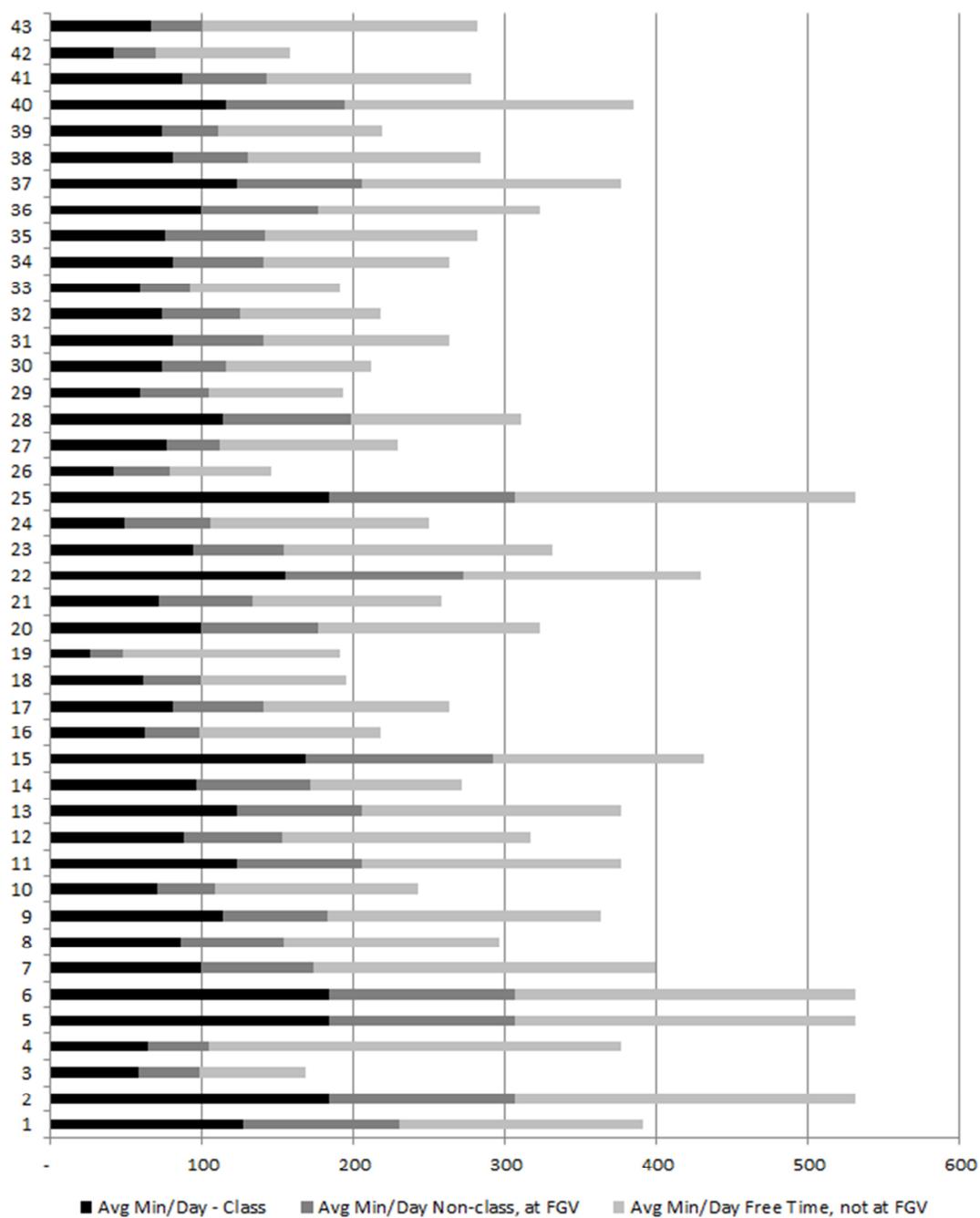


Source: FGV and student's reports; compiled by authors

Usage during class time vs during free time

One interesting refinement of our study is to investigate whether usage during a specific time of the day (e.g., during class as opposed to during free time in weekdays or weekends) is particularly harmful. We were able to test this for the 43 students of our sample who used iPhones, since the App “Moment” registers the exact hour and minute of usage each day. Given that students at FGV typically have classes from Monday to Friday from 7:00AM until 4:40PM, with predetermined break periods, we were able to filter usage to consider only periods of the day when students were supposed to be attending to class and re-run our regressions accordingly. Chart 4 below shows average usage per student during workdays (Monday through Friday), breaking the data up to reflect usage during class time, non-class time spent at school (e.g., breaks) and ‘free time’, i.e., time outside school (before 7:00AM and after 4:40PM).

Chart 4 – Breakdown of Average Cellphone Usage During Weekdays



Source: FGV and students' reports; compiled by authors

First, we re-ran the original regression to include only students with iPhones. Since they represented the vast majority of all students in our original sample, results were practically identical to the previous model. The R^2 of this first model was unaltered at 43.6%.

Cell phone usage during weekdays had a significant (p -value < 0.040) and negative relationship ($\beta = -0.064$) with academic performance. (For better comparison, we have excluded weekends from the data.):

Table 5 - Usage During Weekdays: Regression Outputs

	<i>Coefficients</i>	<i>St Error</i>	<i>t-stat</i>	<i>P-value</i>
Intercept	34,727	15,194	2,286	0,028
SE:SRL	10,164	2,551	3,985	0,000
Entrance Exam	-0,066	0,028	-2,308	0,026
Cellphone Usage (weekday)	-0,063	0,030	-2,130	0,040

SE:SRL = self-efficacy for self-regulated learning; Entrance Exam has inverted scale (better students have lower rankings).

We then conducted a similar regression including only usage **during class time**. Table 6 shows the result of the new regression considering only usage during class time:

Table 6- Usage During Class Time: Results

	<i>Coefficients</i>	<i>St Error</i>	<i>t-stat</i>	<i>P-value</i>
Intercept	34.838	15.020	2.319	0.026
SE:SRL	9.389	2.609	3.599	0.001
Entrance Exam	-0.064	0.028	-2.265	0.029
Cellphone Usage (class time)	-0.120	0.054	-2.204	0.033

SE:SRL = self-efficacy for self-regulated learning; Entrance Exam has inverted scale (better students have lower rankings).

With this refinement, R^2 increased slightly to 44.0% while the impact of cellphone usage *during class time* was twice as high as before ($\beta = -0.120$; p -value < 0.033 vs. $\beta = -0.063$; p -value < 0.040 before). The new regression equation would be the following:

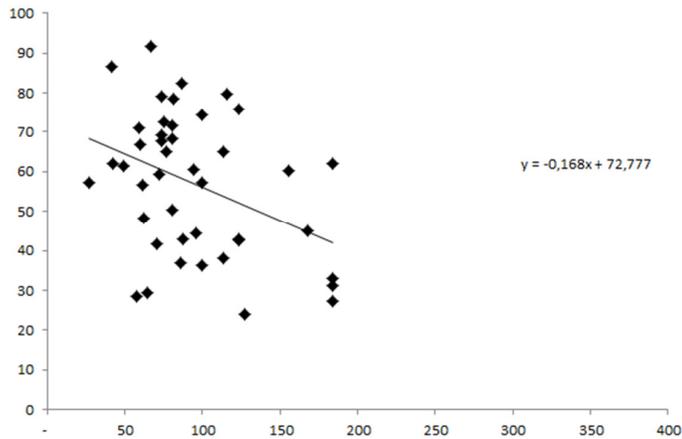
$$G - MNPS = 34.8 + 9.39 SE:SRL - 0.064 Entrance Exam Rank - 0.120 Average Cellphone Usage per Day During Class$$

Therefore, each 10 minutes spent per day using cellphones *during class* reduced a student's G-MNPS by 1.20 points (in a range from 0 to nearly 100). To put this result in perspective, a student would have to rank almost 19 positions lower at the entrance exam (in a ranking from 1 to 350), *ceteris paribus*, for the same type of effect to be observed. The magnitude of the impact is impressive, especially since the other variables considered are much broader in nature: the entrance exam, for example, consists of a thorough test on all major academic subjects for which students prepare along their whole school lives.

In the graphs below we have plotted the relationship between academic performance and cellphone usage in three different periods: during class time (Chart 5), during weekends (Chart 6) and during weekdays' free (i.e., non-class) time (Chart 7). Since the scales of the graphs are the same, it becomes immediately visible, by comparing the slopes of the tendency lines, that usage during class time affects performance much more significantly than usage during weekends, for example.

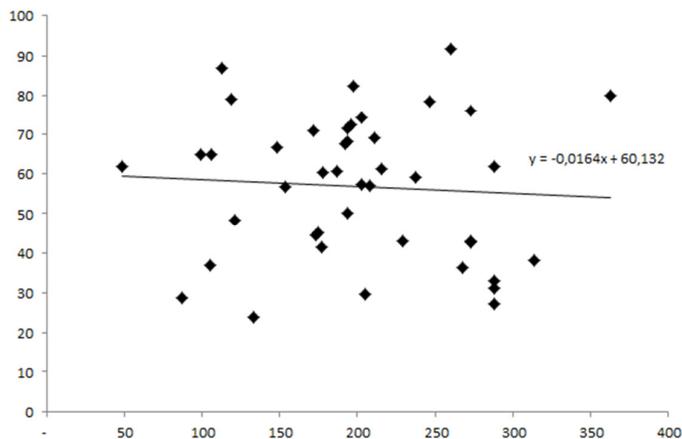
The higher predictive power might be due to the fact that limiting measurement to "class time" generates a more precise proxy of the potentially distracting uses we intend to analyze, since the broader "average daily usage" would include other non-disruptive uses like, for example, geolocation Apps like Waze or Google Maps while driving. Nevertheless, the magnitude of the difference makes it impossible to discard the hypothesis that students might be getting distracted by technology during class time and losing focus on lectures and other academic activities.

Chart 5 - Average Usage/Day during Class time x Position in Ranking



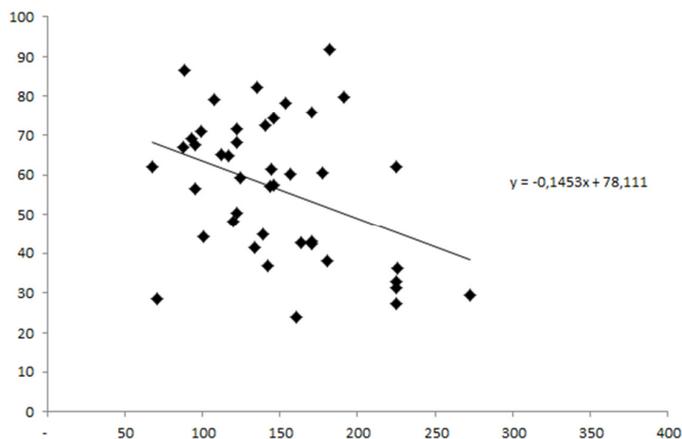
Source: FGV and students' reports; compiled by authors

Chart 6 - Average Usage/Day during Weekends x Position in Ranking



Source: FGV and students' reports; compiled by authors

Chart 7 - Average Usage/Day during Working Days' Free Time x Position in Ranking



Source: FGV and students' reports; compiled by authors

CONCLUSION

The central question of this study was whether increasing cellphone usage among college students had a significant impact on their academic performance. As both the independent and dependent variables for this question could be subjectively interpreted, objective measurable proxies were collected from a sample of 43 students enrolled in the 4th semester of the Business Administration Undergraduate course of FGV, a Brazilian business school. To assess academic performance, the cumulative standardized weighted average (G-MNPS) was anonymously obtained with the Undergraduate's Office while actual cellphone usage data was collected through monitoring applications (namely, "Moment" and "App Usage Tracker") voluntarily installed by participating students.

Other independent variables were used as known predictors in this study's initial analysis since previous research had already proven their significant relationship with academic performance. Peter & Horn (2005) found in a sample of students that females had higher GPAs compared to males while another study suggested that smokers performed worse than nonsmokers (De Berard et al., 2004; Sánchez-Martínez & Otero, 2009). However, in this study's sample, a t-test revealed no significant difference in G-MNPS between genders. Furthermore, none of the participating students declared to be smokers. Therefore, those two variables were excluded from further analysis.

After initial statistical analysis and assumption checking for outliers, normality and homoscedasticity, a hierarchical regression was performed with the remaining explanatory variables. The entrance exam performance and the SE:SRL scale were used as known predictors. The output of the regression model with those two variables only, showed a significant relationship between them and G-MNPS. In that model, 37.1% of G-MNPS's variance was explained by the independent variables. Finally, when cellphone usage variable was added, the regression model revealed a negative significant relationship between the average time spent using cellphone and G-MNPS, while increasing the percentage of the dependent variable's explained by the model to 43.6%. Therefore, this study indicates, based on actual cellphone usage data and official grade average records, that it is more likely that a student who uses less his or her cellphone will have a higher G-MNPS than the one who uses more, given an equal performance in the college's entrance exam and same belief to self-regulate their own studying settings.

The extent of the negative influence of cellphone's usage in academic performance found in this study is compelling. Every additional 10 minutes spent (on average per day) using a cellphone device will likely reduce that student's G-MNPS by 0.63 points.

The magnitude of this effect is even higher if we consider only cellphone usage *during class time*: R^2 increases to 44.0%, while β almost doubles to -0.120 (p-value<0.033) from previous -0.063 (p-value=0.040), when considering full day average usage. Therefore, each 10 minutes spent per day using cellphones *during class* is likely to reduce a student's G-MNPS by 1.2 points. This effect is similar in magnitude to a decline of almost 19 positions at the entrance exam ranking (ranging from 1 to 350).

The scale of the cellphone's impact found is alarming: 100 minutes of additional cell phone usage per day would be enough, for instance, to exclude a top performing student from the Honor's Board of FGV, since the difference of the first mentioned student's G-MNPS to the last is usually 9 to 13 points. Moreover, students might spoil further experiences, since the G-MNPS is applied at FGV as the criteria for choosing students to be accepted in exchange programs abroad and for future non-mandatory courses at FGV.

This conclusion endorses previous research that investigated the impact of particular uses of cellphone, social medias and gaming on academic performance, notably Jacobsen and Forste (2011), who showed the negative impact of texting and calling, Jackson et al (2011) who associated heavy gaming with lower GPAs and Lepp, Barkley and Karpinski (2015) who studied the cellphone as an integrated platform with a negative relationship with GPA. Therefore, it becomes more clear that, despite the set of learning-efficient tools available in current smartphones, these devices are more often a source of distraction in classrooms and any other setting dedicated to studying, rather than a productive platform to find and share information, exercise new learnings and interact with students or professors.

The negative influence of cellphone usage in academic performance also reinforces the findings of Ophir, Nass & Wagner (2009) which concluded that young students often overestimate their ability to multitask. The user's belief that he or she can efficiently pay attention to other activities such as absorb content from a lecture, complete homework or study while keeping the cellphone on standby and using it from time to time is, on average, misleading, as students are more often tempted to game, check social medias and connect with colleagues. However, current smartphones can still be a very powerful tool that should be used to contribute to learning. Therefore, it is possible that it's application brings productive results in specific academic settings while jeopardizes student's performance in

others. Accordingly, further research is needed to find which are these specific settings and how to effectively regulate the where and when cellphone use is permitted.

Furthermore, two other concerns should be explored to extend the understanding of the cellphone's and other technology's impact on academic performance. First, the indirect impact provoked by student's overuse. For instance, professors might be distracted by extensive use of cellphones, computers and tablets, which could potentially jeopardize the quality and clarity of lectures or other class activities. Likewise, heavy users might distract other students by urging them to check an application, send or answer a message or interact in any other way. Second, it might be that some specific uses of cellphone are more harmful than others. In fact, previous research showed that some uses can be positively related to academic performance. Chen and Tzeng (2010) associated extensive use of Internet for gaming with lower academic performance but also showed that students who sought more for information in the Internet over performed academically compared to the ones who searched less. Hence, further research should make it clear which particular uses of cellphone should be incentivized when seeking better academic performance.

This study was based in extensive previous research in the field and used consistent metrics to answer its central research question. However, discretion is advised for any generalization given two main limitations. First, all participants in the experiment were from the same college, same course and same semester. Second, the experiment's sample is significant, but small, and thus fails to comprehend a wider range of diversity as well as to be more representative of the college's universe.

In further studies, it would be enlightening to detail the specific programs and applications used by each student (e.g., texting, social media, web-searching, etc) in order to better understand the distinctive effects each situation have on academic performance.

Despite its limitations, this study coalesces to previous research and brings more data that motivates further exploration in the field. It is indisputable that smartphones will keep developing in a distinguished pace along with possible new disruptive technologies that may be introduced, forcing educators and other stakeholders to have a clear, definitive answer to which are the conditions and settings where cellphone applications can indeed contribute to learning and the ones in which educational tools will be undermined by the temptation of leisure activities.

REFERENCES

- Barkley, J. E., & Lepp, A. (2013). Cellular telephone use is associated with greater sedentary behavior independent of leisuretime physical activity. *Applied Physiology, Nutrition, and Metabolism*, 38(S1), 1023.
- Chen, Y. F., & Peng, S. S. (2008). University students' Internet use and its relationships with academic performance, interpersonal relationships, psychosocial adjustment, and self-evaluation. *CyberPsychology & Behavior*, 11, 467-469.
- Chen, S. & Tzeng, J. (2010). College female and male heavy internet users' profiles of practices and their academic grades and psychosocial adjustment. *Cyberpsychology, behavior, and social networking* 13.3: 257-262.
- DeBerard, M. S., Spielmans, G. I., & Julka, D. C. (2004). Predictors of academic achievement and retention among college freshmen: A longitudinal study. *College Student Journal*, 38(1), 66-80.
- Duncan, D., Hoekstra, A. & Wilcox, B. (2012). Digital Devices, Distraction, and Student Performance: Does In-Class Cell Phone Use Reduce Learning? *Astronomy Education Review*, 11, 010108-1, 10.3847.
- Hong, F. Y., Chiu, S. I., & Hong, D. H. (2012). A model of the relationship between psychological characteristics, mobile phone addiction and use of mobile phones by Taiwanese university female students. *Computers in Human Behavior*, 28, 2152-2159.
- Jackson, L. A., von Eye, A., Witt, E. A., Zhao, Y., & Fitzgerald, H. E. (2011). A longitudinal study of the effects of Internet use and videogame playing on academic performance and the roles of gender, race and income in these relationships. *Computers in Human Behavior*, 27, 228-239.
- Jacobsen, W. C., & Forste, R. (2011). The wired generation: academic and social outcomes of electronic media use among university students. *Cyberpsychology, Behavior, and Social Networking*, 14, 275-280.
- Junco, R. (2012a). The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement. *Computers & Education*, 58, 162-171.
- Junco, R. (2012b). Too much face and not enough books: The relationship between multiple indices of Facebook use and academic performance. *Computers in Human Behavior*, 28, 187-198
- Junco, R., & Cotton, S. R. (2011). Perceived academic effects of instant messaging use. *Computers & Education*, 56, 370-378.
- Junco, R., & Cotton, S. R. (2012). No A 4 U: The relationship between multitasking and academic performance. *Computers & Education*, 59, 505-514.
- Kirschner, P. A., & Karpinski, A. C. (2010). Facebook and academic performance. *Computers in Human Behavior*, 26, 1237-1245.
- Lepp, A., Barkley, J., Karpinski, A. (2015). The relationship between cell phone use, academic performance, anxiety, and Satisfaction with Life in college students. *Computers in Human Behavior*, 31, 343-350.
- Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology*, 1, 30-38

- Ophir, E., Nass, C. & Wagner, A. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences* 106.37 (2009): 15583-15587.
- Pajares, F. (1996). Self-efficacy in academic settings. *Review of Educational Research*, 66, 543-578.
- Peter, K., & Horn, L. (2005). Gender differences in participation and completion of undergraduate education and how they have changed over time (NCES 2005-169). Washington, DC: U.S. Government Printing Office, U.S. Department of Education, National Center for Education Statistics.
- Rosen, L.D., Carrier, Mark L., Cheever, N. A. (2013). Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior*, 29, 948–958.
- Sánchez-Martínez, M., & Otero, A. (2009). Factors associated with cell phone use in adolescents in the community of Madrid (Spain). *CyberPsychology and Behavior*, 12, 131-137
- Schunk, D. H. (1984). The self-efficacy perspective on achievement behavior. *Education Psychologist*, 19, 119-218.
- Schunk, D. H. (1989). Social cognitive theory and self-regulated learning. In B. J. Zimmerman & D. H. Schunk (Eds.), *Selfregulated learning and academic achievement: Theory, research and practice* (pp. 83-110). New York, NY: Springer Verlag.
- Wood, E., Zivcakova, L., Gentile, P., Archer, K., De Pasquale, D., & Nosko, A. (2012). Examining the impact of off-task multitasking with technology on real-time classroom learning. *Computers & Education*, 58, 365-374.
- Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, 29, 663-676.