

Technology Trumping Sleep: Impact of Electronic Media and Sleep in Late Adolescent Students

Kerry L. Moulin¹ & Chia-Jung Chung¹

¹ Department of Graduate and Professional Studies in Education, California State University, Sacramento, USA

Correspondence: Chia-Jung Chung, Department of Graduate and Professional Studies in Education, California State University, Sacramento, USA. Tel: 1-916-278-3587. E-mail: cchung@csus.edu

Received: October 15, 2015

Accepted: December 19, 2016

Online Published: December 28, 2016

doi:10.5539/jel.v6n1p294

URL: <http://dx.doi.org/10.5539/jel.v6n1p294>

Abstract

The purpose of this research study was to explore with what impact evening media use interfered with either schoolwork and/or sufficient healthy sleep. In addition, the study examined with what impact there may be a compromise in students' ability or aptitude for positive academic success, related to either lack of sleep or electronic media use. The participants were 89 high school and college students, ages 16 through 25, with median age of 18. Research was conducted using a secured online survey tool. Electronic habits, internet and social networking usage, sleep and rise times, daily sleepiness and perceptions were examined. College students were randomly sampled and participated in an in-depth, one-time survey. High school students participated in a weeklong nightly electronic sleep & evening media use survey and journal. Data was obtained from anonymous and coded student responses and student and teacher surveys. The results of the study suggested that healthful adolescent sleep is indeed greatly compromised, during a time when the reverse is vitally important. Of students randomly sampled, all but one student owned a cell phone. In the total study group, a majority were smart phone owner-users (84%). Many high school participants slept with a cell phone or tablet in their bed (72%), and among college participants who regularly slept with cell phone, tablet, or laptop, this rose to 86%. Over half of these students continued to access and use their devices in bed for significant amounts of time prior to sleeping. Many of these even awakened after falling asleep to access or respond to electronic messaging. The research indicated that unhealthy sleep habits may be creating a generation of sleep-deprived individuals who may not be functioning at top capacity. Findings regarding a correlation between lack of sleep and quantified academic success are inconclusive, however, student perceptions indicate that they believe there is a relationship. Findings also suggest that all instructors of late adolescent students aged 16-25 may count on the fact of their student clientele owning and using mobile devices to access internet for social purposes. Students allow their social digital world to impede and compete with their academic time and biological sleep cycle. Instructors would be wise to appropriately channel the digital skills of this new generation of no longer-wired, but now "wi-fied" students. Therefore it is strongly suggested that teachers, parents, and medical personnel adopt and provide healthy guidelines for parents to use with pre-teens and teens, to facilitate and develop in the next generation of students some structure and means of protecting their health in the realms of electronics and sleep.

Keywords: adolescent health, electronic social media, networking, wifi, digital device, teen sleep

1. Introduction

1.1 Background

The impetus for this study has grown from the researcher's background and interest in health education and working with adolescents. The experience of raising a teenager to young adulthood in the modern world confronts both the parent and the educator with a conundrum of choices and decisions. Always present is the underlying quandary of whether one is to be popular or respected, friend or foe, on the side of the adolescent or in opposition. Ultimately, we educators are looking out for what is best for students, and we all are striving to raise the next generation to be happy, healthy, and successful. Modern technology and personal electronics provide us all with so many tools and so many distractions to that end. Seeing the gap between what some teachers and parents believe students are doing, and what these adolescents are *actually* doing, led this researcher to want to investigate the situation further.

1.2 Purpose

The purpose of this study was to investigate how the use of modern personal electronics affects healthy sleep in students, and to learn if such effects are correlated with academic performance and aptitude. This study sought to answer two main questions:

- With what impact does evening media use interfere with either school work/study and/or sufficient healthy sleep?
 - Anticipated outcome was that student participants would indeed have intense use of electronics in the evening, for both study and social media, and that recommended hours of sleep would not be met by participants age 16-25.
- With what impact may there be a compromise in students' ability or aptitude for positive academic success, related to either lack of sleep or electronic media use?
 - Anticipated outcome was that students would acknowledge that lack of sleep occurred related to evening media use, and affected their daytime performance academically.

2. Literature Review

2.1 Electronics & Media Use Interfere with Sleep

The PEW Research center released the latest findings for "Teens and Technology 2013" in March 2013. For those who work with adolescents, the results were not ground-breaking news. In this study, "teens" were those aged 12-17, 78% of which were found to own a cell phone, with almost half of those phones as smart phones. One in four teens were found to have a tablet computer. What is remarkable however, is that one in four teenagers were found to be "cell-mostly" internet users, that is, they mostly go online or use the internet using their phone, and not some other device. This is often the case in lower-income households (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013).

In a study by Thomee, Eklof, Gustafsson, Nilsson, and Hagberg (2007), the researchers prospectively examined whether high use of information communication technology among young adults was a risk factor for developing psychological symptoms. Thomee et al. reviewed the associated literature that documented different types of symptoms and Information and Communication Technology (ICT), and also stated that there were a lack of prospective studies of young adults "on the threshold to working life" concerning exposure to ICT. The study utilized a questionnaire with a cohort of 1,204 college students, average age 22, who were assessed at "baseline" and then again one year later. They computed "prevalence ratios" of exposure variables (different types of ICT), and effect variables (perceived stress, symptoms of depression, and sleep disturbances). Though emphasized as "prospective" this exploratory study revealed a relationship between "high" use of ICT (computers, internet, cell phones) and "prolonged stress" (The type of stress that can affect sleep disturbances). High ICT and SMS (text messaging) use were associated with a higher risk of experiencing prolonged stress (continuous stress for more than 7 days during the past 12 months) for the group as a whole. When separately analyzing women and men, high ICT, chatting and SMS use were all associated with a higher risk of experiencing prolonged stress for women. For women, surfing the Internet was associated with developing sleep disturbances in the form of repeated awakenings. For men, high frequency of mobile phone calls and SMS messaging was associated with developing difficulties falling asleep (Thomee, Eklof, Gustafsson, Nilsson, & Hagberg, 2007).

A South Korean study in 2009 found that Internet addiction was strongly associated with excessive daytime sleepiness in adolescents (Choi, Son, Park, Han, Kim, Lee, & Gwak, 2009). In a separate Taiwanese study, researchers inquired and evaluated for a variety of different behavior issues. Most interestingly, in this study problematic CPU (cellular phone use, text messaging and/or calling) was associated with insomnia in all groups of adolescents, and with short nocturnal sleep duration in all groups of adolescents except for in girls 15 years or older. A characteristic of this type of CPU is that without pre-defined stopping points, intensive CPU may lead directly to a reduction in total sleep time by substituting for it. It may also be the contents of CPU that provokes sleep problems, as late and exciting messaging may promote arousal and alertness in the brain (Yang, Yen, Ko, Cheng, & Yen, 2010).

In a research brief for Kaiser Family Foundation, Zimmerman (2008) examined research current at the time and also concluded that there were significant issues with children's media use and sleep problems. It was noted that the effects of media use at different times of day have rarely been explored. A significant point made was that the independence of adolescent children makes it more difficult for parents to monitor and guide their media experiences. He noted studies in Belgian teenagers who were reported to take cell phones to bed with them, most

often for text messaging, and these children reported higher levels of daytime sleepiness. How media use may impact sleep was explored. Questions included wondering about new forms of media use and how their affect on sleep could be different. Today this would include new forms of media in today's world such as iPads and electronic games, which in 2008 when the study was done, were less common for United States teenagers. However, even in 2008 there was a dramatic increase in media use and accessibility, quite unlike that from the generation of parents prior. Factors of format, time, extent, location and content of today's media are so much more pervasive that parents cannot rely on the guidelines of the past. Zimmerman presents several explanations for how electronics and media use may affect and contribute to inadequate sleep in adolescents: media use of all kinds might directly displace sleep: content, drama, and conflict may be too exciting for children especially at bedtime; exposure to light during media use suppresses melatonin secretion, which delays sleep onset; physical activity, which promotes good sleep can be displaced by media use (Zimmerman, 2008).

Another study in Finland explored computer usage, mobile phone usage, sleeping habits, waking time tiredness, and perceived health in adolescents. Results showed that boys play digital games and used the internet more often than girls, but that in girls, mobile phone usage was more intensive. Findings include that among girls, intensive mobile phone usage was significantly directly associated with poor perceived health, as was intensive computer usage among boys. In early adolescence they also substantiated the hypothesis that the association between intensive ICT usage and poor perceived health is mediated through deteriorated sleeping habits and increased waking time tiredness (Punamaki, Wallenius, Nygard, Saarni, & Rimpela, 2007).

The National Sleep Foundation in 2006 conducted an examination of sleep in early adolescence. As a follow up to this, Lund, Reider, Whiting, and Prichard (2010) looked at sleep patterns and predictors of disturbed sleep in a large population of college students. The study had a strong research design with a number of different scale analyses. Lund et al. found that over 60% of students were categorized as poor quality sleepers and that the average amount of sleep time was 7.02 hours a night. In this study, only 29.4% of students reported getting eight or more hours of total sleep time per night, the average amount required for young adults (Lund et al., 2010).

A Finnish study in 2013 looked at pre-adolescent children's sleep habits and computer and TV use. Researchers found that computer use predicted unfavorable changes in sleep duration and bedtimes on school days and weekends and that among boys, media presence in the bedroom predicted poor sleep habits and irregularity of sleep habits (Nuutinen, Ray, & Roos, 2013).

A couple of studies that somewhat influenced research design in the current study were conducted with the use of sleep diaries and questionnaires. In 2013, Fuligni, Gillen-O'Neel, and Huynh examined the cost of sleep loss upon high school student performance the following day using a paper journal checklist method and concluding that sacrificing sleep for study time was common yet counterproductive (Fuligni, Gillen-O'Neel, & Huynh, 2013). In 2005, Amschler and McKenzie looked at elementary students' sleep habits and conducted a well-designed study that utilized extensive specific questions on questionnaires for both students and teachers, with the idea of obtaining the teacher observations of students with code numbers. They found that as early as fifth grade, students are often not getting an adequate quality nor quantity of needed sleep (Amschler & McKenzie, 2005). These studies both informed and inspired the researcher to reach far and dig deep into the night networking habits of local adolescents.

3. Methodology

This research study focused upon late adolescent students in the early years of college and the last year of high school. Two separate research groups were utilized, yielding results to be initially analyzed and discussed as separate data groups. These groups are hereafter referred to as "Group S" a survey of young college students at CSU Sacramento, and "Group R" a survey of a high school senior English class in Roseville, California. Survey Monkey was the instrument used to gather all data for both groups.

4. Results

Overall, this study yielded rich results. The following section will summarize results for both groups, with an emphasis on the college study due to more consistent and reliable results, and also a larger participant base. College student participation (Group S) was based on a one-time survey, so participation was 100%. Due to the different design of the high school group (Group R), participation in the high school group was based upon the individual student motivation, which varied greatly, hovered around 50% at best, but was mostly inconsistent over the one to seven nights that each student may have participated. When the high school participant data are consistent with the college participant data, results will be merged. When the data are inconsistent, it will be contrasted or presented separately.

The Group S, CSUS study was a one time snapshot of student behaviors based on each student's own input and personal assessment of their own activities and aptitudes. The researcher immediately delimited all responses that were outside of the target "adolescent" age range of 18 to 25. Survey Monkey has a filter tool that was accessed to filter the responses to only show those that were in the target age group. The following results are the findings for the target research group. There were 71 participants that fit this group and they were almost evenly divided between male and female. Of the participants, 59% of these were either age 18 or age 19, which fit perfectly into what the researcher was looking for in this study. Results from Group R, the high school group survey, are consistent and congruent with those of the college survey.

Of the CSUS group, Group S, 75% of the respondents were in their first three years of college with 45% being in the very first year of college. By research design, since the survey took place in November of the fall semester 2013, the majority of these respondents were in the very first semester of college. The majority of these participants were those students newly "on their own" without the rules or overriding guidance of parents upon their behaviors and decisions. Additionally, these students would have had the opportunity to experience many of the pressures of college life and academics, and develop some sort of "routine." The participants were asked about the electronic devices that they had access to and owned. A majority of the students owned a laptop computer or iPad/tablet and over 90% also owned a cell phone. When questioned about their cell phone, a majority of the participants owned a smart phone, a cellular phone with internet features beyond calling and texting. Combining the results with the high school Group R shows that 99% of students age 16 to 25 owned cell phones and 85% of those phones are smart phones. Out of the whole survey group, only one individual did not own a cell phone.

With regard to their use of all electronic devices and time spent using electronic devices, the range was great. Anywhere from one hour to 24 hours was answered in the responses. Most common responses were four hours and 10 hours of estimated time spent using electronics per day in a 24-hour period. When asked for the percentage of time that those devices were used for study or academic work this also had a wide range. While 37% said that 75% or more of their time on electronics was used for academic work, the majority used their device for academic work 50% or less of the time that they were on it.

**Q8 Estimate average total hours per "day"
(24 hrs.) "USUALLY" spent on electronic
device(s) for ANY reason:**

Answered: 71 Skipped: 0

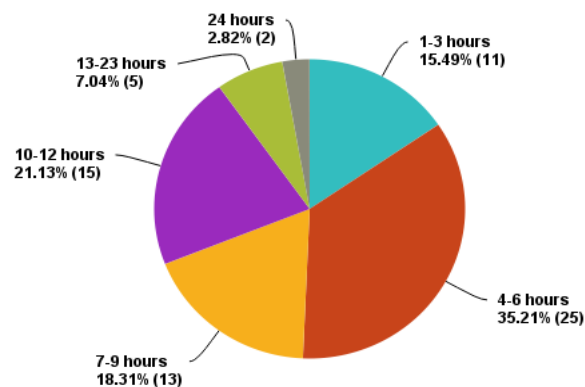


Figure 1. Hours per day using electronic devices by college students

**Q10 Estimate total hours per “day” (24 hrs.)
“USUALLY” spent on electronic device(s)
for ANY reason:**

Answered: 18 Skipped: 0

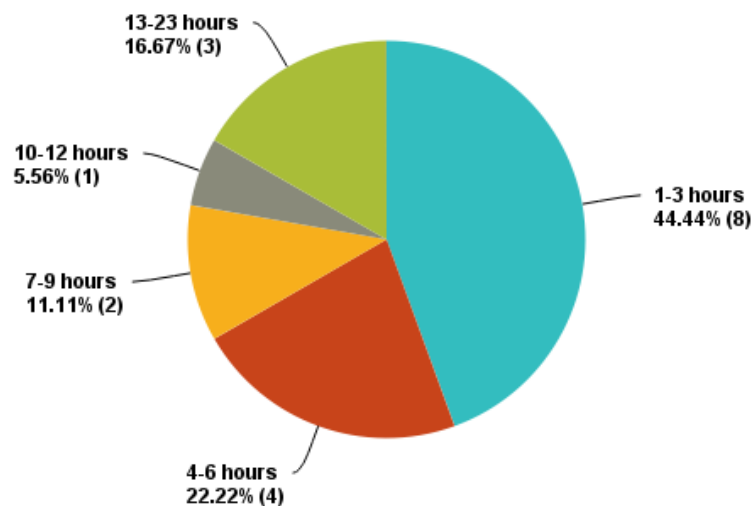


Figure 2. Hours per day using electronic devices by high school students

Group S CSUS students were also questioned about which internet sites or applications they used. The responses don't necessarily indicate amount of time spent on applications, but these percentages of students use the following applications, “apps” as seen graphically in Figure 3.

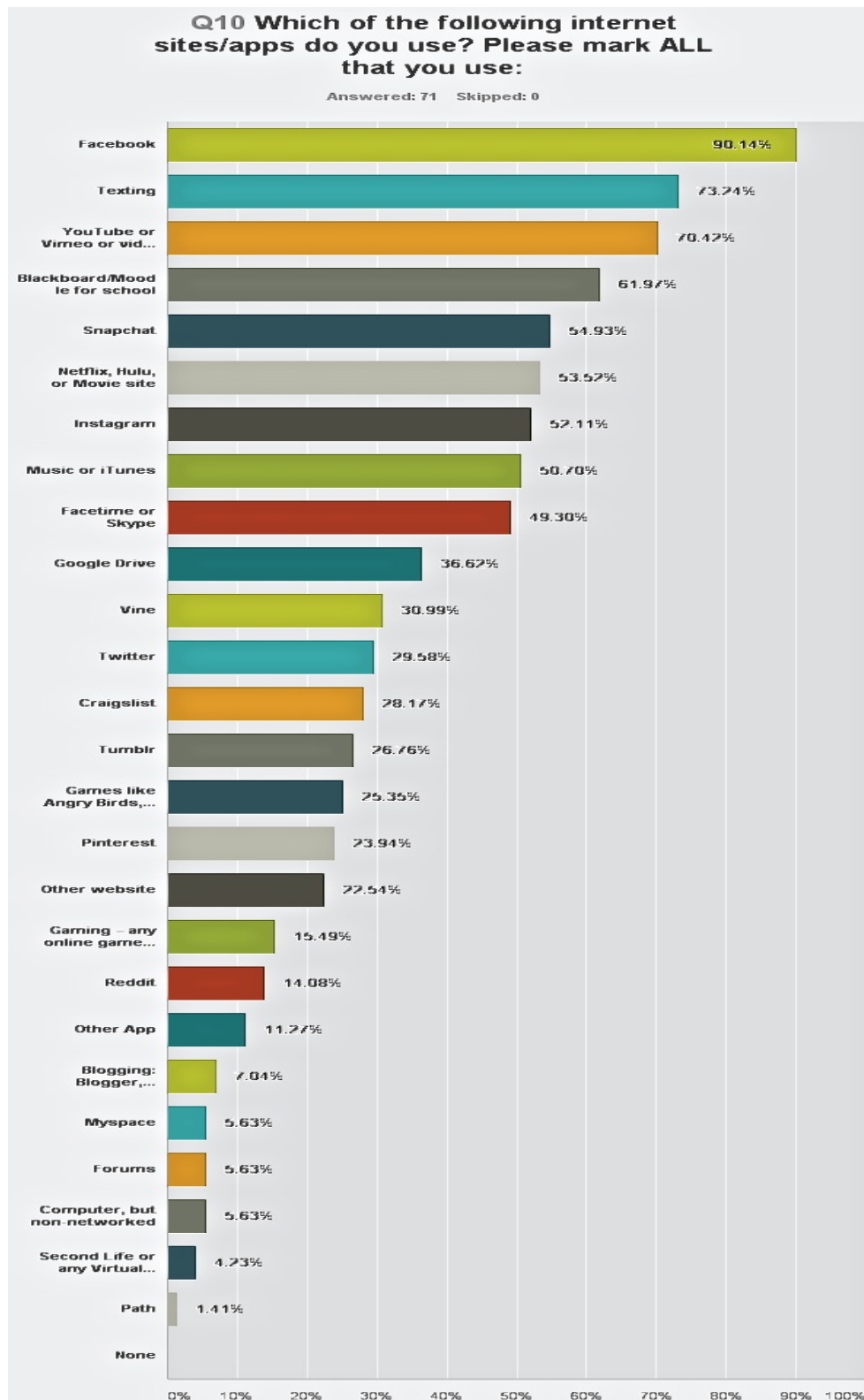


Figure 3. Internet sites and applications used by college students ordered by frequency of students who use it (not necessarily popularity)

The top applications receiving 25% or more of respondents: Facebook, texting, Youtube or video sites, Blackboard or Moodle, Snapchat, Netflix or movie sites, Instagram, music or iTunes, Facetime or Skype, or Google Drive, Vine, Twitter, Craigslist, Tumblr, and games like Angry Birds. Of notable interest is that 90% of college students are using Facebook, 73% are texting, 70% are using YouTube or using video sites; over 50% are using Snapchat or Instagram. Other applications and sites were also used, but it may be significant that 15% of participants participate in massive multiplayer online gaming. Again, these may be seen graphically in Figure 3 above.

College students were asked which electronic devices they used nightly within the “four hours before bed” and then in a separate question “one hour before sleep.” Results were not significantly different in the two questions, although there was somewhat less use of the computer laptop from four hours to one hour. There was about the same amount of cell phone use from four hours to one hour before sleep. Over 80% of students were still using the cell phone within the one hour before sleep. When questioned as to whether or not they turned off electronics or put them “to sleep” or “Do not disturb” mode in the evening, only 24% do turn off or put away electronics for the evening. The majority, over 75% of college students, only “sometimes” “rarely” or “never” put their electronics in an “off/sleep” mode. Even more of high school seniors (83%) only sometimes, rarely, or never put their electronics in an “off/sleep” mode. If participants did put their phone in a sleep mode, they did it mostly from 10 PM to 3 AM, or they didn’t do it at all. Figure 4 and Figure 5 show participant use of electronics in the hour before bed.

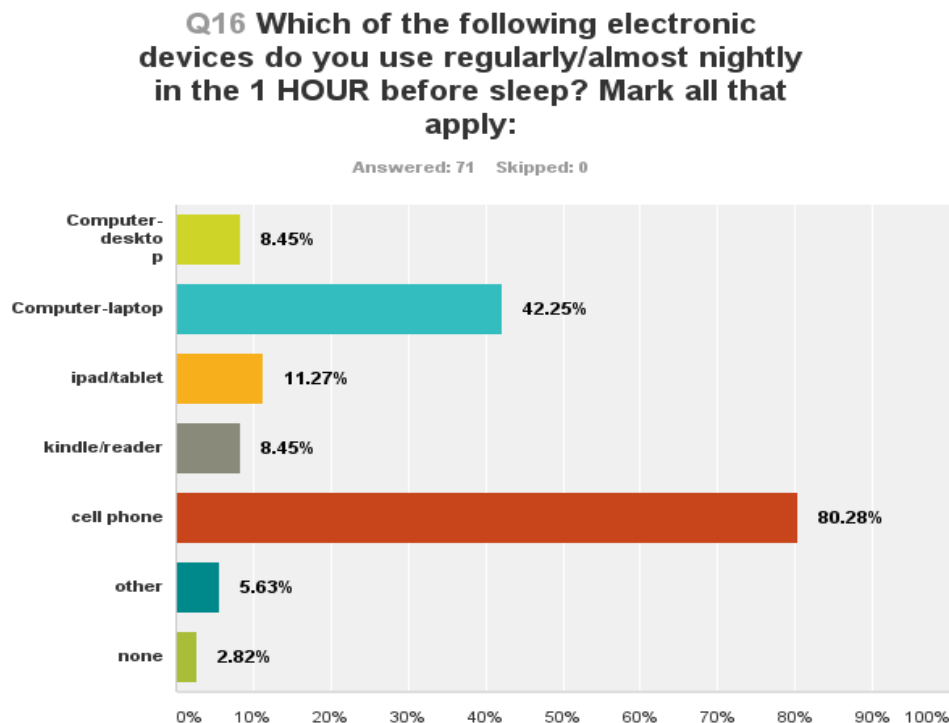


Figure 4. Electronic devices used in the hour before sleep by college students

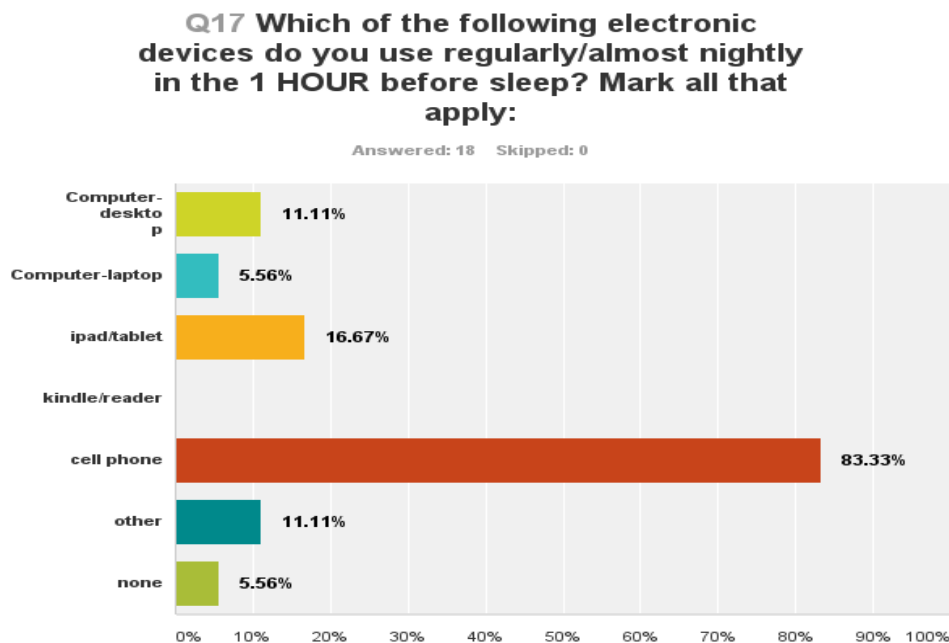


Figure 5. Electronic devices used in the hour before sleep by high school students

All participants were asked directly in the survey if they usually slept with any of the devices in their bed, and to mark all that apply. In the college student survey every device category was marked as sleeping with students in the bed. This included cell phones, which for 65% of college students, spend the night in the bed with them. In the high school survey only iPad/tablets and cell phones and “other” or none were marked. Of high school students, 72% sleep with an iPad/tablet and/or cell phone. In other words, seven out of ten high school senior through college students sleep with an electronic device in their bed (73%).

When questioned about whether or not students continue to use electronic devices after going to bed, and how much longer do they use them, some high school students use them. Many high school students continue to use devices at least five minutes or longer in bed (65%); More than half use them 15 minutes to two hours (61%). A majority of college students use devices in bed from five minutes to more than two hours (85%) and over half use them from 15 minutes to over two hours in bed (59%).

Q20 If you use electronic device(s) after going to bed at night, about how much longer do you use them?

Answered: 71 Skipped: 0

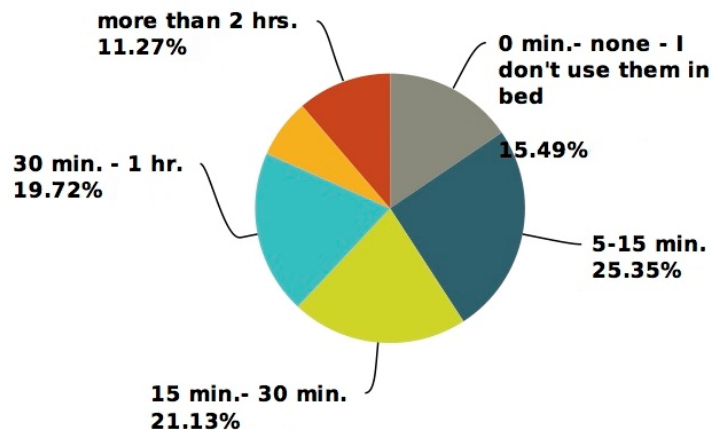


Figure 6. Electronic devices are commonly used in bed by college students

College students go to bed anywhere from 9:30 PM to after 3:00 AM. The majority of the students go to bed from 11:00 PM to 2:00 AM. Most college students responded that their body would tell them it was time to go to bed even if they ignored it at around 10:16 to 11:59 PM. There did not seem to be significant findings about how often college students experience difficulty falling asleep, and the majority of them felt that once they were asleep they slept well.

Q31 About how many hours of sleep do you usually get at night?

Answered: 68 Skipped: 3

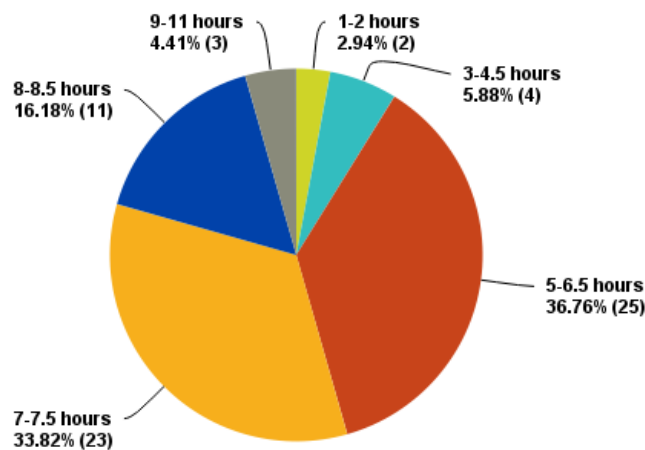


Figure 7. Number of hours of sleep reported by early college students

Only 3% of college students think they get too much sleep and 32% think they get about the right amount. 38% think they almost get enough sleep and about 26% think they should get more sleep or they really did not get

enough sleep. College students awaken anywhere from 5:00 AM to 10:00 AM with the majority of them awakening seven to 7:30 AM or 8:30 to 9:00 AM. The majority of college students' awakening time is 6:00 or 7:00 to 9:00 AM. Fewer than 25% of students are getting at least eight hours of sleep, and about 45% are getting far less than a passable seven to seven and a half hours of sleep at night.

At least one in four college students at least occasionally, if not frequently, does awaken and access or respond to electronics such as text messaging. 11% of students frequently awaken and access or respond, and about one in three high school seniors report awakening and accessing or respond to electronics such as text messaging. In other words, on a regular basis, at least 33% of late adolescent students have their sleep disrupted by mobile electronic devices, after they have fallen asleep.

Q25 After you fall asleep at NIGHT, do you awaken and access or respond to anything electronic such as text messaging? Do not include morning alarm/ after wake up time.

Answered: 71 Skipped: 0

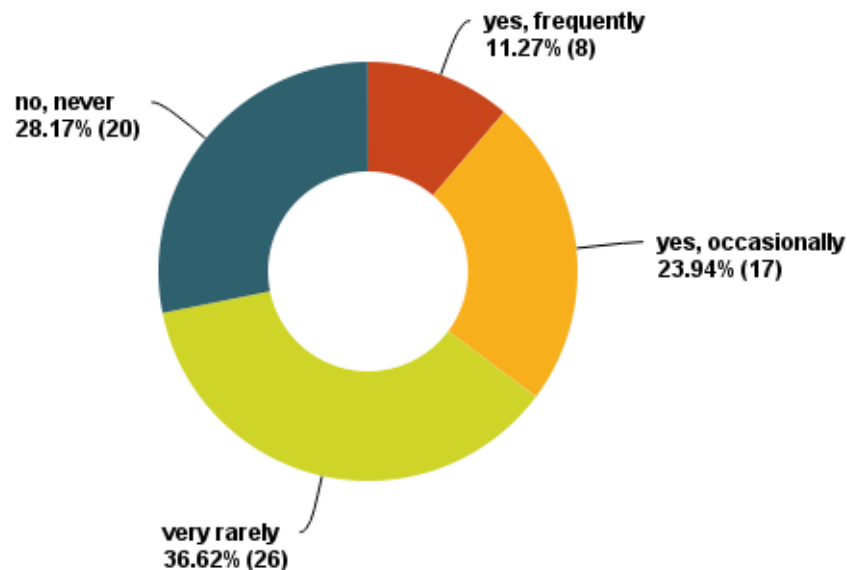


Figure 8. Electronic disruption of sleep reported by early college students

CSUS College Student Survey

Q28 Do you notice in yourself any of the following while "at school?" Mark all that apply:

Answered: 71 Skipped: 0

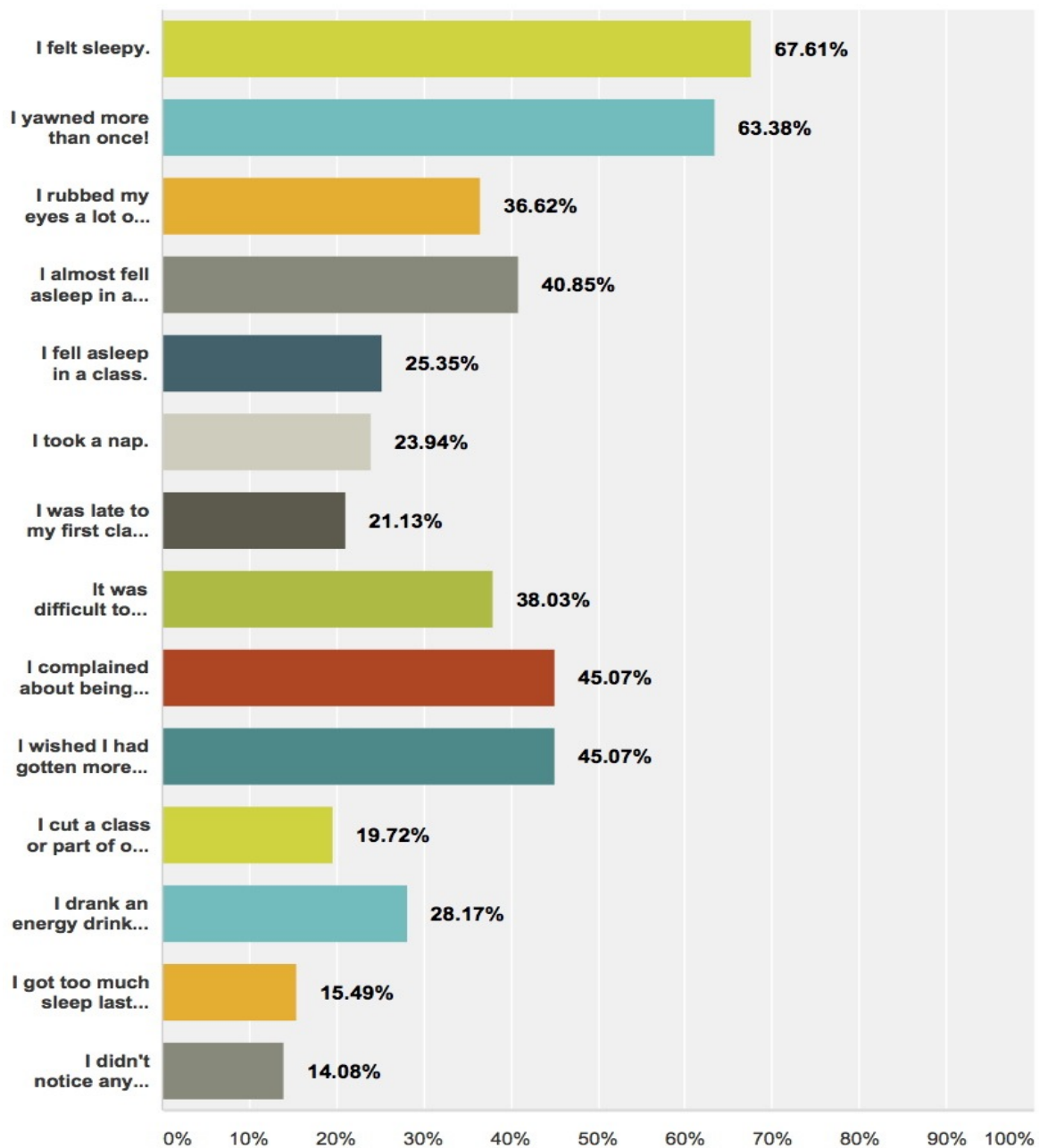


Figure 9. Sleep-loss behaviors noticed by college students

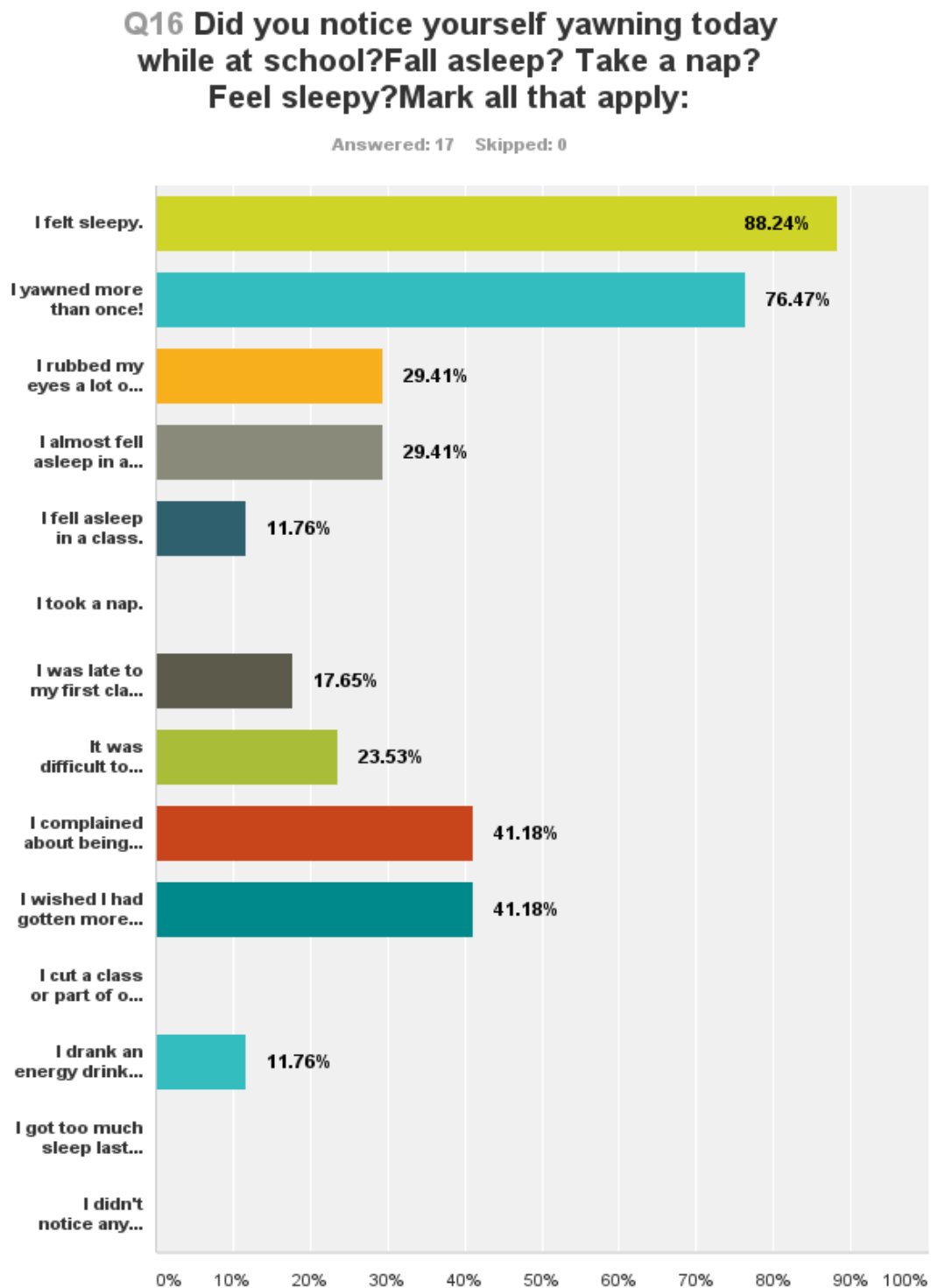


Figure 10. Sleep-loss behaviors noticed by high school students

A majority of college students notice in themselves the following sleep loss/sleep deprivation behaviors as seen above in Figure 9: 68% of students report feeling sleepy, 63% report yawning more than once, 37% complain of rubbing their eyes a lot, 41% almost fell asleep in a class, 24% report taking a nap, 21% report being late because of oversleeping or tiredness, 38% said it was difficult to pay attention, 45% complained about being tired, 45% wish they had gotten more sleep at night, 20% report cutting class so that they could sleep, 28% use energy drinks or caffeinated drinks to be more awake or energetic. Only 14% of college students reported not

noticing the above sleep-related issues in themselves. High school students report fewer symptoms, but with greater distinction—"I felt sleepy" was reported by 88% while not even one student reported not noticing any sleep-loss behaviors in themselves, as seen in Figure 10.

When being questioned if they think or feel the *lack of healthy sleep* may be affecting them in any of these areas, college students respond in resounding numbers: 41% believe that their health and safety choices are affected by a lack of healthy sleep, 15% safe driving, 23% relationships, 30% illness, 52% academics, 13% sports, and only 15% believe that they are getting enough sleep. Figure 11 shows these statistics.

When questioned if they think or feel that *overuse of electronic network devices* may be affecting them in any of these areas, college students respond: health and safety choices (26%), driving (10%), relationships (26%), academics (42%), and in sports (7%). Figure 12 shows these statistics.

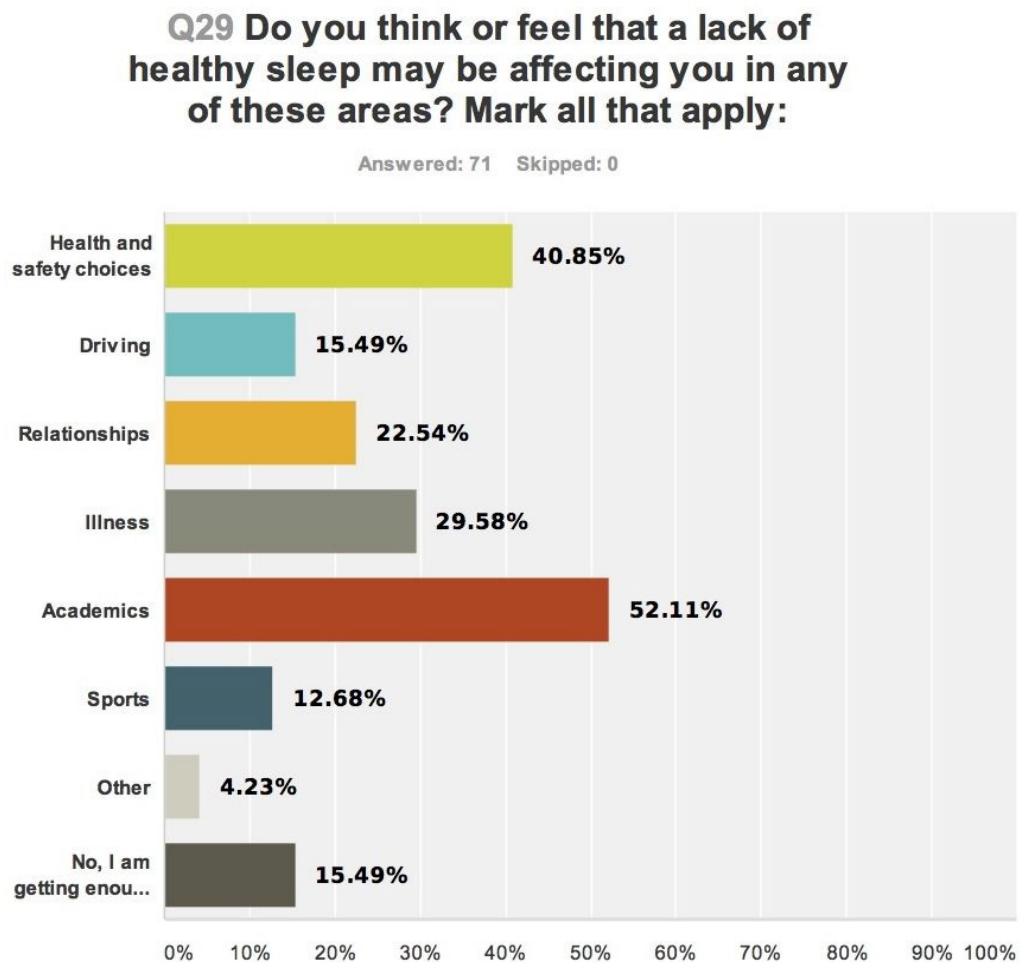


Figure 11. Affects of lack of sleep by college students are prevalent and broad

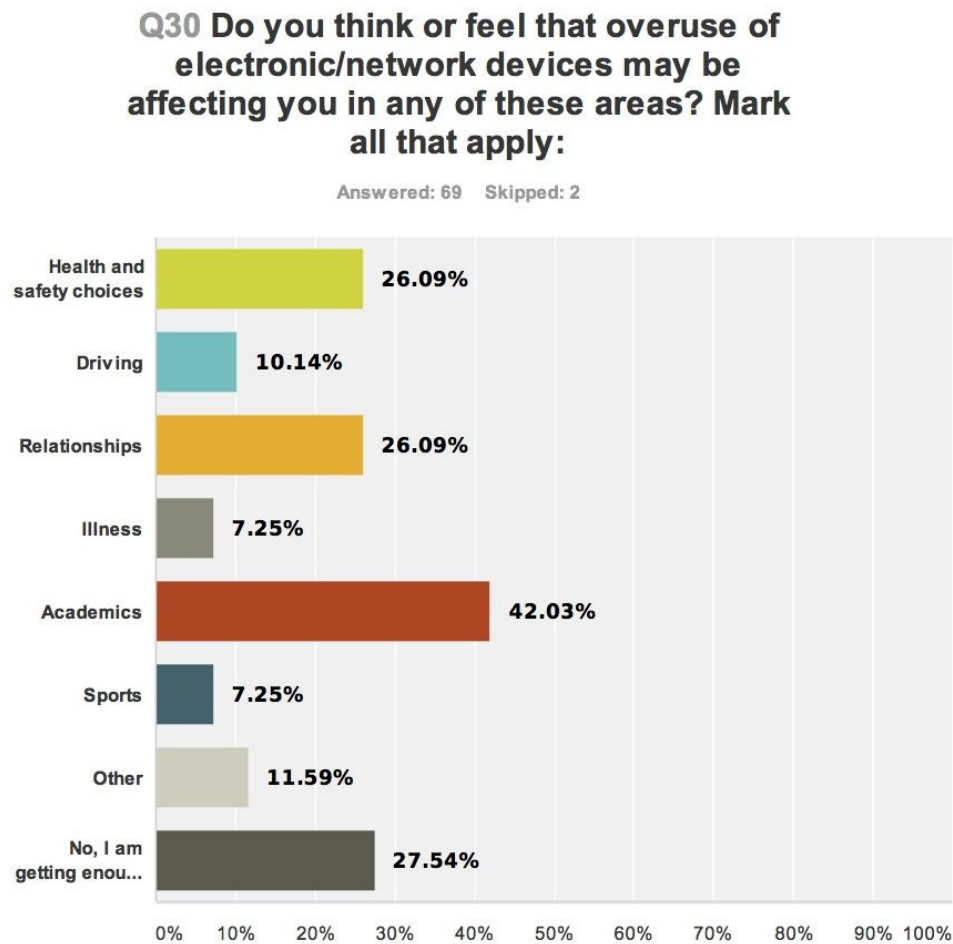


Figure 12. Affects of device/network overuse by college students are not as broad as that of sleep loss, however present significantly

The majority of college students self-reported getting five to eight hours of sleep a night, yet overall, answers ranged from two hours to eleven hours of sleep per night. Only 20% of college students report getting eight to eleven hours of sleep per night. The majority of this group responded that they think “eight hours” of sleep is the number of hours that undergraduate college students should get at night. A majority of college students wonder or think that their *lack of sleep* interferes with their academic aptitude at least monthly if not weekly, as seen in Figure 13. A majority of college students wonder or think that their *use of electronic devices* interferes with their sleep most weekly but at least monthly as seen in Figure 14. A little more than half of college students think that their *use of electronic devices* interferes with their academic aptitude.

Q33 How often do you wonder or think that your LACK OF SLEEP interferes with your “ACADEMIC APTITUDE (school work, academic time, study, achievement)?”

Answered: 71 Skipped: 0

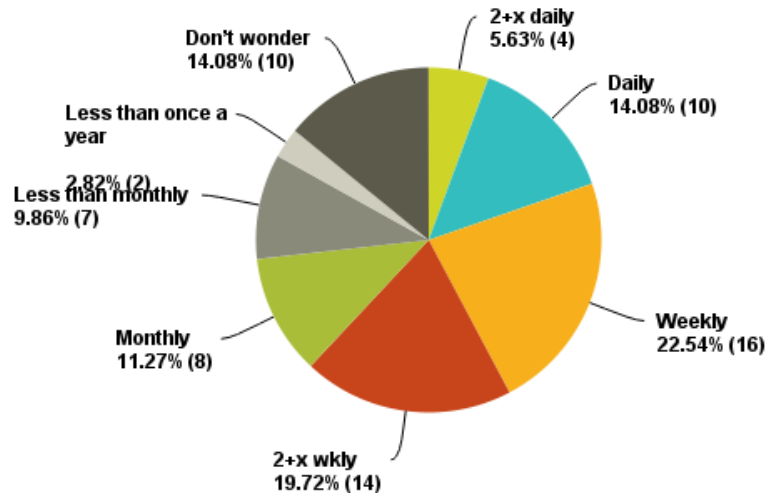


Figure 13. How college students wonder if lack-of-sleep affects academic aptitude

Q34 How often do you wonder or think that your use of ELECTRONIC DEVICES interferes with your SLEEP?

Answered: 71 Skipped: 0

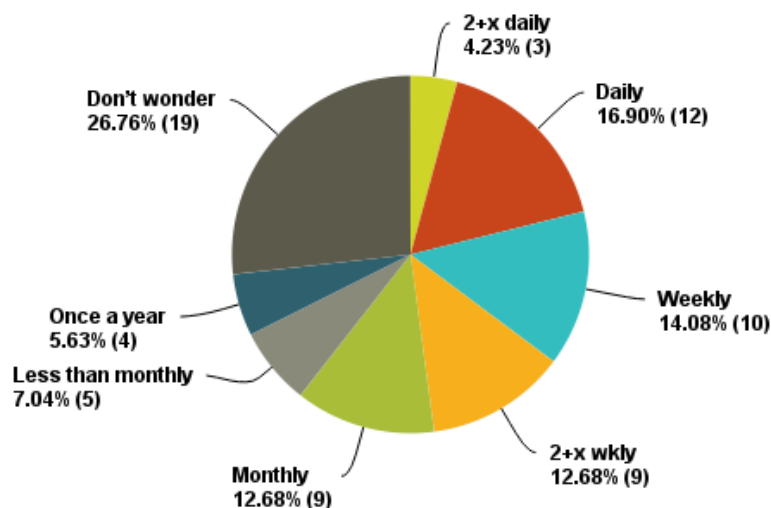


Figure 14. How college students wonder if electronic devices interfere with sleep

Contrary to the original thought, very little qualitative data was gathered from either survey. With Group S, it was discovered that one of the questions, the only “rating” question, was clunky and didn’t flow smoothly as the rest of the survey questions did. So in actual use while participants were taking the survey, that question made it

take more time than desired, however, since data had already been gathered, it was too late to omit the question. Consequently, few participants had the time to make additional optional comments when they got to the end of the survey, for the only “open ended” and not “multiple choice” type question. Also, it seemed as if some people participated in the survey because they wanted to *experience using* the iPad, yet many participants seemed unfamiliar with typing into the iPad, as was needed to answer, “Do you have any comments related to the content of this survey?” As a result, only a couple of students responded to that qualitative question, question 38. Although many participants did verbally state some reflective commentary, it was not recorded as part of this study. Much was similar to the fourth response in the table (Figure 15, line 4), “Good questions! They got me thinking about a lot of things that I would do/use on a day-to-day basis.” The comment (line 3) “I want a blue bouncy ball and m&ms...” refers to the incentives visually present as enticements to lure participants. A large glass jar of very colorful bouncy balls & small plastic frogs sat upon the table next to a basket of candy (Incidentally, these incentives were a huge hit, and definitely recommended for future surveys). One college student voluntarily commented on the survey, “I think that electronic devices and sleeplessness are the only way I can get my schoolwork done.”

Q38 Optional: Do you have any comments related to the content of this survey?

Answered: 10 Skipped: 61

Responses	Date
Yes	11/15/2013 2:58 PM
No	11/15/2013 2:53 PM
I want a blue bouncy ball and m&ms nice shirt	11/15/2013 2:48 PM
Good questions! They got me thinking about a lot of things that I would do/use on a day-to-day basis.	11/15/2013 2:11 PM
A lot of people have different sleep schedules that work for them, and I just happen to be the type of person who can get a lot done with as little as 4 hours of sleep. While I understand for my age range I should be getting much more than the amount I am getting, but I have noticed that while at school, the amount I get is enough. Electronics wise I don't feel make a huge impact in my sleep or academic use, besides being a huge distraction and time waster, but mostly because I'm Skyping my friend in the late hours of the evening.	11/15/2013 2:05 PM
I've performed this self analysis in the past and have set precautions to prevent problems. Good luck on your thesis!	11/8/2013 3:47 PM
Yes, I think that electronic devices and sleeplessness are the only way I can get my school work done.	11/8/2013 3:32 PM
It is well informative.	11/8/2013 3:24 PM
Interesting survey. Good job.	11/8/2013 3:18 PM
Too long	11/8/2013 1:44 PM

Figure 15. The entirety of voluntary qualitative commentary from college students

Group R, the high school study, was significantly different than the college study in that the participants additionally contributed to a nightly survey “sleep-related log/journal” were also observed daily in class by the teacher, and also had a basic profile for each student completed by the classroom teacher. High school students were asked many of the same questions as the college students. They also responded to more specific questions about their behaviors each night for a week. Their extended participation was designed to elicit more in depth connections between evening electronic use, healthy or not-healthy sleep, and academic propensity. Unfortunately, the number of participants started out low (18), just half of the total class size, and dwindled from there. Not all participants were wholly consistent in nightly participation, yet the use of specific secret login codes allowed clear differentiation and exact specificity to the data of individual participant responses. The result of the first night and day of this study may be seen in Figure 16.

For the purpose of clarity and understanding how this study worked, below is a breakdown of the alternating student journal observations and classroom teacher observations.

The progression of the high school “classroom” group study went like this:

Day 1, Monday Day during class: Teacher gave students specific login/direction packets. Materials and codes generated by researcher but codes *assigned* by Teacher.

Night 1, Monday night: Students logged into online survey journal (using secret codes) and answered questions right before bed (Date/time-stamped by the survey tool). Night 1: 18 participants.

Day 2, Day during class: Teacher made in-class observations of specific student sleep-loss-related behaviors on an easy-check chart.

Night 2, Tuesday night: Students logged into online survey journal and answered questions right before bed. Questions included those about sleep-loss-related behaviors experienced during *that* day. Night 2: 17 participants.

Day 3, Wednesday Day during class: Teacher made in-class observations of specific student sleep-loss-related behaviors on an easy-check chart.

Night 3, Wednesday night: Students logged into online survey journal and answered questions right before bed. Questions included those about sleep-loss-related behaviors experienced during *that* day. Night 3: 15 participants.

Day 4, Thursday Day during class: Teacher made in-class observations of specific student sleep-loss-related behaviors on an easy-check chart.

Night 4, Thursday night: Students logged into online survey journal and answered questions right before bed. Questions included those about sleep-loss-related behaviors experienced during *that* day. Night 4: 13 participants.

Day 5, Friday Day during class: Teacher made in-class observations of specific student sleep-loss-related behaviors on an easy-check chart. Teacher removed student name strip from all day charts and substituted the assigned codes. Researcher picked up the charts, without ever seeing the *student name* to code connection.

Nights 5-7: Friday, Saturday, & Sunday nights: *Some* Students logged into online survey journal and answered questions right before bed. Questions included those about differences in weeknight and weekend sleep. Nights 6-7 not “required” but welcomed. Night 5: 11 participants; Night 6: 6 participants; Night 7: 6 participants.

With overall participation numbers low, and a desire to increase participation, the researcher left the beginning survey “open” and requested for the teacher to encourage any non-participating class members to begin late but be sure to start with “Night ONE,” the night in which the bulk of general data was gathered for the high school study. “Night One” was the “Monday” night survey that participants were to “begin” the study with, as it was the survey that asked general and “average” questions. By research design, if a student only ever participated in just *one* night of the study, it was desired to be the first night due to the extensive content of the “Night One” survey questions. In comparing data by code #'s from student evening input with teacher observation for any given day, the researcher had to omit results that were not correlated for the same day/time period. The researcher initially believed that this portion of the study was inconclusive due to a reduced number of actual participants, as less than half the class actually completed the survey for more than 3 nights. Also, the delay of the participant “profile” resulted in somewhat less illuminating content. In other words, when it may have seemed that the teacher observation chart would have shown students with qualitative data, it was checked against student input from that evening’s survey. Often either the student had not participated that night, or the participation was not actually taking place on a day that rendered valid results. Consequently, when that happened, those findings could not be interpreted with validity on an individual basis for qualitative data. Yet, the findings overall were valid in the quantitative group data response, as seen in Figure 16.

Q16 Did you notice yourself yawning today while at school? Fall asleep? Take a nap? Feel sleepy? Mark all that apply:

Answered: 17 Skipped: 0

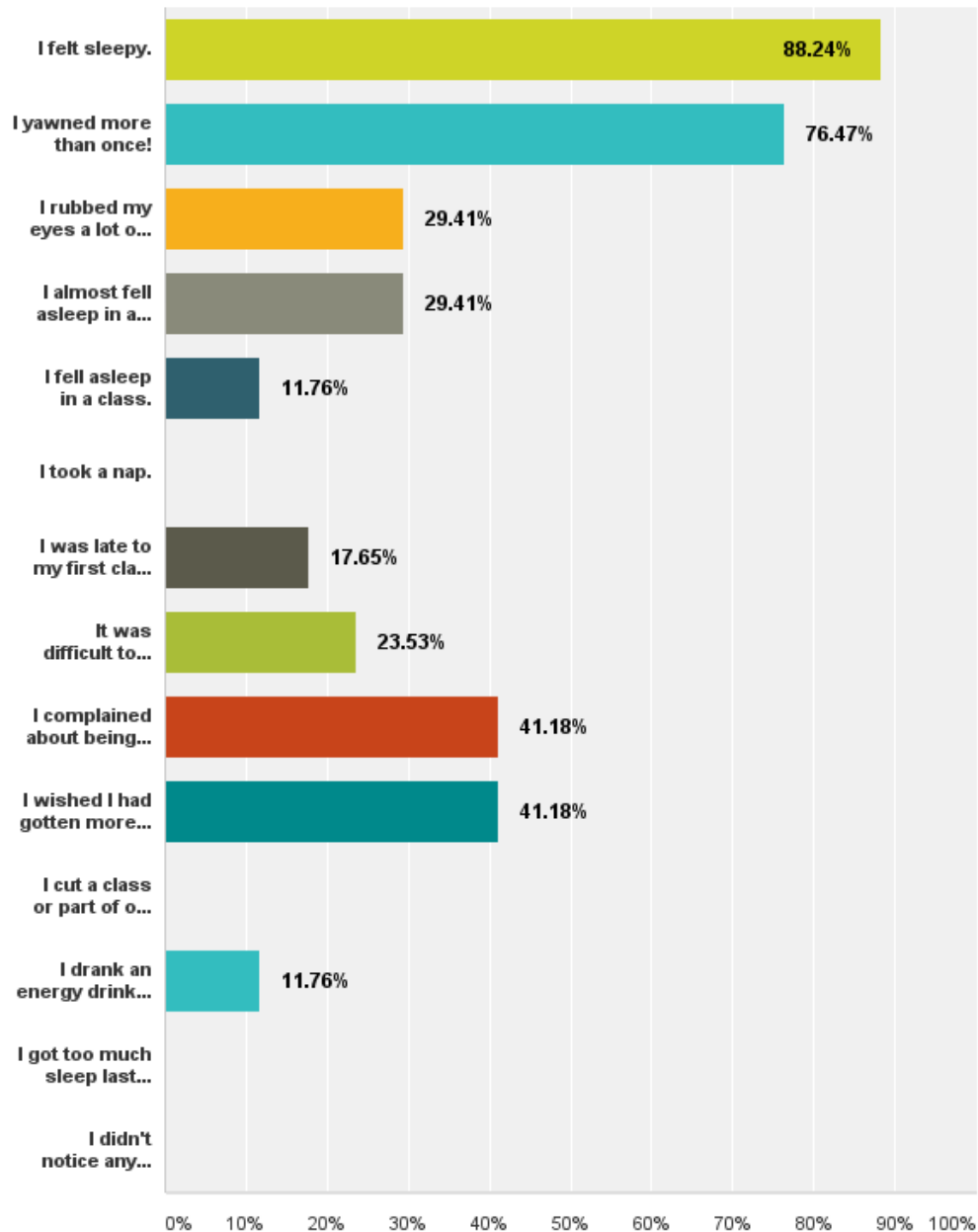


Figure 16. Sleep-loss behaviors noticed by high school students on “Tuesday,” the first day of also being observed by the teacher

In Figure 17 shown, the rows show a list of potential student behaviors that may occur in the classroom when students do not get enough sleep. Figure 17 is a scan of a portion of the actual chart used by the high school teacher for classroom observation of student behaviors. The columns represent individual students as observed during the classroom for one high school period (Period 1) on a Tuesday morning. The student code numbers are blocked to secure confidentiality in this publication. The students in the class would have reported their bedtime in the previous night (Monday) survey. The next day during class (Tuesday), the teacher made the observations about the students as seen below in Figure 17. That night (Tuesday), the students reported their own daytime

symptoms, reflected on the preceding night behaviors and sleep (Monday), and reported their bedtime for that evening (Tuesday). The next day this was repeated, through Friday morning. In Figure 16 one may see how the Group R responded on the Tuesday night survey journal.

Figure 17 shows the teacher's observation of sleep-loss behaviors. In spite of the challenge previously stated, the researcher further analyzed and crossed results using the codes, and found some correlating results with one particular case. In Figure 17, Student #1 (not the actual code nor any real number), to be called for now, "Sam Student" a self-reported male, reported sleep-loss behaviors that were correlated perfectly with the teacher's in-class observations of that individual. The morning after Sam Student entered his first night's survey journal input, he and other classmates attended their regular morning class. The teacher made observations of sleep-loss related behaviors exhibited by students during class. The first student column is the teacher's observation of Sam Student. The check column #1 indicates the teacher observed: student tardy; rubbing eyes, vision or blinking or squinting issues; seems very tired, sleepy, or lethargic; drinking something (unknown) or H2O. Additionally, the teacher's general profile of the student, completed at a later date, included the response: "Student does not seem to get enough sleep on a regular basis."

TUESDAY 9/24/2013

CONFIDENTIAL

Tuesday during class
9/24/13 - Completed by Teacher

Behavior: STUDENT:	N/A	✓	N/A	N/A	N/A	N/A
student absent		✓	✓			
student tardy	✓		✓			
student left early						
yawning more than once					✓	
rubbing eyes, vision or blinking or squinting issues	✓					
near sleep, fluttery, near dozing						
fell asleep briefly, dozing						
fell asleep longer, head bob or snored!						
fell asleep longer, head down						
lack of attentiveness/participation			✓			
complained of tiredness						
complained of lack of sleep						
seems very tired, sleepy, or lethargic	✓					
said they were up all nt/very late (even if overheard)						
drinking something (unknown) or H2O	✓					
drinking energy drink or coffee/tea			✓		✓	✓
said they drank energy drink or coffee						
seems possibly "on" something (substance)						
lack of success on assignment/quiz/test						
obsession/excessive use of device or electronic connection			✓			
appeared hyperactive						
rude, irritable or aggressive towards others						
had behavior issue, outburst, or major discipline event						
Other - write in						

See first student in-class behaviors as observed & recorded by Teacher in classroom. Student codes across the top have been covered to preserve anonymity.

Figure 17. In-class “sleepy” behaviors observed by high school teacher: See student #1(red arrow) whose teacher-reported behaviors match student-reported behaviors

Figures 18 and 19 below show a portion of the initial survey input entered by “Sam Student” on the first night of the study. The student voluntarily expressed interest and preoccupation with online gaming. Of note is the student response to a question (Figure 18, Q14) of whether the practice of gaming may be helping with schoolwork: “No, it is hindering/interfering with schoolwork.” He reported average bed and rise times (Figure 19, Q25, Q29) that indicate he usually got about seven hours of sleep a night.

Night ONE Survey

Q11: Estimate percentage of time (in above question) “USUALLY” spent on electronic devices used for study/academic work:	Most - 75% or more
Q12: Which of the following internet sites/apps do you use? Please mark ALL that you use:	Facebook, Twitter, Gaming – any online game inc. MMORPG like World of Warcraft, etc. , Games like Angry Birds, Solitaire, Bubble, etc that are not massive multi-player , YouTube or Vimeo or video site, Texting
Q14: If you marked online gaming above (any online game inc. MMOG or Massively multiplayer online role-playing game (MMORPG), do you believe that the practice and skills gained is helping with your schoolwork?	No, it is hindering/interfering with schoolwork
Q15: IF you marked online gaming (any online game inc. MMOG or Massively multiplayer online role-playing game (MMORPG), OR virtual worlds in the question above, which games do you most often do? Only answer this Q if you do online gaming that involves other online players.	
optional	League of Legends
optional	League of Legends
optional	I can't stop playing League of freakin Legends!!!

Figure 18. Excerpts of “Sam Student’s” survey response for Night 1 shows student interest in online gaming

Q22: Do you “turn off” electronics or put in “sleep” or “do not disturb mode” in the PM?	Never
Q23: What is the average time that you “leave” or “logoff/shutdown” (are done with) electronics in the evening? This means that you either “stop using” them and/or you put them to sleep or off. If you keep using them “all night,” answer N/A in the choices.	12AM midnight
Q24: Do you usually “sleep with” any of these devices in your bed? Mark all that apply:	cell phone
Q25: What is the average time that you usually go to SLEEP at night?	11:30 PM – 12 AM (midnight)
Q29: What is the time that you were AWAKE/ “got up” TODAY in the AM?	6:30 – 7 AM
Q30: How were you awakened this morning? If more than one answer applies, pick the one that worked the most.	Cell phone alarm
Q31: Do you have a specified “Bedtime?” If “yes,” please answer Q#30 below	no
Q32: What is your bed time? If you do not have a bed time (determined by yourself or someone else) leave blank	<i>Respondent skipped this question</i>
Q33: Who has determined the Bedtime?	Myself - I set my own bedtime

Figure 19. Excerpts of “Sam Student’s” survey response for Night 1 shows student going to bed around midnight and awakening 6.5-7 hours later

The student’s input from the first night, in Figures 18-19, preceded the teacher’s observation the next day, as seen previously in Figure 16. The student survey input for that *following* night *confirms* the teacher’s observation of sleep-loss behaviors. As seen in Figure 20, Sam Student reported that he had continued to use his cell phone (smart phone) 30 minutes-one hour in bed the previous night (before the Tuesday class). The student selected these behaviors for that day at school: I felt sleepy; I yawned more than once; I almost fell asleep in a class; I was late to my first class because of oversleeping or tiredness; I complained about being tired; I wish I had gotten more sleep last night. Sam Student responded, “I should have gotten more sleep.” When asked in the survey that night, “Do you think that your electronic use interfered with your sleep last night?” The participant answered yes, yet when asked, “Do you think that a lack of sleep interfered with your ability to learn or focus today?” The participant answered no. No other sleep log surveys were completed by this participant, yet the teacher continued to observe “sleepy”/lack of sleep behaviors in this student for the rest of the week. There is clearly a correlation between this student’s use of nighttime online electronics, lack of healthy sleep, and resulting diminished academic aptitude in class the next morning.

Night TWO Survey

Q8: LAST NIGHT, where did your cell phone “sleep?” If you don’t have one, put N/A in the blank.	Next to my bed
Q9: Did you actually go to bed/sleep shortly after completing survey LAST NIGHT?	yes I went to bed/sleep
Q10: Did you access any electronics after going to bed last night? Mark all that apply:	cell phone
Q11: If you did use electronic device(s) after going to bed last night, about how much longer did you use them?	30 min. - 1 hr.
Q16: Did you notice yourself yawning today while at school? Fall asleep? Take a nap? Feel sleepy? Mark all that apply:	I felt sleepy., I yawned more than once!, I almost fell asleep in a class., I was late to my first class because of over-sleeping or tiredness. , I complained about being tired., I wished I had gotten more sleep last night.
Q17: Do you think you got “enough” sleep LAST NIGHT?	I should have gotten more sleep
Q18: Do you think that your electronic use interfered with your sleep last night?	yes

Figure 20. Excerpts of “Sam Student’s” survey response for Night 2 show student acknowledgement of electronic use replacing sleep time, and related sleep-loss behaviors that day in the classroom

High school students were also given the opportunity to optionally comment about the study in this question: Optional: Any comments or concerns about your age group, teenagers-late teens, early twenties and electronics/internet/sleep? Only one student, age 17, responded, at 2:08 AM, “Teens are really connected to our electronics. Its [sic] not necessarily bad though. Sometimes it may interfere with our sleep though. And the internet helps us stay connected to what’s going on in the world, and locally, faster than it used to be.”

Q34 THANK YOU for answering this survey! Did this survey get you thinking?

Answered: 13 Skipped: 0

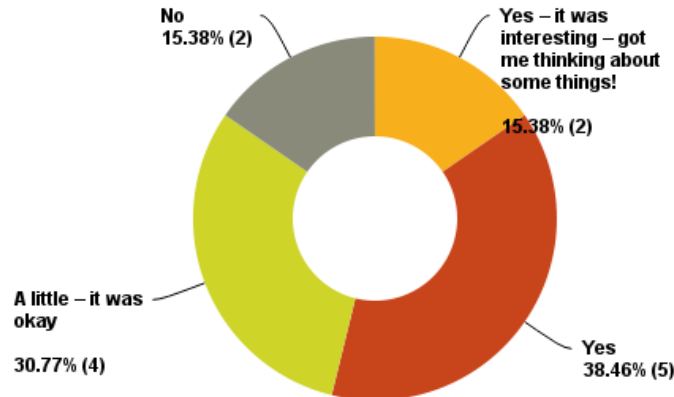


Figure 21. High school students respond to 4th night survey final question

Q37 THANK YOU for answering this survey! Did this survey get you thinking?

Answered: 68 Skipped: 3

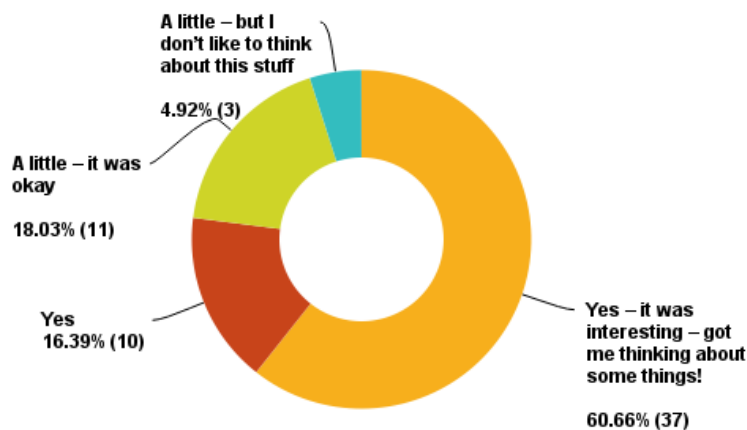


Figure 22. College students respond to survey final question

5. Discussion

This investigation into technology and sleep habits of local adolescents yielded rich and varied results. As studies of current adolescent behavior in these areas within the United States are rare, this examination is helpful. With these results we are able to compare with the few previous studies and see if our students are indeed within the average. Additionally, this study provides some information and insight that previously may not have been documented in the same manner.

The reported results are very straightforward, as it is clearly a case of “the numbers speak volumes” and “a picture is worth 1000 words.” The fact that nearly every student owns a cell phone is remarkable—with 85% of those phones being smart phones, which clearly means that a majority of all students have the capability of being

online, anytime of day, “24/7.” In comparing this to the PEW research study on “2013 Teens and Technology,” which found 78% of teens as cell phone owners, and 25% as “cell-mostly” internet users (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013), the implication is that the rate may actually be much higher. A possible oversight of the current study is that participants were not asked about their main mode of internet connection, nor were they asked which device they were reporting/responding upon (Group R). Even without that information, with a majority of students having both access to online networking and a device to do it upon, one may assume that they would access whenever they feel or want to access.

College students, and high school students to a slightly lesser degree, are spending a tremendous amount of time on electronic devices, and this isn’t really news, except for the part about only about half of that time is spent for academic purposes—Since 75% of students report being on devices over 3 hours a day, then, on the low end, they are getting a large amount of entertainment and social connection with their devices. This is not “bad” yet causes one to wonder if perhaps we don’t have enough knowledge and information about how devices may be used in academic work (other than word processing). Also, perhaps instructors are not integrating technology into the assignments in a practicable manner so that students can see how to use their devices as academic tools for other applications. Indeed, although 62% of students are using Blackboard or Moodle for school, all of the other sites and apps used (top half of Figure 3) are entertainments and social-networking oriented. It seems that incorporating a social component into academic technology use would be productive and applicable. For example, as an instructor, I could include Edmodo, a Facebook group page, collaborative wiki or google drive projects, apps like Quizlet, and collaborative app-based video projects, and allow students to create assignments within virtual world games. If we want to reach them “where they live,” then we need to see technology as a connective tool between the academic and social worlds rather than a divisive force.

The fact that a majority of students are using devices immediately before and into bed is a huge concern. This practice is clearly affecting the amount of healthy uninterrupted sleep that students are getting. Quantity of sleep has already been a concern with this particular population. We’ve added to that a distracting device that brings with it an element of stress, an always-on connection (“What am I missing?”), the unknown of EMF (Electromagnetic Fields) and light. Compounded with the propensity of students to *not* put the device into a sleep mode, and to react and wake up and respond. This is perhaps shocking to those who had naively believed that their students were behaving in the manner of the parents and grandparents generations. Previous studies into adolescent technology behaviors have not questioned and investigated whether or not the subjects slept with their devices. Many adults assume that “going to bed” means disconnection, but for many students today, it means physically being in a bed while they continue their always-on digital lives. Figures 4, 5, 6, 8, 19, and 20 support this. Pre-digital college generations would joke about sleeping with textbooks, and whether a process of diffusion of knowledge could occur. Naturally it couldn’t and didn’t, and yet sleeping with the instruments of knowledge incurred zero risk of harm. This is not so with electronics. At the very least, the disruption and displacement of sleep incurs risk of harm, as the loss of sleep puts the physical body and mental capacity in a diminished state.

That a majority of students are getting far less than the recommended eight hours of sleep, or even just seven hours of sleep is concerning. Although this is not new information, it does support that of previous research. With such high numbers of students reporting that during the day they felt sleepy, yawned more than once, complained about not getting enough sleep, and wished they had gotten more sleep, it seems that there is some predisposition in this group to need for us to provide better sleep education, better value of sleep emphasis in the culture, and a means of structure or guidelines to support the generation’s need for discipline. For example, as an instructor, I would put forth in my syllabus a request that my students put “mobile” electronics to sleep one hour before bed, and to place them in a silent sleep “Do not disturb” mode so that texts do not interrupt. Perhaps I would even develop an online incentive program in which students could earn extra flex-points for going to bed, putting devices to sleep, logging 7 or more hours of sleep and similar positive sleep behaviors.

Although qualitative data was not gathered and perhaps could have been gathered had the researcher planned it in advance, about half-way or so through the college survey, participants often would begin to speak aloud or laugh or comment aloud to their friends nearby. It seemed that just the exposure to being questioned about their behaviors, and the direct thinking about them, caused many students to begin to reflect in a way they had not intentionally done before. Some said things about how some of their choices may be adverse, and that they were now going to look at it differently. Many seemed surprisingly open and not averse to information about managing their habits. Having had the opportunity to be very “on their own” for a couple of months into college, it appeared that some students were looking for a little bit of “momming” chatting informally with the researcher. In many universities, beginning students are required to complete a “library” course that covers aspects of using

and doing research in the library. Some colleges will have an alcohol education of sexual abuse short course that students complete in the first semester of college. It seems appropriate for universities to have an “on your own” health course that incorporates some brief basics of college nutrition, technology use, and sleep. Most adolescents are desirous of making their own decisions about their health and choices, and it is right for us to allow them to do so. Yet, it is irresponsible of us to not provide them with adequate and accurate information so that their choices are better informed.

The first research question asked with what impact evening media use interferes with either school work/study and/or sufficient healthy sleep? The anticipated outcome was that student participants would indeed have intense use of electronics in the evening, for both study and social media, and that recommend hours of sleep would not be met by participants age 16-25. The anticipated outcome was indeed the actual outcome of this study. Participants clearly spend a great deal of evening time using electronic media, and it clearly interferes with sleep, as evidenced by both the reported use of media and reported lack of adequate sleep. Although the original research question just addressed the use of electronic media, an additional insight brought out by this study is that the media use is mainly online use, and dominantly social media and networking media use. Students connect to the online world, and their social networks both near and far.

The second research question asked with what impact may there be a compromise in students’ ability or aptitude for positive academic success, related to either lack of sleep or electronic media use? The anticipated outcome was that students would acknowledge that lack of sleep occurred related to evening media use, and the lack affected their daytime performance academically. This question was also answered with a clear impact, although it must be stated that this was mainly identified through the students’ perspectives. Since there was not a means of collecting true and documented *academic* data in this study, some may believe that the data was too biased and possibly not accurate as such. However, if the outcome had showed “no effect or concern” that could be a valid argument. Often, adolescents will tend to underplay the impact of their “negative” activities upon schoolwork, and overplay the projected grades and achievement. If that is the case in this study, then there still exists a relationship or compromise in student ability or aptitude with the overuse of electronics and apparent lack of sleep. In this study, students self-report their concerns, which says a lot, as seen in Figures 11, 12, 13, and 14. If over 52% of students think that a lack of healthy sleep is affecting them academically, it is. That over 42% think there is a connection to electronic overuse and network devices obviously validates these findings.

Electronic and media over-use is not *directly* linked to reduced academic success. The fact that electronic media over-use results in inadequate student sleep should be paramount. That inadequate adolescent and young college student sleep results in groggy, unhealthy, depressed and stressed-out individuals is enough of a concern. Students who are not adequately healthy do not make the best decisions nor perform adequately nor up to their potentials. When students are not physically equipped by the sleep they need on a regular basis, they are not equipped to be anywhere near the best students they can be, and are at risk of actually experiencing great distress. Further information about this may be seen as cited in the full literature review, “Adolescent Sleep Compromised by Technology” (Moulin, 2015).

Since over half of college students are reporting a relationship between their inadequate sleep and academics, and 40% say that lack of health sleep is affecting their health and safety choices, we need to take these findings very seriously. Even “only” 15% reporting a relationship between lack of sleep affecting their driving is significant, yet there are also 30% saying that their illness level is affected by lack of sleep. Combined with the evidence that electronic use is a factor in students getting an adequate amount of healthful sleep, these findings warrant great concern for the welfare of our current and future generation of students.

6. Conclusion Recommendations

The research indicated that unhealthy sleep habits may be creating a generation of sleep-deprived individuals who may not be functioning at top capacity. Although this first truly digital generation is seeing great benefit from their electronic and media access, they are also paying a cost. Findings regarding a correlation between lack of sleep and *quantified* academic success are inconclusive, however, student perceptions indicate that they believe there is a relationship, which means there is one. Findings also suggest that all instructors of late adolescent students aged 16-25 may count on the fact of their student clientele owning and using mobile devices to access the internet for entertainment and social purposes. Students allow their social digital world to impede and compete with their academic time and biological sleep time. Instructors would be wise to appropriately channel the digital skills of this new generation of no longer-wired, but now “wi-fied” students (Moulin, 2015). Therefore it is strongly suggested that teachers, parents, and medical personnel adopt and provide healthy

guidelines for parents to use with pre-teens and teens, to facilitate and develop in the next generation of students some structure and means of protecting their health in the realms of electronics and sleep.

References

- Amschler, D. H., & McKenzie, J. F. (2005). Elementary students' sleep habits and teacher observations of sleep-related problems. *Journal of School Health*, 75(2), 50-56. <https://dx.doi.org/10.1111/j.1746-1561.2005.tb00010.x>
- Bavelier, D., Green, C. S., Han, D. H., Renshaw, P. F., Merzenich, M. M., & Gentile, D. A. (2011). Brains on video games. *Nature*, 12, 763-768. <https://dx.doi.org/10.1038/nrn3135>
- BBC News, & Wallis, L. (2013, September 23). Is 25 the new cut-off point for adulthood? *BBC News*. Retrieved from <http://www.bbc.com/news/magazine-24173194>
- Beebe, D. W. (2011). Cognitive, behavioral, and functional consequences of inadequate sleep in children and adolescents. *Pediatric Clinics of North America*, 58(3), 649-665. <https://dx.doi.org/10.1016/j.pcl.2011.03.002>
- Beebe, D. W., Simon, S., Summer, S., Hemmer, S., Strotman, D., & Dolan, L. M. (2013). Dietary intake following experimentally restricted sleep in adolescents. *Sleep*, 36(6), 827-834. <https://dx.doi.org/10.5665/sleep.2704>
- Brandstaetter, R. (2015, January 30). Hitting the sack: Sleep cycles can affect athletes' performance. *Science Friday* [Audio episode]. Retrieved from <http://sciencefriday.com/guests/roland-brandstaetter.html#page/full-width-list/1>
- Burwell, S. M. (2013, November 7). *Impacts and Costs of the Government Shutdown* [Blog post]. Office of Management and Budget, The White House Administration. Retrieved from <https://www.whitehouse.gov/blog/2013/11/07/impacts-and-costs-government-shutdown>
- Cain, N., & Gradisar, M. (2010). Electronic media use and sleep in school-aged children and adolescents: A review. *Sleep Medicine*, 11(8), 735-742. <https://dx.doi.org/10.1016/j.sleep.2010.02.006>
- Canadian Paediatric Society. (2003). Age limits and adolescents. *Paediatrics & Child Health*, 8(9), 577. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2794325/>
- Carskadon, M. (2002a). *Adolescent sleep patterns: Biological, social, and psychological influences* (pp. 149-157). Cambridge: Cambridge University Press. <https://dx.doi.org/10.1017/CBO9780511499999>
- Carskadon, M. (2002b). *Interview: Mary Carskadon. Inside the teenage brain* [Transcript, television broadcast]. Frontline PBS. Retrieved from <http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/interviews/carskadon.html>
- Carskadon, M. A. (2011). Forget a's, b's, and c's—What students need is more zzzz's. *Chronicle of Higher Education*, 58(14), 22.
- Choi, K., Son, H., Park, M., Han, J., Kim, K., Lee, B., & Gwak, H. (2009). Internet overuse and excessive daytime sleepiness in adolescents. *Psychiatry and Clinical Neurosciences*, 63(4), 455-462. <https://dx.doi.org/10.1111/j.1440-1819.2009.01925.x>
- Dement, W. C. (1999). *The promise of sleep: A pioneer in sleep medicine explores the vital connection between health, happiness, and a good night's sleep*. New York: Delacorte Press.
- Dworak, M., Schierl, T., Bruns, T., & Struder, H. K. (2007). Impact of singular excessive computer game and television exposure on sleep patterns and memory performance of school-aged children. *Pediatrics*, 120(5), 978-985. <https://dx.doi.org/10.1542/peds.2007-0476>
- Facer-Childs, E., & Brandstaetter, R. (2015). The impact of circadian phenotype and time since awakening on diurnal performance in athletes. *Current Biology*, 25(4), 518-522. <https://dx.doi.org/10.1016/j.cub.2014.12.036>
- Fuligni, A. J., Gillen-O'Neel, C., & Huynh, V. W. (2013). To study or to sleep? The academic costs of extra studying at the expense of sleep. *Child Development*, 84(1), 133-142. <https://dx.doi.org/10.1111/j.1467-8624.2012.01834.x>
- Gupta, N. K., Mueller, W. H., Chan, W., & Meininger, J. C. (2002). Is obesity associated with poor sleep quality in adolescents? *American Journal of Human Biology*, 14(6), 762-768. <https://dx.doi.org/10.1002/ajhb.10093>

- Hart, C. N., Hawley, N., Kuhl, E., & Jelalian, E. (2013). Weight control and obesity. In A. R. Wolfson, & H. Montgomery-Downs (Eds.), *The Oxford Handbook of Infant, Child, and Adolescent Sleep and Behavior* (pp. 443-443). New York, NY: Oxford University Press.
- Johnson, S. B., Blum, R. W., & Giedd, J. N. (2009). Adolescent maturity and the brain: The promise and pitfalls of neuroscience research in adolescent health policy. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, 45(3), 216-221. <https://dx.doi.org/10.1016/j.jadohealth.2009.05.016>
- Kostyun, R. O., Milewski, M. D., & Hafeez, I. (2015). Sleep disturbance and neurocognitive function during the recovery from a sport-related concussion in adolescents. *American Journal of Sports Medicine*, 43(3), 633-640. <https://dx.doi.org/10.1177/0363546514560727>
- Lund, H. G., Reider, B. D., Whiting, A. B., & Prichard, J. R. (2010). Sleep patterns and predictors of disturbed sleep in a large population of college students. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, 46(2), 124-132. <https://dx.doi.org/10.1016/j.jadohealth.2009.06.016>
- Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U. (2013). *Teens and technology 2013*. Pew Research Center, Washington, DC: Pew Research Center's Internet & American Life Project. Retrieved from http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_TeensandTechnology2013.pdf
- Mattson, M. P., Allison, D. B., Fontana, L., Harvie, M., Longo, V. D., Scheer, F., ... Panda, S. (2014). Meal frequency and timing in health and disease. *Proceedings of the National Academy of Sciences, USA*, 111(47), 16647-16653. <https://dx.doi.org/10.1073/pnas.1413965111>
- Moulin, K. L. (2015). *Adolescent sleep compromised by technology* (Unpublished literature review). California State University, Sacramento, California, USA.
- Moulin, K. L. (2015). Technology trumping sleep. In *Proceedings of Society for Information Technology & Teacher Education International Conference 2015*. Las Vegas, NV: Association for the Advancement of Computing in Education (AACE).
- National Sleep Foundation. (2006). *2006 Teens and sleep. Sleep in America Polls*. Washington, DC: National Sleep Foundation. Retrieved from <http://www.sleepfoundation.org/article/sleep-america-polls/2006-teens-and-sleep>
- National Sleep Foundation. (2011). *Communications technology in the bedroom. Sleep in America Polls*. Washington, DC: National Sleep Foundation. Retrieved from <http://www.sleepfoundation.org>
- National Survey of Student Engagement. (2014). *Bringing the Institution into Focus—Annual Results 2014*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- NPR, & Aubrey, A. (Correspondent). (2015, March 10). Circadian surprise: How our body clocks help shape our waistlines. *National Public Radio: Morning Edition* [Audio episode]. Retrieved from <http://www.npr.org/blogs/thesalt/2015/03/10/389596946/circadian-surprise-how-our-body-clocks-help-shape-our-waistlines>
- Nuutinen, T., Ray, C., & Roos, E. (2013). Do computer use, TV viewing, and the presence of the media in the bedroom predict school-aged children's sleep habits in a longitudinal study? *BMC Public Health*, 13(684), 8. <https://dx.doi.org/10.1186/1471-2458-13-684>
- Owens, J., Adolescent Sleep Working Group, & Committee on Adolescence. (2014). Insufficient sleep in adolescents and young adults: An update on causes and consequences. *Pediatrics*, 134(3), 921-932. <https://dx.doi.org/10.1542/peds.2014-1696>
- Punamaki, R. L., Wallenius, M., Nygard, C. H., Saarni, L., & Rimpela, A. (2007). Use of Information and Communication Technology (ICT) and perceived health in adolescence: The role of sleeping habits and waking-time tiredness. *Journal of Adolescence*, 30(4), 569-585. <https://dx.doi.org/10.1016/j.adolescence.2006.07.004>
- Shochat, T., Flint-Bretler, O., & Tzischinsky, O. (2010). Sleep patterns, electronic media exposure and daytime sleep-related behaviours among Israeli adolescents. *Acta Paediatrica*, 99(9), 1396-1400. <https://dx.doi.org/10.1111/j.1651-2227.2010.01821.x>
- Sleep Health. (2015). *Healthy People 2020 topics and objectives*. Office of Disease Prevention and Health promotion, U.S. Department of Health and Human Services. Retrieved from <http://www.healthypeople.gov/2020/topics-objectives/topic/sleep-health?topicid=38>

- Thomee, S., Eklof, M., Gustafsson, E., Nilsson, R., & Hagberg, M. (2007). Prevalence of perceived stress, symptoms of depression and sleep disturbances in relation to information and communication technology (ICT) use among young adults—An explorative prospective study. *Computers in Human Behavior*, 23(3), 1300-1321. <https://dx.doi.org/10.1016/j.chb.2004.12.007>
- Thun, E., Bjorvatn, B., Flo, E., Harris, A., & Pallesen, S. (2013). Sleep, circadian rhythms, and athletic performance. *Sleep Medicine Reviews*, 23, 1-9. <https://dx.doi.org/10.1016/j.smrv.2014.11.003>
- Vitaterna, M. H., Takahashi, J. S., Turek, F. W. (2001). Overview of circadian rhythms. *Alcohol Research & Health*, 25(2), 85-140.
- Weiss, A., Xu, F., Storfer-Isser, A., Thomas, A., Ievers-Landis, C. E., & Redline, S. (2010). The association of sleep duration with adolescents' fat and carbohydrate consumption. *Sleep*, 33(9), 1201-1209.
- Wernick, A. (Writer), & Lim, A. (Producer). (2015, February 4). Sleep cycles can affect an athlete's performance [Audio episode]. *Science Friday*. Retrieved from <http://www.pri.org/stories/2015-02-04/sleep-cycles-can-affect-athletes-performance>
- Wolfson, A. R., & Montgomery-Downs, H. (2013). *The Oxford Handbook of Infant, Child, and Adolescent Sleep and Behavior* (p. 443). New York, NY: Oxford University Press. <https://dx.doi.org/10.1093/oxfordhb/9780199873630.001.0001>
- Wolski, C. A. (Writer), & Lim, A. (Producer). (2015, March). Helping athletes find their (circadian) rhythm. *Sleep Review Journal*. Retrieved from <http://www.sleepreviewmag.com/2015/03/helping-athletes-find-circadian-rhythm/#sthash.4grrZe3s.dpuf>
- World Health Organization. (2015). *Adolescent development*. Retrieved from http://www.who.int/maternal_child_adolescent/topics/adolescence/dev/en/
- Yang, Y. S., Yen, J. Y., Ko, C. H., Cheng, C. P., & Yen, C. F. (2010). The association between problematic cellular phone use and risky behaviors and low self-esteem among Taiwanese adolescents. *BMC Public Health*, 217(10), 1-8. <https://dx.doi.org/10.1186/1471-2458-10-217>
- Zimmerman, F. J. (2008). *Children's media use and sleep problems—Issues and unanswered questions* (pp. 1-8). Kaiser Family Foundation.
- Zimmerman, F. J., & Bell, J. F. (2010). Associations of television content type and obesity in children. *American Journal of Public Health*, 100(2), 334-340. <https://dx.doi.org/10.2105/AJPH.2008.155119>

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).