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Cell Phone Use, Sleep Quality, Academic Performance, and Psychological Well-Being in Young Adults: A Theoretical Framework

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Abstract: Cell phone use (CPU) impacts the sleep quality, academic performance, and psychological well-being (PWB) of young adults. A strong theoretical framework was warranted to explain these impacts. Also, the theoretical framework was warranted to understand the inter-variable interactions for sleep quality, academic performance, and PWB, and their impact on the mental health of young adults. The presented study provides a research-based theoretical framework for CPU-led sleep quality, academic performance, and PWB, which is built on existing developmental theories. The developmental theories are grouped under four overarching theories, which are nested under the bigger umbrella of cognitivism. The framework offers a theoretical explanation for all three CPU-led mechanisms associated with sleep quality, academic performance, and PWB. The Sleep Displacement Theory and Arousal Theory explains CPU-led sleep disruption. The Switch Load Theory and Self-regulated Learning Theory explains CPU multitasking and self-regulated learning behavior. The Six-factor Model of Psychological Well-Being and Maslow's Hierarchy of Psychological Needs explains CPU-led PWB. The presented framework will help explore CPU-led sleep quality, academic performance, and PWB from a theoretical perspective, hence, will help provide theoretical support to the empirical finding relating to these variables. The significance of the theoretical framework in all three domains and the practical implications of the findings to the real world are discussed.

Keywords: Cell phone use; Sleep quality; Sleep displacement; Psychological arousal; Academic performance; Multitasking; Self-regulation; Psychological well-being.

1. Background and Introduction

1.1. Availability and functionality of cell phones in the information age

Mobile phones, often called cellular phones or cell phones, are compact handheld electronic devices meant for voice communication. Technological advancements from the last two decades accelerated the growth of these devices in such a way that "most mobile phones provide voice communications, short message service (SMS), multimedia message service (MMS), and newer phones may also provide internet services such as Web browsing, instant messaging capabilities, and e-mail" (Beal, 2008). With these capabilities, current mobile phones, labeled as cell phones throughout this study, can be used for various purposes including entertainment, information gathering, and social interaction.

Abundant, user-friendly educational applications make cell phones useful learning tools for a digital generation, particularly for "those between the age of 18 and 29," the age range defined for young adults by the PEW Research Center (2011). The vast functionality of these tools for information gathering and social networking compel young adults to be constant users of these devices ("Demographics of mobile device ownership and adoption in the United States," 2021). While the availability of information makes a cell phone a useful tool, it may also risk dependency in the day-to-day life of young adults. Such high cell phone dependency may cause various physical, mental, and psychological issues that might further lead to several problems in this demographic.

1.2. Epidemiological Data on Dependency of Cell Phone Use (CPU)

The recent estimates of cellular communication prevalence indicated that adult dependency on cell phones in the United States is high compared to other countries (Hitlin, 2020). The mobile-cellular subscription rate per capita in the United States was estimated to reach its highest in 2018, making it the third-largest subscription rate in the world, only behind the Commonwealth of Independent States (CIS) and Europe (ITU World Telecommunication/ICT indicators database, 2018; The Internet World Stats, 2016). Interestingly, the rate was found to be higher in countries where cell phones were primarily used for communication and social networking (Lopez-Fernandez et al., 2017).

Smartphones are the modified versions of traditional cellular phones. More precisely, as per the definition, a smartphone is a combination of both cellular (calling and texting) and computer (accessing the internet, storing information, installing programs, etc.) capabilities in one small handheld device (Beal, 2008). According to the PEW Research Center (2018), 95% of American adults own a cell phone of some kind, with 77% owning a smartphone. Cell phone ownership of young adults (18 - 29 yrs.) is 100%, with 94% of them owning a smartphone. The data also found that cell phone dependency in American adults has increased over time; the percentage of smartphone users who do not have a broadband connection at home has reached 20% in 2018, which was 12% in 2016. Recent mobile-cellular subscriptions (e.g., mobile phone or smartphone) indicated that cell-phone ownership in the US has almost saturated (ITU World Telecommunication/ICT indicators database, 2018). This data reflects how cell phone dependency has increased over the years and may continue to escalate in years to come.

One-in-five American adults prefer to have "smartphone-only" internet over traditional home broadband services ("Demographics of Internet and Home Broadband Usage in the United States," 2018). Recently, Perrin and Jiang (2018) from the PEW Research Center, have reported that "39% of 18- to 29-year-olds now go online almost constantly and 49% go online multiple times per day." Young adults envision cell phones as an integral component of their day-to-day life as they perceive cell phones as a primary tool for accessing the internet. In fact, they perceive cell phones as something that they cannot live without ("Americans' Views on Mobile Etiquette," 2015). Cell phones have become a fundamental living need in today's world, which explains the high rate of cell phone dependency.

1.3. Data on the Utilization of Cell Phones/CPU

Young adult cell phone operationalization has a wide range, including texting, calling, listening to audio, gaming, emailing, shopping, banking, networking, recording, or using any other app or software. According to the PEW Research Center (2018), 73% of all Americans used their cell phones for texting, with 92% of young adults for texting or taking pictures. Entertainment (70%) and information retrieval (64%) were other top purposes for CPU. Apart from texting, calling, or basic internet browsing, Americans used their cell phones for health information (62%), online banking (57%), and real estate listing (44%) searches ("PEW Research Center," 2015). With vast operationalization capabilities, a cell phone comes with several pros and cons associated with its daily use; the following sections will highlight these advantages and disadvantages.

1.4. Advantages of Cell Phones/CPU

There are several benefits associated with CPU classified in three major categories, i. e., important tools in emergency situations, means to connect, and usefulness for education and wellness (Wade, 2017). More than 40% of young adults have found their cell phones helpful in emergency situations and around 51% have found them useful for information retrieval (PEW Research, 2011). This study also found calling, texting, and social networking as key means to connect. Additionally, several cell phone applications enable young adults to use cell phones for educational (i. e., online resources including MOOC, Khan Academy, etc.) and wellness purposes (i. e., Sports Tracker and Health Workout applications) (Wade, 2017). Notable advantages of CPU can be described as portability and transportability, quick and easy communication, accessibility to the internet, safety and rescue for an emergency, tracking capability (locating), and a powerful learning tool (Lombardo, 2015).

1.5. Disadvantages of CPU

Several disadvantages are associated with the use of cell phones. These disadvantages include distractions, heightened levels of danger, increased cheating in exams, sexual abuse, and higher e-waste (Lombardo, 2015). Prevalent data on CPU described disadvantages in terms of risky behavior, abuse, dependency, problematic use, excessive use, and cell phone addiction (Sohn et al., 2021; De-Sola Gutiérrez, Rodríguez, & Rubio, 2016). The disadvantages were so adverse that the World Health Organization considered CPU to be a public health concern in the year 2015. In other words, there are many disadvantages associated with CPU that vary in number and type, and they may increase with the rapid growth of cell phone operations each day.

The adverse effects on biological materials from direct thermal or indirect non-thermal radiofrequency energy produced by cell phones were another matter of concern (Słojewski, 2013). However, studies could only establish these effects on male erectile function (Al–Ali, Patzak, Fischereder, Pummer, & Shamloul, 2013). In addition to physical hazards, CPU has several behavioral risks, and cell phone addiction is one of them. Cell phone addiction (Kwon et al., 2013; Kwon, Kim, Cho, & Yang, 2013) compels young adults to compromise their safety and health and leaves them with difficulty focusing (LaMotte, 2017). Overall, CPU is found to be associated with numerous disadvantages, which may grow in intensity if not addressed adequately and in a timely manner.

High cell phone dependency may also lead to nomophobia, a disorder coined in 2008 (Mail Online, 2008). Nomophobia, which was termed as a subtype of anxiety in a recent study (Lin, Griffiths, & Pakpour, 2018), as defined by King et al. (2014) as "the modern fear of being unable to communicate through a mobile phone (MP) or the Internet. Nomophobia is a situational phobia related to agoraphobia and includes the fear of becoming ill and not receiving immediate assistance (p. 28)." Also, Nomophobia was recognized as one of the CPU disorders that young adults encounter (70% within the age range 18-24, 61% within the age range 25-34), with women (70%) being more susceptible than men (61%) (SecurEnvoy, 2012). Excessive CPU has brought the current generation into a dilemma about the use of cell phones. It not only brings positive effects such as instant access to information but also negative effects like dependency and addiction. The important issue requiring immediate attention is how people can best use cell phones without harmful effects.

Despite several advantages and disadvantages, the transformation of cell phones, from a typical communication tool to a multipurpose electronic device, has made these devices popular among users of all ages. Young adults (18 - 29 yrs.) are the largest user demographic ("Demographics of mobile device ownership and adoption in the United States," 2021; PEW Research, 2018). The affinity of young adults' CPU has increased enormously in previous decades, reaching a plateau in the current decade. Being the largest consumer demographic of cell phones, young adults are the most vulnerable population to be influenced by the disadvantages of CPU. It is therefore imperative to study how CPU habits of young adults are associated with their health and overall well-being.

2. Key Health Variables Affected by CPU

Cell phones have evolved in the last two decades as one of the most-used technological communication devices. CPUsages include but are not limited to texting, calling, gaming, browsing the internet, listening to music, watching videos, and social networking. Texting and calling alone create several health problems including sleep disorders, depression, and anxiety (Joshi, Woodward, & Woltering, 2021; Joshi, 2022; Murdock, Horissian, & Crichlow-Ball, 2017; Towne et al., 2017; Adams & Kisler, 2013). Texting, calling, and social networking negatively influence academic performance and sleep quality in young adults (Mendoza, Pody, Lee, Kim, & McDonough, 2018; Felisoni & Godoi, 2018; Lepp, Barkley, & Karpinski, 2015; Li, Lepp, & Barkley, 2015; Junco & Cotten, 2012; Eyvazlou, Zarei, Rahimi, & Abazari, 2016). In addition, excessive CPU affects psychological well-being (PWB) variables and levels of PWB in this demographic (Joshi, Woltering, & Woodward, 2023; Park & Lee, 2012; Kumcagiz & Gunduz, 2016). There is good reason to think high CPU may affect sleep quality, academic performance, and PWB of young adults negatively and could be detrimental to the benefits of the cell phone as a 21st Century communication device.

2.1. Aspects of Sleep Quality:

Since the beginning of the current decade, sleep disorders, "a group of conditions in which the normal sleep patterns or sleep behaviors are disturbed ("Sleep disorders," 2018)," due to high CPU have become so prevalent that CPU-led sleep quality became a matter of concern for contemporary researchers. Adams and Kisler (2013) have found that 47% of the college students in the sample woke up at night just to respond to their text messages and 40% to answer phone calls. From this data, 29% of the college students woke up once or twice, and 27.5% woke up thrice or more to respond to their calls or text messages. Adams and Kisler (2013) further concluded that CPU-led sleep quality mediates between CPU and sleep-related variables, such as depression and anxiety.

Excessive CPU may create sleep disruptions in young adults, as it is linked to low sleep quality, which may further develop into sleep disorders. Most previous studies recruited college students, aged 18-24, as the study sample because, as of fall 2019, eleven million college students in the U.S. were between the age of 18-24 ("College enrollment statistics and student demographic statistics," 2019). The studies have recruited samples from college students and generalized the outcomes to a larger population of young adults. It can be concluded that among young adults, college students are the most representative samples (Amez & Baret, 2020) that are ideal for studying the CPU habits of the current young adult population.

The times during the day when young adults' CPU was the highest were the hours right before bed and right after waking up. Three-quarters of Americans keep their cell phones turned on round-the-clock ("U. S. smartphone users…," 2017). The seamless and restriction-free access to cell phones, in terms of time and place, in day-to-day life, enables young adults to interact with their cell phones at all times. Moreover, frequent use of cell phones, especially when used for a long time in one sitting, makes young adults evening-oriented, which further results in psychiatry issues that may be caused due to desynchronization of circadian oscillations (Harada, Morikuni, Yoshi, Yamashita, & Takeuchi, 2002). It was reconfirmed by several studies (Tao et al., 2017; Murdock et al., 2017) that texting and calling are the most used features of cell phones, which contributes to the majority of sleep disorders concerning CPU. Such CPU-led sleep disorders further created a sleep-deprived generation, as sleep latency and daytime dysfunctioning exacerbate symptoms of insomnia in young adults (Zarghami et al., 2015). It is clear that high CPU is linked with low sleep quality and sleep quality variables, i.e., sleep latency and sleep disturbances mediates the association between nighttime cell phone use and psychological well-being in college students (Joshi, Woodward, & Woltering, 2021; Joshi, 2022). Overusing cell phones for different activities, including browsing the internet and social media, may worsen sleep quality.

Awareness and compulsion to check cell phone notifications are the key factors that affect sleep quality (Meng et al., 2021; Murdock et al., 2017; Li et al., 2015). Additional factors such as CPU 'in bed' and

CPU 'after lights are out' also negatively influence sleep patterns (Moulin & Chung, 2017; Zarghami, Khalilian, Setareh, & Salehpouret, 2015). These factors collectively lead to cell phone overuse. Excessive CPU is negatively correlated to sleep quality and may be problematic for sleep-related mental health (Eyvazlou et al., 2016; Towne et al., 2017). Nearly 83% of college students use their cell phones within one hour of going to bed (Moulin & Chung, 2017), and around 66% check cell phone notifications before getting out of bed in the morning ("For most smartphone users…," 2017). Also, young adults use their cell phones, on average, 4.4 hours per day (Towne et al., 2017; Eyvazlou et al., 2016) and check notifications 150 times a day ("Which generation is most distracted by their phones?", 2016). Such constant connection of young adults with their cell phones is linked to several sleep disorders, including depression and anxiety (Moulin & Chung, 2017) that may contribute to a sleep-deprived generation (Zarghami et al., 2015; Eyvazlou et al., 2016). Previous researchers show that college students, in particular, are susceptible to CPU-led sleep deficiencies and young adults are the largest demographic influenced by CPU. Constantly increasing operations and open access to social media make cell phones more engaging. Such engagements let young adults to spend most of their time with cell phones and leave them as excessive CPUsers.

2.2. Aspects of Academic Performance:

Over two-thirds of college students use some sort of electronic device, including cell phones, to complete their academic tasks (Jacobsen & Forste, 2011). College students have a positive outlook on cell phones as these devices provide the flexibility of time and place in achieving academic goals with little or no effort (Tossell et al., 2015). However, Elder (2013) found that college students were neutral about their in-class CPU. In another experimental study, a treatment group, i. e., a group of college students who were allowed to text during class lectures, were found to perform worse than the control group (Gingerich & Lineweaver, 2014). These results indicate that college students are somewhat aware of the harmful effects of in-class CPU, particularly of texting, but few of them (8%) realize that it can impede their academic achievements (Froese et al., 2012; Berry & Westfall, 2015).

For college students, cell phones are equally important as other learning tools such as textbooks. Almost all college students bring their cell phones to class (Tindell & Bohlander, 2012), but the majority of them put these devices on "vibrate" or on "silent" mode (Berry & Westfall, 2015). Authors Pettijohn, Frazier, Rieser, Vaughn, and Hupp-Wilds (2015) have found that college students leave the classroom just to check text messages, however, this percentage was not very high. Further, Pettijohn et al., (2015) concluded that, from 10.3% of students who leave the classroom for one or the other reasons, "32% indicated that they had an emergency and 24% indicated they were bored or just 'had to check' (p. 515)". The study also mentions other responses such as work, business, or to avoid disturbing the class for leaving the classroom to check cell phones. These studies suggest that carrying a cell phone to the classrooms creates an option for collegiate young adults to get involved with something other than class and/or study, however, advantages such as using cell phones for an emergency cannot be ruled out.

Classroom CPU may be distracting for the primary user as well as for others. Although a majority of college students (90 - 97%) are aware of their classmate's CPU (Berry & Westfall, 2015), most of them, approximately 77%, were not bothered by it (Pettijohn et al., 2015). College students spend around 2.69 minutes texting during a six-minute classroom simulation presentation and perform 27% worse than non-texters on a quiz on lecture material (Froese et al., 2012). Academic achievements of college students were found to be reduced by 6.3 points, on a scale ranging from 0 to 100, for every 100 minutes of CPU, and the impact of CPU during class/study time was almost double than that of CPU outside/free time (Felisoni & Godoi, 2018).

College students often switch from class and/or study to check cell phone notifications (Joshi, Woodward, & Woltering, 2022; Rosen et al., 2013). Such frequent switches add up and lead to increased CPU hours per day. Increased number of daily CPU hours resulted in poor academic performance, even during the first year of college (Joshi, Woodward, & Woltering, 2022; Jacobsen & Forste, 2011). Authors Jacobsen and Forste (2011) have found notifications from texting, social media, and gaming as the key contributors to daily CPU hours. In fact, texting and social networking affected academic achievement the most. For example, in a study, texting, and Facebook'ing (checking Facebook regularly), during academic tasks negatively affected the overall GPA of college students (Junco & Cotton, 2012). Moreover, frequently checking cell phone notifications, spending long hours on texting, social networking and gaming are the potential causes of declining academic performance of young adults (Hong et al., 2012; Rosen et al., 2013). However, social media usage, such as Facebook'ing and Twitter'ing, impacts GPA more severely than that of texting (Bjornsen & Archer, 2015), as college students spend more time on social media (Wood, 2018).

High CPU diminishes young adults' academic performance (Joshi, Woodward, & Woltering, 2022; Sapci et al., 2021; Troll et al., 2021; Felisoni & Godoi, 2018; Mendoza et al., 2018; Lepp et al., 2015). Cell phone activities such as texting, calling, and social media, including Facebook, were found to be distractions for academic activities (Felisoni & Godoi, 2018, Lepp et al., 2015) and correlated with low college grade point average (Junco & Cotten, 2012). Young adults become involved in multi-tasking and task-switching and lose track of their educational goals (Rosen et al., 2013; Junco & Cotten, 2012), resulting in poor performance on exams (Patterson, 2016). Young adults using cell phones, inside and outside the classroom, are left with less time for study, therefore score poor in test grades (Bjornsen & Archer, 2015). The use of cell phones during study and/or class distracts young adults from academic tasks, which may leave them with low academic performance. Young adult CPU task-switching, particularly during the study and/or class, is a major concern and requires researchers' immediate attention.

On the contrary, increased familiarity with cell-phone-mediated communication (CPMC) was found to have a positive influence on the self-efficacy and behavioral intentions of college students (Han & Yi, 2018). Increased self-efficacy and regulated behavior enabled improvement in CPU perceptions of learning, thereby enhancing academic performance. Such studies have focused on a side of CPU related to self-belief, self-control, ability to modulate behaviors, and ultimately, academic achievements. However, less ability to use cell phones as learning tools was found to adversely affect academic performance (Han & Yi, 2018). Nevertheless, cell phones can be helpful tools for learning if used wisely.

2.3. Aspects of PWB:

It is a well-substantiated fact that CPU-affected sleep quality, directly or indirectly, influences the physical and mental health of young adults, which may further affect their judgments of life. Life judgments determine satisfaction with life, one of the three components of subjective well-being (Diener, 1984; Andrews & Withey, 1976), and may serve as a crucial factor for well-being. In previous studies, a satisfaction-with-life scale was used to investigate the subjective well-being of young adults (Diener, Emmons, Larsen & Griffin, 1985). However, a flourishing scale, a new well-being scale that includes both emotional and psychological aspects of well-being does not measure subjective well-being independently (Diner et al., 2009a; Diner et al., 2009b).

The socio-psychological prosperity of more extroverted CPUsers is higher than that of less extroverted users because the latter have lower psychological benefits (Park & Lee, 2012). Psychological benefits may have an association with motives, actions, and responses because Park and Lee (2012) have found 'connecting with others as one of the motives of CPU. This motive helps build social relationships and is negatively associated with PWB variables, such as loneliness and depression. On the contrary, cell phone addiction, termed as smartphone addiction in case of smartphone usage, of young adults was found to be related to low levels of PWB, which jeopardizes their social relationships (Kumcagiz & Gunduz, 2016). CPU was found to be good and bad both for PWB because it builds social relationships but also leads to behavioral issues such as cell phone addiction. Such conflicting outcomes make understanding PWB ambiguous, which itself is a matter of concern for researchers.

Psychological well-being, based on the humanistic theories of positive and negative effective functioning, is the key indicator of socio-psychological prosperity in social relationships (Diener et al., 2009a). It is grounded on the principles of developmental and clinical psychology and may be directly linked to the CPU of young adults. A few studies have investigated levels of PWB and associated variables but ended up with conflicting outcomes. For example, PWB variables such as loneliness and depression were negatively associated with CPU (Park & Lee, 2012), whereas, improved levels of PWB were positively associated with lower CPU (Kumcagiz & Gunduz, 2016). However, a direct correlation between CPU and PWB is yet to be investigated.

3. Problem Statement: Need for Proposed Framework

Previous studies investigating CPU and sleep quality of young adults have several limitations regarding CPU instruments and study samples (Murdock et al., 2017; Towne et al., 2017; Eyvazlou et al., 2016; Rosen, Carrier, & Cheever, 2013). For example, some studies (i. e., Eyvazlou et al., 2016) have used a CPU scale that was developed in the year 2007; however, it may not suffice for the current young adult population or the advances in cell phone technology. In addition, a study (Li et al., 2015) has shown different components of CPU (i.e., CPU_Night and CPU_Class) to be associated with sleep quality and grade point average (GPA) respectively. The results may not be unilaterally true because CPU from different times of the day or night may affect sleep quality, academic performance, or both. Although CPU affects collegiate academic performance in various ways, existing studies failed to provide a holistic assessment in terms of cell phone applications, interaction time, and the impact of CPU on the academic performance of a diverse young adult population. Concerning PWB, existing studies (Kumcagiz & Gunduz, 2016; Park & Lee, 2012) have claimed to investigate social implications of CPU and their relationships with PWB but so far, this research has been limited to a superficial analysis of study variables. In addition, these studies have not used the flourishing scale, a specific scale developed to measure PWB (Diener et al., 2009b), and did not investigate a direct relationship between CPU and PWB. As a result, problems with CPU and PWB are an entirely new area of research. In a nutshell, previous studies indicated that CPU impacts sleep quality, academic performance, and PWB in various ways. However, these studies failed to provide a theoretical explanation to the empirical findings concerning CPU-led sleep quality, academic performance, and PWB. Moreover, a theoretical framework unifying all these mechanisms was not available. The present study, therefore, propose to present a theoretical framework explaining CPU-led sleep disruption, classroom multitasking, self-regulation and PWB.

4. Underlying Theories

4.1. Theories Concerning Sleep Quality

4.1.1. Sleep Displacement Theory

High frequency of CPU may disrupt sleep through three possible mechanisms (Cain & Gradisar, 2010): exposure to bright light (melatonin hypothesis; hormonal secretion), sleep displacement (place hypothesis; CPU in bed), and media content (arousal hypothesis) (Joshi, Woodward, & Woltering, 2021; Joshi, 2022; Tosini, Ferguson, & Tsubota, 2016; Clayton, Leshner, & Almond, 2015; Exelmans & Van den Bulck, 2016). Most researchers, however, are concerned with the exposure to the bright light emitted from cell phones.

The bright light, particularly in the shorter wavelength range (blue light: 446 – 483 nm), impacts both human physiology, such as hormonal secretion (Brainard et al., 2001; Cajochen et al., 2005; Chellappa et al., 2013), and human behavior, such as clock gene expression or circadian rhythms (Cajochen et al., 2006). Melatonin suppression is a phenomenon in which the short-wavelength blue light emitted from self-luminous electronic devices such as cell phones influences hormonal secretion and circadian rhythm, thereby leading to irregular sleep patterns (Tosini et al., 2016; Wood, Rea, Plitnick, & Figueiro, 2013). Briefly, CPU at night affects hormonal secretion perturbing the circadian clock cycle and ultimately impacting sleep quality (Blask et al., 1999).

Sleep displacement theory is based on the concept in which the use of electronic media for unstructured leisure, with no time limit, displaces several activities including sleep (Joshi, Woodward, & Woltering, 2021; Kubey, 1986; Van den Bulk, 2004). Displacement of sleep happens when the brain believes it is still working because one continues to use a cell phone while in bed, creating an association in the brain between the location of the CPU (i.e., the bed) and work (anything outside of sleep) (Exelmans & Van den Bulck, 2016; Moulin & Chung, 2017). The CPUser from any age group may be affected by the displacement of sleep, however, it appeared to be highest in young adolescents (Hysing et al., 2015).

4.1.2. Psychological Arousal Theory

Arousal theory is based on the fact that the use of electronic media such as cell phones just before sleep may increase mental (cognitive), emotional or psychological arousal (Joshi, Woodward, & Woltering, 2021; Cain & Gradisar, 2010). Such arousal may happen due to violent and sexual media content (Brown et al., 2006; Dill, Gentile, Richter, & Dill, 2005). The media content (arousal hypothesis) concept can also be illustrated by mental (cognitive), emotional and/or psychological arousal as the brain takes time to prepare for sleep after screen time (Clayton et al., 2015; Matar Boumosleh & Jaalouk, 2017). Screen time may include video gaming, online chatting, internet browsing (shopping, surfing, scrolling, etc.), social networking, and watching videos. Playing video games before sleep also results in reduced sleep quality, longer sleep latency, and poor memory performance (King et al., 2013; Dworak, Schierl, Bruns, & Struder, 2007; Weaver, Gradisar, Dohnt, Lovato, & Douglas, 2010), however, CPU for unstructured leisure, especially in bed, affects sleep variables substantially (Exelmans & Van den Bulck, 2016). In sum, interacting with cell phones before sleep may increase emotional and/or mental (cognitive) arousal, which might lead to sleep latency, sleep disruption, and poor sleep quality. Hormonal secretion, i.e., melatonin suppression, is the biological aspect of sleep disruption and was tested through several clinical trials in previous studies. However, sleep displacement and arousal are the psychological (mental/emotional) aspects of sleep quality and were not previously investigated. The presented framework, therefore, focuses on these psychological aspects and investigates sleep displacement and arousal mechanisms of sleep disruption.

4.2. Theories Concerning Academic Performance

4.2.1. Switch Load Theory

CPU during class and/or study time may compel young adults to switch between tasks like cell phone use and academic activities. According to switch-load theory, a two-stage model of executive control, there is a time loss, called switching-time cost, associated when one switches between the tasks (Rubinstein, Meyer, & Evans, 2001). Switching-cost (loss of efficiency caused due to task-switching) per switch may be relatively small but adds up to a large amount when switched between tasks multiple times. Task switching dilates response time, even when switching takes place between two predictable tasks, thereby decreasing productivity.

The model of executive control (Rubinstein et al., 2001) also suggested that there are two distinct and complementary stages, goal-shifting and rule-activation, involved in performing a task. Goal-shifting is shifting goals between current and future tasks whereas rule-activation is turning on the rules for a current task and turning off the rules for a prior task. The model was tested by an experimental study, comprising of four sets of experiments using math problems and geometric objects. It was found that there is a time loss, named switching-cost when switching between two tasks. Switching-cost significantly increases in cases of switching between complex tasks and is even greater for switching between relatively unfamiliar tasks (Rubinstein et al., 2001).

4.2.2. Self-regulated Learning Theory

Self-regulated learning (SRL) theory “focuses attention on how students personally activate, alter, and sustain their learning practices in specific contexts” (Zimmerman, 1986, p. 307). As per the theory, students need to be able to “control contextually specific cognitive, affective, and motoric learning processes” with “varying amounts of selectivity and structuring in order for them to learn.” This theory has progressed through three models i. e. Triadic Analysis model, Cyclical Phase model, and Multi-Level model (Zimmerman, 1986; Zimmermann, 2000; Zimmerman & Moylan, 2009). The triadic Analysis model of SRL was visualized as Bandura’s triadic model of social cognition that described the interaction between environment, behavior, and the person itself (Zimmerman, 1989). The cyclical Phase model described how metacognitive and motivational processes interrelate whereas, the Multi-Level model depicted the stages of acquiring self-regulatory competency.

Zimmermann and Martinez-Pons (1986) have identified various categories of SRL strategies, which were found to be closely related to academic achievements. These strategies included metacognitive (plan, organize, self-instruct, self-monitor, and self-evaluate), motivational (perceiving themselves as competent, self-efficacious, and autonomous), and behavioral (select, structure, and create environments) processes that help students to actively participate in their own learning (Zimmerman, 1989). Various cell phone operations may help young adults in implementing these SRL strategies during class and study (Joshi, Woodward, & Woltering, 2022), which may further regulate their metacognitive, motivational, and behavioral learning processes and thereby may lead to better academic performance.

4.3. Theories Concerning PWB

4.3.1. Six-factor Model of Psychological Well-Being

CPU may be associated with the different states of effective human functioning that were described by different theorists and are as follows: meaning and purpose, supportive and rewarding relationships, engaged and interested, contribute to the well-being of others, competency, self-acceptance, optimism, being respected (Ryff, 1989; Ryan & Deci, 2000; 2001). The states, such as the feeling of engagement and interest, pleasure, and meaning and purpose (Seligman, 2002) may also have a correlation with the use of cell phones. In previous studies, engagement and flow were recognized as the core components of well-being and psychological capital (Csikszentmihalyi, 1990), which may be linked to the CPU.

The features of positive psychological functioning, described by previous theorists, constituted the core dimensions of the theory of psychological well-being proposed by Ryff (1989). As per the theory, six theory-guided dimensions constitute positive psychological functioning. Kumcagiz and Gunduz (2016) have recently referred to this six-dimensional theory and stated that “psychological well-being is closely related to self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth besides healthy physiology without stress and other mental problems” (Ryff, 1989). Optimism was considered one of the key factors of positive and healthy functioning (Peterson & Seligman, 2004). Cell phone social networking (CPSN) may help young adults to become involved in activities that they find meaningful and purposeful, and thereby help them feel engaged and interested. Young adults may also find CPSN meaningful and purposeful as they feel optimistic about CPSN-based social relationships.

4.3.2. Maslow's Hierarchy of Psychological Needs

A positive social relationship is defined by both having support from others and by being supportive of others, individually or in a community (Ryff, 1989; Ryan & Deci, 2000). Supportive and rewarding social relationships were viewed as one of the key components of mental health (Ryff, 1989). Thus, having positive and supportive relations with others in society and communities were always important ingredients of PWB theories. The use of cell phones for social media may help young adults to fulfill their psychological needs (i. e., esteem needs and belongingness, and love needs). The feeling of belongingness and accomplishments are the psychological needs that include love, belonging, and esteem needs and are described by the third and fourth levels of Maslow’s hierarchy of needs ("Maslow's Hierarchy of Needs," 2018; Maslow, 1987). The third level involves the feeling of belongingness such as affiliation, social interaction, friendship, giving and receiving, etc. The fourth level involves the feeling of accomplishment. The giving and the receiving components of the feeling of belongingness further contribute to the happiness and well-being of others.

Providing social support to others was found to be more important to health and well-being than receiving support (Brown, Nesse, Vinokur, & Smith, 2003). Brown et al. (2003) found that “mortality was significantly reduced for individuals who reported providing instrumental support to friends, relatives, and neighbors, and individuals who reported providing emotional support to their spouse (p. 320).” The study thereby articulated ‘giving support’ as a key component of interpersonal relationships and well-being. Dunn, Akin, and Norton (2008) found that spending one’s income on others had a positive impact on happiness and well-being. The study further concluded that giving to others provides more happiness than that of receiving from others. Cell phones may help young adults to contribute to the happiness and well-being of others when providing support on social media thereby fulfilling their psychological needs.

4. Theoretical Framework

4.1. The Overview of the Development of the Framework

Based on the description of the theories concerning sleep quality, academic performance, and PWB, a hierarchical model was developed. The hierarchical model was based on the perspectives provided by Ormrod (2016) regarding different learning theories. The learning theories aligned with the domains of sleep quality, academic performance, and PWB were clustered with those particular domains, and all the theories were grouped with four overarching theories: information processing, cognitive neurology, social cognition, and contextual (including sociocultural) processes. These four overarching theories were nested under the broader umbrella of cognitivism (Fig. 1). The following sections will provide a detailed description of how these theories were sorted into the respective overarching theories.

4.1.1. Placing of CPU Sleep Displacement and CPU Arousal Theories in the Framework

Since the beginning of the current decade, sleep disorders, "a group of conditions in which the normal sleep patterns or sleep behaviors are disturbed ("Sleep disorders," 2018)," due to high CPU have become so prevalent that CPU-led sleep quality became a matter of concern for contemporary researchers. Adams and Kisler (2013) have found that 47% of the college students in the sample woke up at night just to respond to their text messages and 40% to answer phone calls. From this data, 29% of college students woke up once or twice, and 27.5% woke up thrice or more to respond to their calls or text messages. Adams and Kisler (2013) further concluded that CPU-led sleep quality mediates between CPU and sleep-related variables, such as depression and anxiety.

The times during the day when young adults' CPU was the highest were the hours right before bed and right after waking up. Three-quarters of Americans keep their cell phones turned on round-the-clock ("U. S. smartphone users…," 2017). The seamless and restriction-free access to cell phones, in terms of time and place, in day-to-day life, enables young adults to interact with their cell phones at all times. Moreover, frequent use of cell phones, especially when used for a long time in one sitting, makes young adults evening-oriented, which further results in psychiatry issues that may be caused due to desynchronization of circadian oscillations (Harada, Morikuni, Yoshi, Yamashita, & Takeuchi, 2002). It was reconfirmed by several studies (Tao et al., 2017; Murdock et al., 2017) that texting and calling are the most used features of cell phones, which contributes to the majority of sleep disorders concerning CPU. Such CPU-led sleep disorders further created a sleep-deprived generation, as sleep latency and daytime dysfunctioning exacerbate symptoms of insomnia in young adults (Zarghami et al., 2015). It is clear that high CPU is linked with low sleep quality and sleep quality variables, i.e., sleep latency and sleep disturbances mediate the association between nighttime cell phone use and psychological well-being in college students (Joshi, Woodward, & Woltering, 2021; Joshi, 2022). In a nutshell, overusing cell phones for different activities, including browsing the internet and social media, displaces sleep and creates psychological arousal, therefore, worsening sleep quality.

In previous studies, the sleep displacement mechanism was seen through the lens of sleep theories that were based on repair and restoration (Oswald, 1980), memory processing, and information consolidation (Ormrod, 2016; Maquet, et al., 2000). The psychological arousal was seen through the lens of the arousal theories based on cognitive simulation and neuropsychology (Ormrod, 2016; Maquet, et al., 2000). Therefore, Sleep Displacement Theory was kept under the first overarching theory, i.e., Information Processing Theory and CPU Arousal Theory was placed under the second overarching theory, i.e., Cognitive Neurology.

4.1.2. Placing of Switch Load Theory and Self-regulated Learning Theory in the Framework

Over two-thirds of college students use some sort of electronic device, including cell phones, to complete their academic tasks (Jacobsen & Forste, 2011). College students have a positive outlook on cell phones as these devices provide the flexibility of time and place in achieving academic goals with little or no effort (Tossell et al., 2015). However, Elder (2013) found that college students were neutral about their in-class CPU. In another experimental study, a treatment group, i.e., a group of college students who were allowed to text during class lectures, was found to perform worse than the control group (Gingerich & Lineweaver, 2014). These results indicate that college students are somewhat aware of the harmful effects of in-class CPU, particularly of texting, but few of them (8%) realize that it can impede their academic achievements (Froese et al., 2012; Berry & Westfall, 2015).

For college students, cell phones are equally important as other learning tools such as textbooks. Almost all college students bring their cell phones to class (Tindell & Bohlander, 2012), but the majority of them put these devices on “vibrate” or in “silent” mode (Berry & Westfall, 2015). Authors Pettijohn, Frazier, Rieser, Vaughn, and Hupp-Wilds (2015) have found that college students leave the classroom just to check text messages, however, this percentage was not very high. Further, Pettijohn et al., (2015) concluded that, from 10.3% of students who leave the classroom for one or the other reasons, “32% indicated that they had an emergency and 24% indicated they were bored or just ‘had to check’ (p. 515)”. The study also mentions other responses such as work, business, or avoiding disturbing the class by leaving the classroom to check cell phones. These studies suggest that carrying a cell phone to the classrooms creates an option for collegiate young adults to get involved with something other than class and/or study, however, advantages such as using cell phones for an emergency cannot be ruled out.

Classroom CPU may be distracting for the primary user as well as for others. Although a majority of college students (90 - 97%) are aware of their classmate’s CPU (Berry & Westfall, 2015), most of them, approximately 77%, were not bothered by it (Pettijohn et al., 2015). College students spend around 2.69 minutes texting during a six-minute classroom simulation presentation and perform 27% worse than non-texters on a quiz on lecture material (Froese et al., 2012). Academic achievements of college students were found to be reduced by 6.3 points, on a scale ranging from 0 to 100, for every 100 minutes of CPU, and the impact of CPU during class/study time was almost double that of CPU outside/free time (Felisoni & Godoi, 2018).

College students often switch from class and/or study to check cell phone notifications (Joshi, Woodward, & Woltering, 2022; Rosen et al., 2013). Such frequent switches add up and lead to increased CPU hours per day. Increased number of daily CPU hours resulted in poor academic performance, even during the first year of college (Joshi, Woodward, & Woltering, 2022; Jacobsen & Forste, 2011). Authors Jacobsen and Forste (2011) have found notifications from texting, social media, and gaming as the key contributors to daily CPU hours. In fact, texting and social networking affected academic achievement the most. For example, in a study, texting, and Facebook-ing (checking Facebook regularly), during academic tasks negatively affected the overall GPA of college students (Junco & Cotton, 2012). Moreover, frequently checking cell phone notifications, and spending long hours on texting, social networking, and gaming are the potential causes of declining academic performance of young adults (Hong et al., 2012; Rosen et al., 2013). However, social media usages, such as Facebook’ing and Twitter’ing, impact GPA more severely than that texting (Bjornsen & Archer, 2015), as college students spend more time on social media (Wood, 2018).

Prevalence and scope data on CPU indicated that current cell phones possess numerous operations and Apps that are highly engaging. Such CPU-based engagements are directly linked to the information processing in the brain and to social cognition (Ormrod, 2016). Therefore, the theory connected to CPU during class and/or study time and switching between tasks, i.e., Switch Load Theory, was kept under Information Processing Theory. The Self-regulated Learning Theory provided by Zimmerman (1989) was directly linked to self-control, self-reaction, and self-regulation, therefore, was kept under Social Cognitive Theory. The Social Cognitive Theory of self-regulation, based on the model of triadic reciprocal determinism, emphasized the key functions that influence human behavior. According to Bandura (1991, p. 248), "the major self-regulative mechanism operates through three principal subfunctions. These include self-monitoring of one's behavior, its determinants, and its effects; judgment of one's behavior in relation to personal standards and environmental circumstances; and affective self-reaction.”

4.1.3. Placing of Six-factor Model of Psychological Well-Being and Maslow's Hierarchy of Psychological Needs in the Framework

It is a well-substantiated fact that CPU-affected sleep quality, directly or indirectly, influences the physical and mental health of young adults, which may further affect their judgments of life. Life judgments determine satisfaction with life, one of the three components of subjective well-being (Diener, 1984; Andrews & Withey, 1976), and may serve as a crucial factor for well-being. In previous studies, a satisfaction-with-life scale was used to investigate the subjective well-being of young adults (Diener, Emmons, Larsen & Griffin, 1985). However, a flourishing scale, a new well-being scale that includes both emotional and psychological aspects of well-being does not measure subjective well-being independently (Diner et al., 2009a; Diner et al., 2009b).

PWB is based on effective human functioning. Effective human functioning consists of various aspects of personal and professional achievements. These aspects include engagement and connectedness, competency and accomplishment, pleasure and sense of enjoyment, sense of purpose and fulfillment, sense of belonging and acceptance, and optimism about the future ((Diner et al., 2009a). The achievement aspects also include the feeling of belongingness including affiliation, social interaction, friendship, giving and receiving, and contributions to the well-being of others (Maslow, 1987). Authors Diener et al. (2009b) say that studying only the cognitive and emotional aspects of well-being objectively wouldn't suffice; therefore the aspects of achievement need to be investigated as well. Likewise, the impact of CPU on the aspects of personal and professional achievements cannot be ruled out.

The Six-factor Model of Psychological Well-Being (Ryff, 1989) and Maslow's Hierarchy of Psychological Needs (Maslow, 1987) suggest that social factors are vital for cognitive development (Vygotsky, 1978), and are crucial in sociocultural contexts. The socio-cultural aspect of learning develops the cognitive outlook of well-being, such as gratitude, self-esteem, optimism, locus of control/autonomy, competence, connectedness, attributional style, etc. (Margolis & Lyubomirsky, 2018). The components of the cognitive outlook of well-being "focus on how a society's adults and cultural creations enhance cognition and pass accumulated wisdom along to children and on how physical tools (e.g., technology) and local or global social-support systems can enhance performance and learning" (Ormrod, 2016), and closely related to the factors of psychological well-being and psychological needs. For these reasons, the Six-factor Model of Psychological Well-Being (Ryff, 1989) and Maslow's Hierarchy of Psychological Needs (Maslow, 1987) were placed under the fourth overarching theory, i.e., Sociocultural Theory and other Contextual Theories.

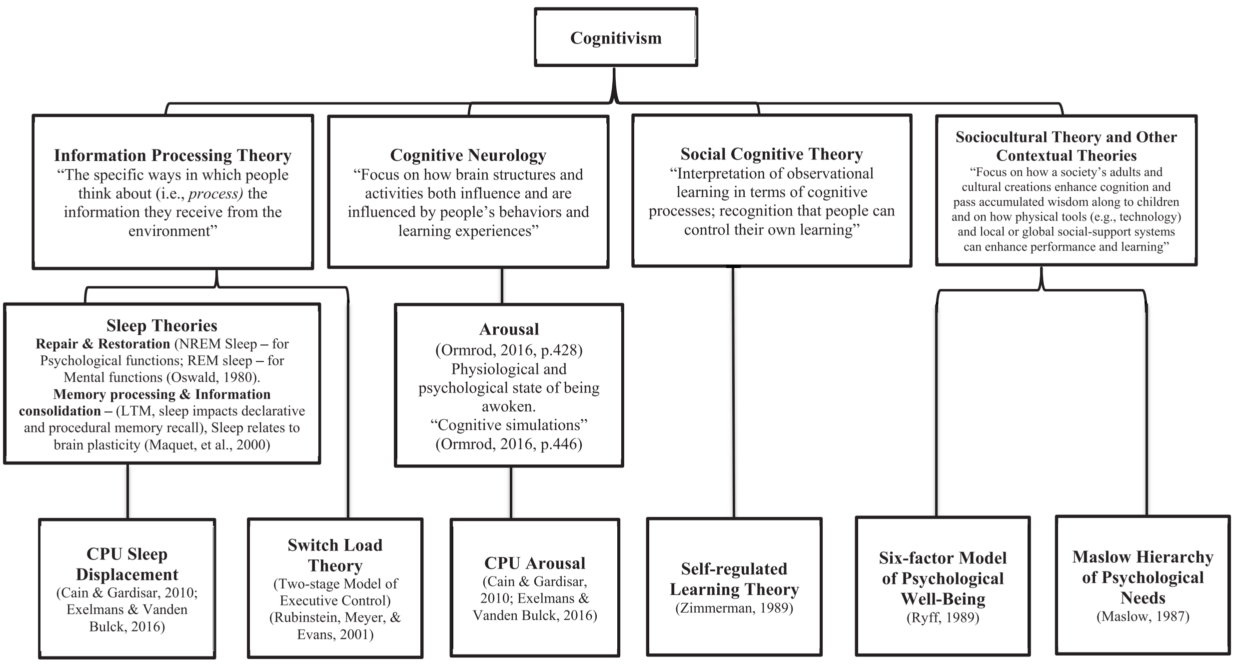

Figure 1. Theoretical Framework for Cell Phone Use

6. The Significance of the Theoretical Framework

6.1. Significance Pertaining to the Domain of CPU and Sleep Quality

6.1.1. Investigating CPU, CPU Before Bed, and CPU Arousal

Previous studies examining the correlation between CPU and sleep quality have not assessed CPU as a separate independent variable. For example, authors Towne et al. (2017), Moulin and Chung (2017), and Adams and Kisler (2013) have assessed the use of technology as a whole, but CPU was just one of many components. In another study (Melton et al., 2014), CPU was assessed through a single sub-question asking for the total number of hours college students spend on phone applications, which was part of a larger construct measuring health technology use. Notably, Melton et al. did not include any item in the general technology use construct assessing the use of cell phones. The presented framework will allow investigating CPU as an independent variable, and examining the components of CPU in terms of CPU before bed and CPU arousal.

6.1.2. Examining the Correlation between CPU and Sleep Components

Previous studies from the domain of sleep quality have provided a subjective assessment of sleep quality. For example, studies from authors Tao et al. (2017), Adams and Kisler (2013), and Harada et al. (2006) have assessed the subjective sleep quality of young adults. In addition, previous studies have used sleep diaries for assessing the duration of sleep (Murdock, et al., 2017). Also, the correlation of specific sleep components such as sleep latency and sleep difficulty with their respective CPU factors such as CPU before bed and CPU arousal was missing in the existing literature. For example, studies from authors Murdock, Horissian, and Crichlow-Ball (2017) and from several others including, Chen and Li (2017), Eyvazlou et al. (2016), Lepp et al. (2015), and Demirci et al. (2015) have assessed the correlation of CPU with the overall sleep quality of young adults but did not investigate CPU before bed and CPU arousal. Moreover, some studies have used just one item for assessing the hours of sleep during 24 hours (Towne et al. 2017). The presented framework will help investigate the correlation of specific sleep components, sleep latency, and sleep difficulty, with the CPU factors, CPU before bed, and CPU arousal, along with examining the correlation of CPU with overall sleep quality from a period of 30 days by using a validated scale, i.e., Pittsburgh Sleep Quality Index (PSQI).

6.1.3. Investigating CPU Arousal and its correlation with Sleep difficulty and Sleep Quality

Nighttime CPU, especially just before and after going to bed, may increase mental (cognitive), emotional, or psychological arousal (Cain & Gradisar, 2010) in young adults, which may potentially create sleep disturbance (sleep difficulty) in this demographic. Previous studies have investigated a correlation between violent and sexual media content, and arousal (Anderson et al., 2010; Van der Molen & Bushman, 2008). However, a correlation between arousal due to media content and sleep quality was not yet investigated. In other words, it is yet unknown how CPU arousal correlates with sleep disturbance (sleep difficulty), and with the overall sleep quality of young adults. Further, previous studies have investigated sexting, “using technology to create, send, and receive sexually explicit photos, videos, and/or text-only messages” (Fleschler Peskin et al., 2013) among high school students, but have not assessed how sexting may affect sleep quality.

The presented framework will help investigate psychological arousal due to the use of cell phones to engage in emotionally charged text messages and images, in explicit content pertaining to sexuality (pornography, tinder, dating sites, etc.), and in explicit content pertaining to violence (video games, movies, etc.) just before or after going to bed at night. The framework will also help examine the relationship that CPU arousal may have with sleep difficulty and with the overall sleep quality of young adults.

6.1.4. Theoretical Support to the Established Correlations between CPU and Sleep Components

Previous studies (Murdock et al., 2019, 2017; Xu, Adams, Cohen, Earp, & Greaney, 2019; Dowdell & Clayton, 2018; Towne et al., 2017; Tao et al., 2017; Chen & Li, 2017) have not explored the correlation of sleep components, sleep latency, and sleep difficulty (sleep disturbance), with the use of cell phones from specific times of the day and night, and for specific purposes. In addition, these studies have not provided theoretical support to the established correlations of examined variables. This framework will provide a clear justification of how and why nighttime CPU may affect sleep latency, sleep difficulty, and overall sleep quality of young adults as the sleep hypotheses can be supported by sleep disruption theories. For example, the sleep latency hypothesis can be supported by sleep displacement theory, and the sleep difficulty hypothesis can be supported by the arousal theory. Outcomes of the sleep latency hypothesis will explain how the use of cell phones for unstructured leisure activities before sleep may affect sleep latency. The outcomes of the sleep difficulty hypothesis will explain how accessing explicit or emotionally charged media content before sleep may affect sleep difficulty.

6.2. Significance Pertaining to the Domain of CPU and Academic Performance

6.2.1. Investigating Cell Phone Media-multitasking

Cell phones are ubiquitous handheld electronic devices that young adults use widely and wildly, even in the classroom. The role of cell phones has been underestimated in previous studies while assessing the impact of media multitasking on the academic performance of the young adult demographic. For example, Patterson (2016) investigated the impact of digital media multitasking on exam performance, however, did not provide any information on the digital devices used for multitasking. Another example can be drawn from a study examining the impact of various distractions on learning during an online lecture (Blasiman, Larabee, & Fabry, 2018). Blasiman et al. have considered texting as the only cell phone activity/operation for measuring distraction due to the use of cell phones while listening to the lecture. One more example comes from a recent study (Redner, Lang, & Brandt, 2019) that investigated the impact of electronic usage as a whole on academic performance. Assessing the use of all electronic devices may not provide a clear picture on classroom cell phone media multitasking. The presented framework will help investigate cell phone media multitasking during a class/lecture, lab, and/or study session, which advances the existing literature on digital media multitasking.

6.2.2. Investigating CPU Switching Frequency during Academic Tasks

Previous studies have measured the total time college students spend on cell phones during class and/or study sessions (Mendoza et al., 2018; Pettijohn et al., 2015; Lawson & Henderson, 2015; Gingerich & Lineweaver, 2014; Froese et al., 2012;). Also, these studies have focused on texting and calling, which may not be the complete representation of all cell phone activities/operations that influenced academic performance. Irrespective of measuring the total time spent on cell phones, the presented framework will help investigate the number of times college students switch to their cell phones during class, lab, and/or study sessions. In addition, this framework will help examine switching frequency for potential cell phone activities/operations influencing academic performance, i.e., texting, calling, emailing, shopping, banking, surfing the internet, and gaming.

6.2.3. Examining CPU during Class/Lecture, Lab, and/or Study Session

Previous studies investigating CPU and academic performance provide the correlation between per-day-CPU and academic performance (Felisoni & Godoi, 2018; Lepp et al., 2015). Some studies have investigated students' perceptions and attitudes towards the use of cell phones in the classroom. For example, a study from authors Berry and Westfall (2015) examined college students' daily CPU, their perceptions and attitudes towards CPU, and classroom policies. Another study from Fernandez (2018) assessed students' views on classroom CPU, and one study from authors Tossell et al. (2015) presented student perceptions of CPU for educational purposes over one year. Such outcomes may not provide accurate information on how exactly the use of cell phones during class and/or study sessions affected academic performance. This framework will help examine college students' CPU in a 60-minute block of time related to class/lecture, lab, and/or study sessions, which will help researchers understand how the use of cell phones affects the academic performance of college students.

6.2.4. Examining CPU for Self-Regulated Learning Behaviors

The potential positive aspects, such as the use of cell phones for self-regulated learning behaviors, were ignored in previous studies examining CPU and academic performance. Most of the studies (Mendoza et al., 2018, Felisoni and Godoi, 2018, Pettijohn et al., 2015, Lawson and Henderson, 2015, and Lepp et al., 2015) have focused only on time spent on classroom cell phone activities and on how such activities influenced academic grades. In a way, these studies over-represented the time spent on classroom CPU and the negative correlation between CPU and academic performance in the existing literature. Some other studies, for example, Ya'u and Idris (2015) and Han and Yi (2018), have investigated students' behavioral intentions towards the use of cell phones in the classroom, but have overlooked examining the use of cell phones for self-regulated learning behaviors. This framework, therefore, irrespective of just examining the correlation between CPU and academic performance, will identify the pros and cons of the use of cell phones for academic purposes. The framework will investigate the use of cell phones during a class/lecture, lab, and/or study session, and will examine the use of cell phones for self-regulated learning behaviors.

6.2.5. Theoretical Support to the Established Correlation between CPU and Academic Performance

Authors from previous studies have used different approaches to establish a connection between classroom CPU and academic performance. For example, some authors, including Mendoza et al. (2018), Felisoni and Godoi (2018), Lawson and Henderson (2015), Gingerich and Lineweaver (2014), and Rosen et al., (2011) have used experimental methods. Authors, including, Pettijohn et al. (2015), Lepp et al. (2015), Tossell et al. (2015), and Braguglia (2008) have used quantitative survey methods. Authors, including Bjornsen and Archer (2015), and Froese et al. (2012) have used both of these methods. However, these studies have not provided a theoretical justification of how and why classroom CPU influences academic performance, and how and why the use of cell phones for self-regulated learning behaviors can improve academic performance. The present framework will attempt to provide a clear justification of how and why CPU affects academic performance as both the hypotheses from the academic performance domain are based on existing theories. The CPU classroom hypothesis can be based on switch-load theory and the CPU self-regulated learning hypothesis can be based on the Zimmerman theory of self-regulated learning. The CPU classroom hypothesis will investigate how the frequency of switching away from class/lecture, lab, and/or study sessions using a cell phone may affect academic performance. The CPU self-regulated learning hypothesis will investigate how the use of cell phones for self-regulated behaviors may help improve academic performance.

6.3. Significance Pertaining to the Domain of CPU and PWB

6.3.1. Exploring the CPU and PWB of Young Adults

The CPU of young adults was examined with health variables along with the subjective well-being (SWB) in previous studies; however, CPU and PWB were left unexplored. Several health variables were found to be influenced by the use of cell phones, i.e., numbness or burning sensation on ears (Al-Khamees, 2007), headache, laziness, and tiredness (Zarghami et al., 2015), daytime dysfunctioning (Zarghami et al., 2015), mental overload (Thomee et al., 2010), and stress, anxiety, and depression (Thomee et al., 2007; Adams & Kisler, 2013; Lepp et al., 2014; Demirci et al., 2015; Tao et al., 2017). The SWB of young adults was assessed in terms of satisfaction with life (Volkmer & Lermer, 2019; Li et al., 2015; Lepp et al., 2014), emotional and relational well-being (McDaniel & Drouin, 2019), and overall well-being (Hoffner & Lee, 2015; Volkmer & Lermer, 2019), and was found to be correlated with CPU. The present framework will help explore the CPU and PWB of the young adult demographic, which will be new information in this area of research.

6.3.2. Investigating the Direct Relationship between the CPU and PWB of Young Adults

Some previous studies have claimed to investigate CPU and PWB; however, they either astray from assessing a direct correlation between CPU and PWB or end up with conflicting outcomes. For example, Chan (2013) investigated the use of cell phones in terms of four CPU dimensions (voice communication, online communication, information seeking activities, and time-pass activities), and focused only on the emotional aspect of well-being. Chen and Li (2017) examined how communicative uses of cell phones, including friending self-disclosure, may help predict PWB through bonding and bridging social capital. Further, Murdock, Gorman, and Robbins (2015) investigated how co-rumination via cell phones moderates the association of perceived interpersonal stress and PWB. Examples of conflicting outcomes arise from the following two studies. The first study (Park & Lee, 2012) shows a negative correlation between CPU and PWB variables, such as loneliness and depression, whereas the second study (Kumcagiz & Gunduz, 2016) shows a positive correlation between low CPU and the improved levels of PWB. Similarly, in the first study, the socio-psychological prosperity of more extroverted cell phone users was found to be higher than that of less extroverted cell phone users, and in the second study, high CPU was found to be related to low levels of PWB. The present framework will help resolve existing conflicts about the correlation between CPU and PWB by investigating a direct relationship between CPU and PWB.

6.3.3. Theoretical Support to the Established Correlation between CPU and PWB

One reason why previous studies from this domain (Chen & Li, 2017; Kumcagiz & Gunduz, 2016; Murdock, et al., 2015; Chan, 2013; Park & Lee, 2012) lacked theoretical support perhaps because a direct correlation between CPU and PWB was not investigated in these studies. This framework will help examine two CPU social media hypotheses: CPU social media feelings and CPU social media responses, and both the hypotheses will be supported by the existing developmental theories. The CPU social media feeling hypothesis will be supported by the humanistic theories of positive functioning, and the CPU social media response hypothesis will be supported by two theories: Maslow's hierarchy of needs and self-determinant theory. The hypotheses from this specific domain were expected to assess well-being components (the feeling of engagement and interest, pleasure, meaning and purpose, and optimism) and psychological need components (affiliation, social interaction, friendship, giving and receiving, and the feeling of accomplishments) of young adults. These hypotheses will examine the correlation between CPU and PWB of the young adult demographic, which will be new knowledge for the literature from developmental science research.

7. Conclusion

The purpose of this study was to provide a theoretical framework for explaining CPU-led sleep quality, academic performance, and PWB. The study presented the theoretical framework, which was based on learning and developmental theories from the domains of CPU-led sleep quality, academic performance, and PWB. In this framework, the fundamental theories from all three domains were grouped under four overarching theories: information processing, cognitive neurology, social cognition, and sociocultural, which were nested under cognitivism. The framework provided a theoretical explanation for all CPU-led mechanisms. For example, Sleep Displacement Theory and Arousal Theory explained CPU-led sleep disruption. The Switch Load Theory and Self-regulated Learning Theory explained CPU multitasking and self-regulated learning behavior. The Six-factor Model of Psychological Well-Being and Maslow's Hierarchy of Psychological Needs explained CPU-led PWB.

Recent studies (Joshi, Woodward, & Woltering, 2021; 2022; Joshi, Woltering, & Woodward, 2023) have provided empirical evidence for the theoretical framework presented in this study. These studies have investigated CPU-led mechanisms pertaining to sleep quality, academic performance, and PWB.

Theories concerning CPU-led sleep disruption i.e., Sleep Displacement Theory and Psychological Arousal Theory were tested by Joshi et al. (2021) for a sample of university students. The study revealed that the use of cell phones before going to bed negatively affected sleep latency and sleep difficulty. The study further concluded that young adults who used cell phones before sleep and accessed emotionally charged content before going to bed were more likely to report trouble sleeping. In this study, CPU-led sleep latency was described through Sleep Displacement Theory, and CPU-led sleep difficulty was described through Psychological Arousal Theory. The displacement of sleep was related to the ways people process information, therefore was grouped under Information Process Theory, and psychological arousal was related to the ways brain activities influence behavior, therefore was grouped under Cognitive Neurology (Cain & Gardisar, 2010; Exelmans & Vanden Bulck, 2016; Ormrod, 2016).

Theories concerning CPU multitasking and self-regulated learning behavior were tested in a study investigating potential negative (i.e., multitasking) and positive (i.e., self-regulation) aspects of CPU for academic performance in young adults (Joshi, Woodward, & Woltering, 2022). The study discovered that CPU multitasking was related negatively, but CPU self-regulated behavior was unrelated to the college GPA of undergraduate students. The study concluded that young adults who switch to their cell phones during class or study-related activities are more likely to have lower performance in exams as CPU multitasking costs time and efficiency (Switch Load Theory). The study also concluded that young adults who use their cell phones for self-regulated learning behavior are less likely to have an impact on their academic performance as CPU self-regulated behavior helps regulate habits but not learning processes. In the study, CPU multitasking was described through Switch Load Theory, and CPU self-regulated behavior was described through Self-regulated Learning Theory. The switching cost and switching efficiency were related to executive control in the brain, therefore, were grouped under Information Process Theory, and self-regulation was related to observation and cognition, therefore, was grouped under Social Cognitive Theory (Rubinstein, Meyer, & Evans, 2001; Zimmerman, 1989; Ormrod, 2016).

Theories concerning psychological well-being and psychological needs were tested in a recent study exploring the psychological and social aspects of cell phone social media behaviors of young adults (Joshi, Woltering, & Woodward, 2023). The study revealed that cell phone social media connectedness to self and cell phone social media connectedness to others were positively associated with the psychological well-being of undergraduate students. Two theories were attributed to the association between cell phone social media use variables (i.e., cell phone social media connectedness to self and cell phone social media connectedness to others) and PWB. The first theory, the Six-factor Model of Psychological Well-being (Ryff, 1989), was attributed to the association between cell phone social media use and cell phone social media connectedness to self. The second theory, the Maslow Hierarchy of Psychological Needs (Maslow, 1987), was attributed to the association between cell phone social media use and cell phone social media connectedness to others. Both the theories were grouped under Sociocultural Theory and Other Contextual Theories in the framework as these theories "focus on how a society's adults and cultural creations enhance cognition and pass accumulated wisdom along to children and on how physical tools (e.g., technology) and local or global social-support systems can enhance performance and learning" (Ormrod, 2016).

Based on the empirical studies presented above, it can be concluded that the theoretical explanation for various CPU-led mechanisms presented in this paper aligned well with the respective theories of sleep quality, academic performance, and PWB.

8. Practical Implications and Application to the Real World

The outcomes of the presented study will have several practical implications for CPUsers from young adults and other user demographics on the risk of excessive/constant CPU. In addition, results will guide future researchers in examining not only the negative aspect of CPU but also the positive side of the use of cell phones. The study will also serve as a guiding document for health professionals and cell phone manufacturers. The following sections describe the implications from the three specific domains: sleep quality, academic performance, and PWB.

8.1. Implications from the Domain of CPU and Sleep Quality

The theoretical framework presented in this study linked CPU-led sleep disruption to information processing activities such as repair, restoration, memory processing, and information consolidation. Repair and restoration relate to psychological (NREM Sleep) and mental functions (REM sleep) (Oswald, 1980), and memory processing and information consolidation relate to declarative and procedural memory recall, which further relates to brain plasticity (Maquet, et al., 2000). Repair, restoration, memory processing, and information consolidation had their basis in information processing and cognitive neurology, providing a clear linkage of CPU-led sleep disruption with existing theories relating to brain functioning. The connection of CPU-led sleep quality with the sleep displacement and psychological arousal will provide practical implications for the use of cell phones, especially before going to bed. Such connections will help understand how CPU may influence information processing, learning experiences, and people's behaviors. Such connection will also help researchers and practitioners create guidelines for cell phone addiction and internet-related disorders.

The outcomes of the study by Joshi, Woodward, and Woltering (2021) provided empirical evidence to CPU-led Sleep Displacement Theory and Psychological Arousal Theory. These outcomes can also be used as the potential practical implications of the framework. The established correlation between nighttime CPU and sleep quality will shed light on the harmful effects of bedtime CPU, and therefore, will guide CPUsers to limit their nighttime cell phone screen time. More specifically, the known correlation between CPU before bed and sleep latency will help educate excessive CPUsers to regulate before-bed CPU habits. Knowing the impact of CPU, especially for unstructured leisure activities, and for accessing emotionally charged media content before bed, on sleep difficulty (sleep disturbance), will create awareness about the usage of cell phones from a specific time, particularly during evening/night, and for a specific purpose. Such awareness will help regulate CPU nighttime behaviors, for example, putting cell phones away before sleep hours and avoiding accessing emotionally charged media content before sleep. Such interventions will also help prevent the current generation from sleep deprivation. Additionally, the outcomes of this domain of the study will have recurring implications for clinical and non-clinical future studies, for CPUsers, health professionals, and cell phones manufacturers.

8.2. Implications from the Domain of CPU and Academic Performance

The theoretical framework in the domain of academic performance linked CPU-led multitasking and CPU-led self-regulation to switching cost, switching efficiency, and executive control in the brain. Switching cost, switching efficiency, and executive control had their basis in information processing and cognition, providing a clear linkage of multitasking and self-regulation with Switch Load Theory, Self-regulated Learning Theory, and Social Cognitive Theory (Rubinstein, Meyer, & Evans, 2001; Zimmerman, 1989; Ormrod, 2016). Switch Load Theory is a two-stage model of executive control (Rubinstein, Meyer, & Evans, 2001), Self-regulated Learning Theory focuses "on how students personally activate, alter, and sustain their learning practices in specific contexts" (Zimmerman, 1986, p. 307)," and Social Cognitive Theory provides "interpretation of observational learning in terms of cognitive processes" (Ormrod, 2016). Having a theoretical mechanism linking CPU-led multitasking with executive control, cognition, and self-regulation will help researchers in testing these theories empirically, which will further help understand the cognitive processes involved in multitasking and task-switching.

The outcomes of the study by Joshi Woodward, and Woltering (2022) provided the empirical evidence to CPU-led multitasking and CPU-led self-regulatory behaviors. These outcomes can also be used as the potential practical implications of the framework. The outcome from this study provides clear guidelines on the feasibility of CPU during class/lecture, lab, and/or study session, and for other study-related tasks, which have direct implications in the field of education. The correlation between CPU switch, i.e., classroom CPU, and academic performance will help make a clear case of why cell phones should or should not be used for or during academic pursuits. The statistical data on CPU classroom task-switching will help develop preventive measures on classroom multitasking. The data on cell phone self-regulated behaviors (metacognitive, motivational, and behavioral) will help educate young adults with self-control strategies, which will help improve their self-efficacy. This data will also potentially help teachers to integrate cell phones into classrooms for various teaching-learning purposes including adhering to study schedules, setting goals, monitoring student progress, and reinforcing classroom instruction. With negative and positive attributes established, CPU-supported self-regulation interventions may be generated to not let the CPU take control of our learning, which will be the most significant practical implication of the outcomes from this study.

8.3. Implications from the Domain of CPU and PWB

The theoretical framework presented in this study proposed a link between cell phone social media use with the Six-factor Model of PWB (Ryff, 1989) and the Maslow Hierarchy of Psychological Needs (Maslow, 1987). Six-factor model and Maslow hierarchy of needs had their basis in positive psychological functioning and positive social relationships. Positive psychological functioning comprises self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth. Positive social relationships comprise psychological needs including esteem needs, belongingness, and love needs (Ryff, 1989; Maslow, 1987). Moreover, positive psychological functioning and positive social relationships had their basis in Sociocultural Theory and Other Contextual Theories, which "focus on how a society's adults and cultural creations enhance cognition and pass accumulated wisdom along to children and on how physical tools (e.g., technology) and local or global social-support systems can enhance performance and learning" (Ormrod, 2016). The connection of cell phone social media use with the Six-factor Model of PWB and the Maslow Hierarchy of Psychological Needs will help researchers find empirical evidence of the impact of CPU on PWB.

The study that was conducted for testing CPU-led PWB empirically (Joshi, Woltering, & Woodward, 2023), also presents the potential practical implications of the framework concerning the Six-factor Model of PWB and the Maslow Hierarchy of Psychological Needs. The study mentioned that "social media is the biggest virtual platform where young adults portray their lives to the public, and cell phones are the most accessible devices suitable for that purpose." The study provided comprehensive data on CPU social media feelings and CPU social media responses of the young adult demographic. Specifically, the data on CPU social media feelings will inform us about how a cell phone makes participants feel from a social media standpoint (Instagram, Twitter, Facebook, Snapchat, LinkedIn, etc.) along different dimensions: engagement and connectedness, interest, pleasure, and sense of enjoyment, meaningfulness, purposefulness, optimism, belongingness, and acceptance, and competence and feeling accomplished. The data on CPU social media responses will tell us how young adults perceive a response to their own posts and their own responses to others' posts on cell phone social media. CPU social media response data will also educate us about the feelings of connectedness, being liked by others, reward, and contributing to the well-being of others based on responses with social media apps (Instagram, Twitter, Facebook, Snapchat, LinkedIn, etc.). The established correlation between CPU and PWB will have direct practical implications, as it will inform us on how cell phone social media shall be used as a potential tool for fulfilling psychological needs.

9. Limitations

While this study has provided a novel theoretical framework for CPU-led sleep quality, academic performance, and PWB, there are limitations to be considered while using this framework. As the framework included theories from the domain of sleep quality, academic performance, and PWB, the application of the framework for derivative variables would be limited. The study revolved around CPU, therefore, the implementation of the framework for other screen-based technological devices such as computers, laptops, television, iPad, etc. may be limited. The studies providing empirical support to the framework were conducted for young adults (18-29 years), and the studies used to build the framework also comprised the young adult population, therefore, the application of the framework for the remaining population may be limited. In addition, the application of the framework for non-college CPUsers from the young adult demographic may be limited. Lastly, grouping the developmental theories under four overarching theories, and finally nesting them under cognitivism, may have some limitations as there may be several other theories that could be connected to CPU-led sleep quality, academic performance, and PWB.

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References

[1] Adams, S. K., & Kisler, T. S. (2013). Sleep quality as a mediator between technology-related sleep quality, depression, and anxiety. *Cyberpsychology, Behavior, and Social Networking, 16*(1), 25-30. doi:10.1089/cyber.2012.0157

[2] Al–Ali, B. M., Patzak, J., Fischereder, K., Pummer, K., & Shamloul, R. (2013). Cell phone usage and men's erectile dysfunction: A short communication. *Central European Journal of Urology, 66*(1), 75-77. doi:10.5173/ceju.2013.01.art23

[3] Al-Khamees, N. (2007). A study in Kuwait of health risks associated with using cell phones. *College Student Journal, 41*(1), 187-203.

[4] Anderson, C. A., Shibuya, A., Ihori, N., Swing, E. L., Bushman, B. J., Sakamoto, A., … Saleem, M. (2010). Violent video game effects on aggression, empathy, and prosocial behavior in Eastern and Western countries: A meta-analytic review. *Psychological Bulletin, 136*(2), 151-173. doi:10.1037/a0018251

[5] Andrews, F. M., & Withey, S. B. (1976). Americans' well-being: Life-as-a-whole. *Social Indicators of Well-Being*, 309-335. doi:10.1007/978-1-4684-2253-

5_10
[6] Americans' views on mobile etiquette. (2015). Retrieved from http://www.pewinternet.org/2015/08/26/americans-views-on-mobile-etiquette/
[7] Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes, 50*(2), 248-287. doi:10.1016/0749-5978(91)90022-l
[8] Beal, V. (2008). The difference between a cellular phone, smartphone, and PDA. Retrieved from https://www.webopedia.com/DidYouKnow/Hardware_Software/smartphone_cellphone_pda.asp
[9] Berry, M. J., & Westfall, A. (2015). Dial D for distraction: The making and breaking of cell phone policies in the college classroom. *College Teaching, 63*(2), 62–71. doi:10.1080/87567555.2015.1005040
[10] Bjornsen, C. A., & Archer, K. J. (2015). Relations between college students' cell phone use during class and grades. *Scholarship of Teaching and Learning in Psychology*, 1(4), 326–336. doi:10.1037/stl0000045
[11] Blasiman, R. N., Larabee, D., & Fabry, D. (2018). Distracted students: A comparison of multiple types of distractions on learning in online lectures. *Scholarship of Teaching and Learning in Psychology, 4*(4), 222–230. https://doi.org/10.1037/stl0000122
[12] Blask, D. E., Sauer, L. A., Dauchy, R. T., Holowachuk, E. W., & Ruhoff, M. S. (1999). New insights into melatonin regulation of cancer growth. *Advances in Experimental Medicine and Biology*, 337-343. doi:10.1007/0-306-46814-x_38
[13] Braguglia, K. H. (2011). Cellular telephone use: A survey of college business students. *Journal of College Teaching & Learning (TLC), 5*(4). doi:10.19030/tlc.v5i4.1279
[14] Brainard, G. C., Hanifin, J. P., Rollag, M. D., Greeson, J., Byrne, B., Glickman, G., … Sanford, B. (2001). Human melatonin regulation is not mediated by the three cone photopic visual system. *The Journal of Clinical Endocrinology & Metabolism, 86*(1), 433-436. doi:10.1210/jcem.86.1.7277
[15] Brown, J. D., L'Engle, K. L., Pardun, C. J., Guo, G., Kenneavy, K., & Jackson, C. (2006). Sexy media matter: Exposure to sexual content in music, movies, television, and magazines predicts black and white adolescents' sexual behavior. *Pediatrics, 117*(4), 1018-1027. doi:10.1542/peds.2005-1406
[16] Brown, S. L., Nesse, R. M., Vinokur, A. D., & Smith, D. M. (2003). Providing support may be more beneficial than receiving it: Results from a prospective study of mortality. *Psychological Science, 14*, 320–327. doi:10.1111/1467-9280.14461.
[17] Cain, N., & Gradisar, M. (2010). Electronic media use and sleep in school-aged children and adolescents: A review. *Sleep Medicine, 11*(8), 735-742. doi:10.1016/j.sleep.2010.02.006
[18] Cajochen, C., Münch, M., Kobialka, S., Kräuchi, K., Steiner, R., Oelhafen, P., … Wirz-Justice, A. (2005). High sensitivity of human melatonin, alertness, thermoregulation and heart rate to short wavelength light. *The Journal of Clinical Endocrinology & Metabolism, 90*(3), 1311-1316. doi:10.1210/jc.2004-0957
[19] Cajochen, C., Jud, C., Münch, M., Kobialka, S., Wirz-Justice, A., & Albrecht, U. (2006). Evening exposure to blue light stimulates the expression of the clock gene PER2 in humans. *European Journal of Neuroscience, 23*(4), 1082-1086. doi:10.1111/j.1460-9568.2006.04613.x
[20] Chan, M. (2013). Mobile phones and the good life: Examining the relationships among mobile use, social capital and subjective well-being. *New Media & Society, 17*(1), 96-113. doi:10.1177/1461444813516836
[21] Chellappa, S. L., Steiner, R., Oelhafen, P., Lang, D., Götz, T., Krebs, J., & Cajochen, C. (2013). Acute exposure to evening blue-enriched light impacts on human sleep. *Journal of Sleep Research, 22*(5), 573-580. doi:10.1111/jsr.12050
[22] Chen, H., & Li, X. (2017). The contribution of mobile social media to social capital and psychological well-being: Examining the role of communicative use, friending and self-disclosure. *Computers in Human Behavior, 75*, 958-965. doi:10.1016/j.chb.2017.06.011
[23] Clayton, R. B., Leshner, G., & Almond, A. (2015). The extended iSelf: The impact of iPhone separation on cognition, emotion, and physiology. *Journal of Computer-Mediated Communication,*

20(2), 119-135. doi:10.1111/jcc4.12109

[24] College enrollment statistics and student demographic statistics. (2019, June 7). Retrieved from https://educationdata.org/college-enrollment-statistics/

[25] Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper & Row.

[26] Demirci, K., Akgönül, M., & Akpinar, A. (2015). Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *Journal of Behavioral Addictions, 4*(2), 85-92. doi:10.1556/2006.4.2015.010

[27] *Demographics of mobile device ownership and adoption in the United States*. (2021, April 7). Pew Research Center: Internet, Science & Tech. Retrieved May 3, 2021, from https://www.pewresearch.org/internet/fact-sheet/mobile/

[28] Demographics of internet and home broadband usage in the United States. (2018, February 5). Retrieved from https://www.pewinternet.org/fact-sheet/internet-broadband/

[29] De-Sola Gutiérrez, J., Rodríguez de Fonseca, F., & Rubio, G. (2016). Cell-phone addiction: A review. *Frontiers in Psychiatry, 7*. doi:10.3389/fpsyt.2016.00175

[30] Diener, E. (1984). Subjective well-being. *Psychological Bulletin, 95*, 542-575.

[31] Diener, E. D., Emmons, R. A., Larsen, R. J, & Griffin, S. (1985). The satisfaction of life scale. *Journal of Personality Assessment, 49*(1), 71-75.

[32] Diener, E., Wirtz, D., Tov, W., Kim-Prieto, C., Choi, D., Oishi, S., & Biswas-Diener, R. (2009a). New well-being measures: Short scales to assess flourishing and positive and negative feelings. *Social Indicators Research, 97*(2), 143-156. doi:10.1007/s11205-009-9493-y

[33] Diener E, Wirtz D, Biswas-Diener R, Tov, W., Kim-Prieto, C., Choi, D., & Oishi, S. (2009b). New measures of well-being. In: Diener E (ed.) *Assessing Well-Being: The Collected Works of Ed Diener*. Champaign, IL: Springer, pp. 247–266.

[34] Dill, K. E., Gentile, D. A., Richter, W. A., & Dill, J. C. (2005). Violence, sex, race, and age in popular video games: A content analysis. In: Cole, E., Henderson, D.J. (Eds.). American Psychological Association, Washington, DC. *Featuring females: Feminist analyses of media*, 115-130. doi:10.1037/11213-008

[35] Dowdell, E. B., & Clayton, B. Q. (2018). Interrupted sleep: College students sleeping with technology. *Journal of American College Health*, 1-7. doi:10.1080/07448481.2018.1499655

[36] Dunn, E., Aknin, L. B., & Norton, M. I. (2008). Spending money on others promotes happiness. *Science*, 319, 1687–1688. doi:10.1126/science.1150952.

[37] 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. doi:10.1542/peds.2007-0476

[38] Elder, A. D. (2013). College students' cell phone use, beliefs, and effects on their learning. *College Student Journal, 47*(4), 585–592.

[39] Exelmans, L., & Van den Bulck, J. (2016). Bedtime mobile phone use and sleep in adults. *Social Science & Medicine, 148*, 93-101. doi:10.1016/j.socscimed.2015.11.037

[40] Eyvazlou, M., Zarei, E., Rahimi, A., & Abazari, M. (2016). Association between overuse of mobile phones on quality of sleep and general health among occupational health and safety students. *Chronobiology International, 33*(3), 293-300. doi:10.3109/07420528.2015.1135933

[41] Felisoni, D. D., & Godoi, A. S. (2018). Cell phone usage and academic performance: An experiment. *Computers & Education, 117*, 175-187. doi:10.1016/j.compedu.2017.10.006

[42] Fernandez, S. (2018). University student's perspectives on using cell phones in classrooms - Are they dialing up disaster? *The Turkish Online Journal of Educational Technology, 17*(1), 246-258.

[43] Fleschler Peskin, M., Markham, C. M., Addy, R. C., Shegog, R., Thiel, M., & Tortolero, S. R. (2013). Prevalence and Patterns of Sexting Among Ethnic Minority Urban High School Students. *Cyberpsychology, Behavior, and Social Networking, 16*(6), 454-459. doi:10.1089/cyber.2012.0452

[44] For most smartphone users, it's a 'round-the-clock' connection. (2017). Retrieved from https://www.

reportlinker.com/insight/smartphone-connection.html

[45] Froese, A. D., Carpenter, C. N., Inman, D. A., Schooley, J. R., Barnes, R. B., Brecht P. W., & Chacon, J. D. (2012). Effects of classroom cell phone use on expected and actual learning. *College Student Journal, 46*(2), 323–332.

[46] Gingerich, A. C., & Lineweaver, T. T. (2014). OMG! Texting in class = U Fail :(empirical evidence that text messaging during class disrupts comprehension. *Teaching of Psychology, 41*(1), 44–51. doi:10.1177/0098628313514177

[47] Han, S., & Yi, Y. J. (2018). How does the smartphone usage of college students affect academic performance? *Journal of Computer Assisted Learning, 35*(1), 13-22. doi:10.1111/jcal.12306

[48] Harada, T., Morikuni, M., Yoshi, S., Yamashita, Y., and Takeuchi H. (2002). Usage of mobile phone in the evening or at night makes Japanese students evening-typed and night sleep uncomfortable. *Sleep and Hypnosis, 4*(4), 149-153.

[49] Harada, T., Tanoue, A., & Takeuchi, H. (2006). Epidemiological studies on dreams, sleep habits and mental symptoms in students aged 18-25 years and the 24 hour a day commercialization of Japanese society (1). *Sleep and Biological Rhythms, 4*(3), 274-281. doi:10.1111/j.1479-8425.2006.00232.x

[50] Hitlin, P. (2020, May 30). *Use of internet, social media, digital devices plateau in US*. Pew Research Center. Retrieved May 3, 2021, from https://www.pewresearch.org/fact-tank/2018/09/28/internet-social-media-use-and-device-ownership-in-u-s-have-plateaued-after-years-of-growth/

[51] Hoffner, C. A., & Lee, S. (2015). Mobile phone use, emotion regulation, and well-being. *Cyberpsychology, Behavior, and Social Networking, 18*(7), 411-416. doi:10.1089/cyber.2014.0487

[52] Hong, F., Chiu, S., & Huang, D. (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*(6), 2152-2159. doi:10.1016/j.chb.2012.06.020

[53] Hysing, M., Pallesen, S., Stormark, K. M., Jakobsen, R., Lundervold, A. J., & Sivertsen, B. (2015). Sleep and use of electronic devices in adolescence: results from a large population-based study. *BMJ Open, 5*(1), e006748-e006748. doi:10.1136/bmjopen-2014-006748

[54] ITU World telecommunication/ICT indicators database. (2018). Global ICT developments, 2001–2018. Retrieved from http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

[55] 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*(5), 275–280.

[56] Joshi, S. C., Woodward, J, & Woltering, S. (2022). Cell phone use distracts young adults from academic work with limited benefit to self-regulatory behavior. *Current Psychology*. https://doi.org/10.1007/s12144-022-03830-4

[57] Joshi, S. C. (2022). Sleep latency and sleep disturbances mediates the association between nighttime cell phone use and psychological well-being in college students. *Sleep and Biological Rhythms, 20*, 431-443. https://doi.org/10.1007/s41105-022-00388-3

[58] Joshi, S. C., Woodward, J, & Woltering, S. (2021). Nighttime cell phone use and sleep quality in young adults. *Sleep and Biological Rhythms, 20* (1), 97-106. https://doi.org/10.1007/s41105-021-00345-6

[59] Joshi, S. C., Woltering, S., & Woodward, J. (2023). Cell phone social media use and psychological well-being in young adults: Implications for internet-related disorders. *International Journal of Environmental Research and Public Health, 20*(2), 1197. https://doi.org/10.3390/ijerph20021197

[60] Junco, R., & Cotten, S. R. (2012). No A 4 U: The relationship between multitasking and academic performance. *Computers & Education, 59*(2), 505-514. doi:10.1016/j.compedu.2011.12.023

[61] King, D. L., Gradisar, M., Drummond, A., Lovato, N., Wessel, J., Micic, G., … Delfabbro, P. (2013). The impact of prolonged violent videogaming on adolescent sleep: An experimental study. *Journal of Sleep Research*, 22, 137–143.

[62] King, A. L. S., Valença, A. M., Silva, A. C., Sancassiani, F., Machado, S., & Nardi, A. E.

(2014). "Nomophobia": Impact of cell phone use interfering with symptoms and emotions of individuals with panic disorder compared with a control group. *Clinical Practice and Epidemiology in Mental Health, 10*(1), 28–35. doi:10.2174/1745017901410010028

[63] Kubey, R. W. (1986). Television use in everyday life: Coping with unstructured time. J*ournal of Communication, 36*(3), 108-123. doi:10.1111/j.1460-2466.1986.tb01441.x

[64] Kumcagiz, H., & Gunduz, Y. (2016). Relationship between psychological well-being and smartphone addiction of university students. *International Journal of Higher Education, 5*(4). doi:10.5430/ijhe.v5n4p144

[65] Kwon, M., Lee, J., Won, W., Park, J., Min, J., Hahn, C., … Kim, D. (2013). Development and validation of a smartphone addiction scale (SAS). *PLoS ONE, 8*(2), e56936. doi:10.1371/journal.pone.0056936

[66] Kwon, M., Kim, D., Cho, H., & Yang, S. (2013). The smartphone addiction scale: Development and validation of a short version for adolescents. *PLoS ONE, 8*(12), e83558. doi:10.1371/journal.pone.0083558

[67] Lawson, D., & Henderson, B. B. (2015). The costs of texting in the classroom. *College Teaching, 63*(3), 119–124. doi:10.1080/87567555.2015.1019826

[68] Lepp, A., Barkley, J. E., & Karpinski, A. C. (2015). The relationship between cell phone use and academic performance in a sample of U.S. college students. *SAGE Open, 5*(1), 215824401557316. doi:10.1177/2158244015573169

[69] Li, J., Lepp, A., & Barkley, J. E. (2015). Locus of control and cell phone use: Implications for sleep quality, academic performance, and subjective well-being. *Computers in Human Behavior, 52*, 450-457. doi:10.1016/j.chb.2015.06.021

[70] Lin, C., Griffiths, M. D., & Pakpour, A. H. (2018). Psychometric evaluation of Persian Nomophobia questionnaire: Differential item functioning and measurement invariance across gender. *Journal of Behavioral Addictions, 7*(1), 100-108. doi:10.1556/2006.7.2018.11

[71] Lopez-Fernandez, O., Kuss, D. J., Romo, L., Morvan, Y., Kern, L., Graziani, P., … Billieux, J. (2017). Self-reported dependence on mobile phones in young adults: A European cross-cultural empirical survey. *Journal of Behavioral Addictions, 6*(2), 168-177. doi:10.1556/2006.6.2017.020

[72] Lombardo, C. (2015). 18 Essential pros and cons of cell phones. Retrieved from https://greengarageblog.org/18-essential-pros-and-cons-of-cell-phones

[73] Mail Online. (2008). Nomophobia is the fear of being out of mobile phone contact - and it's the plague of our 24/7 age. Retrieved from

[74] http://www.dailymail.co.uk/news/article-550610/Nomophobia-fear-mobile-phonecontact--Plague-24-7-age.html

[75] Maquet, P., Laureys, S., Peigneux, P., Fuchs, S., Petiau, C., Phillips, C., … Cleeremans, A. (2000). Experience-dependent changes in cerebral activation during human REM sleep. *Nature Neuroscience, 3*(8), 831-836. doi:10.1038/77744

[76] Margolis, S., & Lyubomirsky, S. (2018). Cognitive outlooks and well-being. In E. Diener, S. Oishi, & L. Tay (Eds.), *Handbook of well-being*. Salt Lake City, UT: DEF Publishers. DOI:nobascholar.com

[77] Maslow, A. H. (1987). *Motivation and personality (3rd ed.)*. Delhi, India: Pearson Education.

[78] Maslow's Hierarchy of Needs. (2018). Retrieved from https://www.simplypsychology.org/maslow.html

[79] Matar Boumosleh, J., & Jaalouk, D. (2017). Depression, anxiety, and smartphone addiction in university students- A cross sectional study. *PLOS ONE, 12*(8), e0182239. doi:10.1371/journal.pone.0182239

[80] McDaniel, B. T., & Drouin, M. (2019). Daily technology interruptions and emotional and relational well-being. *Computers in Human Behavior*, 99, 1-8. https://doi.org/10.1016/j.chb.2019.04.027

[81] Melton, B. F., Bigham, L. E., Bland, H. W., Bird, M., & Fairman, C. (2014). Health-related Behaviors and Technology Usage among College Students. *American Journal of Health Behavior, 38*(4), 510-518. doi:10.5993/ajhb.38.4.4

[82] Mendoza, J. S., Pody, B. C., Lee, S., Kim, M., & McDonough, I. M. (2018). The effect of cellphones on attention and learning: The influences of time, distraction, and nomophobia.

Computers in Human Behavior, 86, 52-60. doi:10.1016/j.chb.2018.04.027

[83] Meng, J., Wang, F., Chen, R., Hua, H., Yang, Q., Yang, D., Wang, N., Li, X., Ma, F., Huang, L., Zou, Z., Li, M., Wang, T., Luo, Y., Li, Y., & Liu, Y. (2021). Association between the pattern of mobile phone use and sleep quality in Northeast China college students. *Sleep and Breathing, 25*(4), 2259-2267. https://doi.org/10.1007/s11325-021-02295-2

[84] Moulin, K. L., & Chung, C. (2017). Technology trumping sleep: Impact of electronic media and sleep in late adolescent students. *Journal of Education and Learning, 6*(1), 294. doi:10.5539/jel.v6n1p294

[85] Murdock, K. K., Gorman, S., & Robbins, M. (2015). Co-rumination via cellphone moderates the association of perceived interpersonal stress and psychosocial well-being in emerging adults. *Journal of Adolescence, 38*, 27-37. https://doi.org/10.1016/j.adolescence.2014.10.010

[86] Murdock, K. K., Horissian, M., & Crichlow-Ball, C. (2017). Emerging adults' text message use and sleep characteristics: A multimethod, naturalistic study. *Behavioral Sleep Medicine, 15*(3), 228-241. doi:10.1080/15402002.2015.1120203

[87] Ormrod, J. E. (2016). *Human Learning (7th ed.)*. New York, NY: Pearson.

[88] Oswald, I. (1980). Sleep as a Restorative Process: Human Clues. *Progress in Brain Research,* 53, 279-288.

[89] Park, N., & Lee, H. (2012). Social implications of smartphone use: Korean college students' smartphone use and psychological well-being. *Cyberpsychology, Behavior, and Social Networking, 15*(9), 491-497. doi:10.1089/cyber.2011.0580

[90] Patterson, M. C. (2016). A naturalistic investigation of media multitasking while studying and the effects on exam performance. *Teaching of Psychology, 44*(1), 51-57. doi:10.1177/0098628316677913

[91] Perrin, A., & Jiang, J. (2018). A quarter of Americans are online almost constantly. Retrieved from http://www.pewresearch.org/fact-tank/2018/03/14/about-a-quarter-of-americans-report-going-online-almost-constantly/

[92] Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues*. Oxford: Oxford University Press.

[93] Pettijohn, T. F., Frazier, E., Rieser, E., Vaughn, N., & Hupp-Wilds, B. (2015). Classroom texting in college students. *College Student Journal, 49*(4), 513–516.

[94] PEW Research Center, Internet & Technology: Mobile fact sheet. (2018). Retrieved from http://www.pewinternet.org/fact-sheet/mobile/

[95] PEW Research Center, Internet & Technology: U.S. smartphone use in 2015. (2015, March 31). Retrieved from https://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/pi_2015-04-01_smartphones_03/

[96] PEW Research, Internet & Technology; Americans and their cell phones. (2011). Retrieved from http://www.pewinternet.org/2011/08/15/americans-and-their-cell-phones/

[97] Redner, R., Lang, L. M., & Brandt, K. P. (2019). Evaluation of an electronics intervention on electronics use in a college classroom. *Behavior Analysis: Research and Practice*. doi:10.1037/bar0000158

[98] Rosen, L. D., Carrier, M., & Cheever, N. A. (2013). Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior, 29*, 948–958.

[99] Rubinstein, J. S., Meyer, D. E., & Evans, J. E. (2001). Executive control of cognitive processes in task switching. *Journal of Experimental Psychology: Human Perception and Performance, 27*(4), 763-797.

[100]Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology, 57*, 1069–1081.

[101]LaMotte, S. (2017). Smartphone addiction could be changing your brain. Retrieved from https://www.cnn.com/2017/11/30/health/smartphone-addiction-study/index.html

[102]Sapci, O., Elhai, J. D., Amialchuk, A., & Montag, C. (2021). The relationship between smartphone use and students` academic performance. *Learning and Individual Differences, 89*, 102035. https://doi.org/10.1016/j.lindif.2021.102035

[103]SecurEnvoy. (2012). 66% of the population suffer from Nomophobia the fear of being

[104]without their phone. Retrieved from http://www.securenvoy.com/blog/2012/02/16/66-of-the-population-suffer-fromnomophobia-the-fear-of-being-without-their-phone/

[105]Sleep disorders - Latest research and news | Nature. (2018). Retrieved from https://www.nature.com/subjects/sleep-disorders

[106]Słojewski, M. (2013). Cell phones give more benefits than risks, but... *Central European Journal of Urology, 65*, 54-55. doi:10.5173/ceju.2013.01.art17

[107]Sohn, S. Y., Krasnoff, L., Rees, P., Kalk, N. J., & Carter, B. (2021). The association between smartphone addiction and sleep: A UK cross-sectional study of young adults. *Frontiers in Psychiatry, 12*. https://doi.org/10.3389/fpsyt.2021.629407

[108]Tao, S., Wu, X., Zhang, Y., Zhang, S., Tong, S., & Tao, F. (2017). Effects of sleep quality on the association between problematic mobile phone use and mental health symptoms in chinese college students. *International Journal of Environmental Research and Public Health, 14*(2), 185. doi:10.3390/ijerph14020185

[109]The Internet World Stats. (2016). Mobile internet – mobile phones and smart mobile phones. Retrieved from http://www.internetworldstats.com/mobile.htm

[110]Thomée, S., Eklöf, 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. doi:10.1016/j.chb.2004.12.007

[111]Thomée, S., Dellve, L., Härenstam, A., & Hagberg, M. (2010). Perceived connections between information and communication technology use and mental symptoms among young adults - a qualitative study. *BMC Public Health, 10*(1). doi:10.1186/1471-2458-10-66

[112]Tindell, D. R., & Bohlander, R. W. (2012). The use and abuse of cell phones and text messaging in the classroom: A survey of college students. *College Teaching, 60*(1), 1–9. doi:10.1080/87567555.2011.604802

[113]Tosini, G., Ferguson, I, & Tsubota, K. (2016). Effects of blue light on the circadian system and eye psychology. *Molecular Vision, 22*, 61-72.

[114]Tossell, C. C., Kortum, P., Shepard, C., Rahmati, A., & Zhong, L. (2015). You can lead a horse to water but you cannot make him learn: Smartphone use in higher education. *British Journal of Educational Technology, 46*(4), 713–724. doi:10.1111/bjet.12176

[115]Towne, S. D., Ory, M. G., Smith, M. L., Peres, S. C., Pickens, A. W., Mehta, R. K., & Benden, M. (2017). Accessing physical activity among young adults attending a university: the role of sex, race/ethnicity, technology use, and sleep. *BMC Public Health, 17*(1). doi:10.1186/s12889-017-4757-y

[116]Troll, E. S., Friese, M., & Loschelder, D. D. (2021). How students' self-control and smartphone-use explain their academic performance. *Computers in Human*

[117]*Behavior, 117*, 106624. https://doi.org/10.1016/j.chb.2020.106624

[118]U.S. smartphone users statistics in 2017: a 'Round-the-Clock' connection. (2017). Retrieved from https://www.reportlinker.com/insight/smartphone-connection.html

[119]Van den Bulck, J. (2004). Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children. *Sleep, 27*(1), 101-104. doi:10.1093/sleep/27.1.101

[120]Van der Molen, J. H., & Bushman, B. J. (2008). Children's Direct Fright and Worry Reactions to Violence in Fiction and News Television Programs. T*he Journal of Pediatrics, 153*(3), 420-424. doi:10.1016/j.jpeds.2008.03.036

[121]Volkmer, S. A., & Lermer, E. (2019). Unhappy and addicted to your phone?—Higher mobile phone use is associated with lower well-being. *Computers in Human Behavior, 93*, 210–218. https://doi.org/10.1016/j.chb.2018.12.015

[122]Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* Cambridge, Mass.: Harvard University Press.

[123]Wade, J. (2017). The advantages of teenagers having mobile phones. Retrieved from https://howtoadult.com/the-advantages-of-teenagers-having-mobile-phones-12944089.html

[124]Weaver, E., Gradisar, M., Dohnt, H., Lovato, N., & Douglas, P. (2010). The effect of presleep video-game playing on adolescent sleep. *Journal of Clinical Sleep Medicine, 6*(2), 184–189.

[125]Which generation is most distracted by their phones? (2016). Retrieved from https://priceonomics.com/which-generation-is-most-distracted-by-their/

[126]Wood, J. (2018). College students in study spend 8 to 10 hours daily on cell phone. Retrieved from https://psychcentral.com/news/2014/08/31/new-study-finds-cell-phone-addiction-increasingly-realistic-possibility/74312.html

[127]Wood, B., Rea, M. S., Plitnick, B., & Figueiro, M. G. (2013). Light level and duration of exposure determine the impact of self-luminous tablets on melatonin suppression. *Applied Ergonomics, 44*(2), 237-240. doi:10.1016/j.apergo.2012.07.008

[128]Xu, F., Adams, S. K., Cohen, S. A., Earp, J. E., & Greaney, M. L. (2019). Relationship between physical activity, screen time, and sleep quantity and quality in US adolescents aged 16–19. *International Journal of Environmental Research and Public Health, 16*(9), 1524. doi:10.3390/ijerph16091524

[129]Ya'u, L., & Idris, B. (2015). Theory of planned behaviour and the use of cell/mobile phone in the classroom. *International Research Journal of Electronics and Computer Engineering, 1*(1), 1. doi:10.24178/irjece.2015.1.1.01

[130]Zarghami, M., Khalilian, A., Setareh, J., & Salehpour, G. (2015). The impact of using cell phones after light-out on sleep quality, headache, tiredness, and distractibility among students of a university in north of Iran. I*ranian Journal of Psychiatry and Behavioral Sciences, 9*(4). doi:10.17795/ijpbs-2010

[131]Zimmerman, B. J. (1986). Becoming a self-regulated learner: which are the key subprocesses?. *Contemporary Educational Psychology, 11*, 307–313. doi: 10.1016/0361-476x(86)90027-5

[132]Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal*, 23, 614 - 628.

[133]Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology, 81*, 329–339. doi: 10.1037/0022-0663.81.3.329

[134]Zimmerman, B. J. (2000). “Attaining self-regulation: a social cognitive perspective,” in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 13–40. doi: 10.1016/b978-012109890-2/50031-7

[135]Zimmerman, B. J., & Moylan, A. R. (2009). “Self-regulation: where metacognition and motivation intersect,” in *Handbook of Metacognition in Education*, eds D. J. Hacker, J. Dunlosky, and A. C. Graesser (New York, NY: Routledge), 299–315.