Computers in Human Behavior 31 (2014) 343–350

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

The relationship between cell phone use, academic performance, anxiety, and Satisfaction with Life in college students

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ARTICLE INFO

Article history:
Available online 23 November 2013

Keywords:
Mobile phones
GPA
Anxiety
Satisfaction with Life
Technology
Post-secondary education

ABSTRACT

While functional differences between today's cell phones and traditional computers are becoming less clear, one difference remains plain – cell phones are almost always on-hand and allow users to connect with an array of services and networks at almost any time and any place. The Pew Center's Internet and American Life Project suggests that college students are the most rapid adopters of cell phone technology and research is emerging which suggests high frequency cell phone use may be influencing their health and behavior. Thus, we investigated the relationships between total cell phone use ($N = 496$) and texting ($N = 490$) on Satisfaction with Life (SWL) in a large sample of college students. It was hypothesized that the relationship would be mediated by Academic Performance (GPA) and anxiety. Two separate path models indicated that the cell phone use and texting models had good overall fit. Cell phone use/texting was negatively related to GPA and positively related to anxiety; in turn, GPA was positively related to SWL while anxiety was negatively related to SWL. These findings add to the debate about student cell phone use, and how increased use may negatively impact academic performance, mental health, and subjective well-being or happiness.

1. Introduction

Distinctions between today's cellular phones (henceforth cell phones) and traditional notions of the computer are becoming less and less clear. For example, in 2011, the 8th US Circuit Court of Appeals ruled that smart phones as well as ordinary cell phones (those used only to make calls and send text messages) are, from a legal standpoint, computers (United States v. Kramer, 2011). In terms of functionality, cell phones complete many of the same tasks as an Internet connected computer. As such, today's cell phones allow users to call, text, e-mail, video conference, micro-blog, interact on social-networks, surf the Internet, watch and share videos and pictures, play video games, and utilize a tremendous array of software driven applications. In contrast to traditional notions of the computer, the mobile nature of the cell phone allows these services to be accessed almost anywhere and at almost any time. Considering that cell phones and their growing suite of applications are typically within arm's reach of nearly everyone, it is worth considering what influence they may have on users' beliefs, attitudes, behaviors and behavioral outcomes. It may be that cell phone use (CPUse) has implications for human behavior which extend beyond the realm of communication.

For example, a recent study by our group (Lepp, Barkley, Sanders, Rebold, & Gates, 2013) found that CPUse was negatively related to an objective measure of physical fitness (VO2peak) among a sample of typical college students. In other words, high cell phone users were less physically fit than low cell phone users. Interview data collected as part of the study explained the negative relationship by suggesting that CPUse disrupts physical activity behavior, causing high frequency users to be less physically active and more sedentary in comparison to low frequency users. Unpublished interview data collected during the same study also suggested that CPUse may disrupt college students' academic achievement and contribute to anxiety. Specifically, when participants were asked to provide details about their CPUse, several indicated that it occurred during class time or while studying. For example, one participant stated "I usually go on my phone if I am bored sitting there in class. Or during homework I will take little Twitter breaks." Likewise, when asked to explain their experience of CPUse, some indicated that CPUse is associated with feelings of anxiety. For example, another participant stated:

> The social network sometimes just makes me feel a little bit tied to my phone. It makes me feel like I have another obligation in my life that I have to stick to. Sometimes the cell phone just makes me feel like it is a whole new world of obligations that I have because anybody can get a hold of me at any time by just thinking about me. You know, if my mom wanted to give me a call right now, and just talk for a second, she could. And if I did

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http://dx.doi.org/10.1016/j.chb.2013.10.049

not call her back by the end of the day, she would get worried. It creates a bit of anxiety and it is kind of annoying sometimes.

Closely inspecting the data revealed that such responses were more common among high frequency cell phone users than low frequency cell phone users. Considering this, the purpose of this study was to investigate these potential relationships further using objective or validated measures. Of particular interest were the following relationships: CPUse and academic performance; CPUse and anxiety; and CPUse and Satisfaction with Life as mediated by academic performance and anxiety.

1.1. Cell phone use, academic performance, and anxiety

Research investigating CPUse and academic performance is limited and methods vary substantially from study to study. Nevertheless, results suggest a relationship exists. Jacobsen and Forste (2011) identified a negative relationship between the use of a variety of electronic media including cell phones (calling and texting) and academic performance (self-reported GPA) among first year university students in the United States. Using data collected from a sample of Taiwanese adolescents, Yen et al. (2009) found an association between CPUse (calling and texting) and participants' self-assessment of whether or not they had allowed CPUse to interfere with "important social, *academic*, or recreational activities" during the previous year (p. 866). Hong, Chiu, and Hong (2012) found daily CPUse (calling and texting) to be correlated with a self-reported measure of academic difficulty among a sample of female, Taiwanese university students. Finally, Sánchez-Martínez and Otero (2009), using a sample of Spanish high school students, found a relationship between "intensive" CPUse and school failure. School failure was operationalized as having repeated the previous year's grade level or failing four or more courses during the previous academic year. Although these studies utilized a variety of self-reported measures, academic performance was consistently and negatively associated with CPUse (calling and texting).

Several researchers have pointed to multi-tasking as an explanation for the negative relationship identified between CPUse and academic performance (Jacobsen & Forste, 2011; Junco & Cotton, 2011, 2012; Rosen, Carrier, & Cheever, 2013; Wood et al., 2012). Jacobsen and Forste (2011) reported that over two-thirds of the university students in their study used electronic media (including cell phones) while in class, studying, or doing homework. Likewise, Sánchez-Martínez and Otero (2009) found that although CPUse was typically prohibited in the classroom, half of the students in their sample reported bringing the device to school and keeping it on during class. In two studies specifically targeting multi-tasking and academic performance, Junco and Cotton examined large samples of college students and found that sending text messages and checking Facebook while studying or doing homework was common behavior. Furthermore, this behavior interfered with schoolwork (2011) and was negatively related to overall college GPA (2012). Wood et al. (2012) measured the influence of multitasking with an array of digital technologies (texting, e-mail, Facebook, MSN messaging) on real-time learning. Participants were randomly assigned to various conditions (multi-tasking with one of the four technologies or no multitasking) while participating in classroom learning activities. After the learning activities were complete, a 15-item multiple choice test was used to assess learning. Results showed that multi-tasking with any of the technologies examined had a negative impact on learning. Most recently, Rosen, Carrier et al. (2013) observed the study behaviors of a sample of middle school, high school, and university students and found participants typically became distracted by media such as Facebook and texting in less than 6 min after initiating a studying session. Furthermore, measurements of daily Facebook use and daily texting behavior predicted off-task behavior during study periods. Notably, all of the media related technologies associated with increases in multi-tasking and decreases in academic performance are now commonly accessed with a single, Internet-connected cell phone.

Like the research investigating CPUse and academic performance, research investigating CPUse and anxiety is limited. Furthermore, measures of anxiety vary from study to study. Nevertheless, there is evidence of a positive relationship between CPUse and anxiety, particularly among individuals identified as problematic cell phone users (Beranuy, Oberst, Carbonell, & Chamarro, 2009; Bianchi & Phillips, 2005; Ha, Chin, Park, Ryu, & Yu, 2008; Jenaro, Flores, Gómez-Vela, González-Gil, & Caballo, 2007; Lu et al., 2011). Problematic cell phone use has been described as an addiction-like behavior leading individuals to use the cell phone compulsively (Takao, Takahashi, & Kitamura, 2009). However, it is not clear whether the relationship between CPUse and anxiety exists independent of problematic behavior. For example, Hong et al. (2012) found a positive correlation between daily CPUse (calls and texts) and anxiety, but further investigation suggested that the relationship was mediated by cell phone addiction. Taken as a whole, these studies identify a positive relationship between problematic CPUse and anxiety. Moreover, these studies suggest a need to expand our understanding of this relationship beyond problematic users. As Merlo (2008) suggests, even typical cell phone users may experience some level of anxiety as a result of perceived obligation to remain constantly connected with others. In support of this idea, Rosen, Carrier et al. (2013), and Rosen, Whaling, Rab, Carrier, and Cheever (2013)investigated anxiety related to technology use among a large sample of teens, young adults and adults. Their results show that not being able to connect with technology, particularly Facebook, text messages and cell phone calls, as frequently as desired was associated with feelings of anxiety. Furthermore, technology use and technology related anxiety was predictive of mood and personality disorders.

Increasingly, a diversity of media-related technologies are accessible through the modern cell phone. Thus, when exploring the behavioral impacts of CPUse there is a need to consider other cell phone uses such as Facebook, surfing the Internet, and playing video games. Research has explored many of these activities in relation to academic performance and anxiety independent of CPUse. In many ways, the findings are similar to what has been described above for calling and texting. For example, video game playing has been associated with lower GPAs (Jackson, von Eye, Fitzgerald, Witt, & Zhao, 2011; Jackson, von Eye, Witt, Zhao, & Fitzgerald, 2011). High levels of Internet use have been associated with anxiety (Beranuy et al., 2009; Jenaro et al., 2007) and low levels of Internet use have been associated with improved academic performance (Chen & Peng, 2008). However, there is research to suggest that it is not the amount of time that a student spends online but rather what a student does online which affects these variables (Chen & Tzeng, 2010). Chen and Tzeng found that female high Internet users who engage in information seeking and chatting had better academic performance than low users. On the other hand, the same group of female high users felt more depressed than low users. Likewise, heavy Internet users who focused on information seeking, chatting and video games had lower levels of academic performance and felt more depressed than low users.

When considering specific Internet-based activities, social networking (e.g., Facebook, MySpace, and Twitter) has become extremely popular in recent years, and several studies have identified a negative relationship between social-networking site (SNS) use and academic performance (e.g.: Rosen, Carrier et al., 2013; Stollak, Vandenberg, Burklund, & Weiss, 2011). Kirschner and Karpinski (2010) demonstrated that Facebook users have lower GPAs and spend fewer hours per week studying than non-users. Likewise,

studies by Junco (2012a,b) have examined the relationship between Facebook use, time spent studying, and overall GPA. Results indicated that time spent on Facebook was strongly and negatively related to overall GPA while only weakly related to time spent studying. The negative relationship between Facebook use and academic performance has been found in countries outside the United States as well (Karpinski, Kirschner, Ozer, Mellott, & Ochwo, 2013). Because all of these Internet-based activities are now easily accomplished with a cell phone, there is a need to expand our understanding of CPUse beyond calling and texting. Current and future studies should operationalize CPUse to consider a wider range of activities.

1.2. Academic performance, anxiety, and Satisfaction with Life

To our knowledge, very little research if any, has explored the possible relationship between CPUse and measures of subjective well-being such as one's Satisfaction with Life; although, a relationship has been suggested in commentary published in the Journal of the American Medical Association (Spiegelman & Detsky, 2008). Certainly, much cell phone marketing hinges upon the assumption that CPUse increases subjective well-being or happiness. However, if CPUse is negatively related to academic performance and positively related to anxiety then it may have an indirect, negative influence on life satisfaction. Life satisfaction, as first described by Shin and Johnson (1978), "refers to a judgmental process in which individuals assess the quality of their lives on the basis of their own unique set of criteria" (Pavot & Diener, 1993, p. 164). The most widely used measure of life satisfaction is the "Satisfaction with Life Scale" developed by Diener, Emmons, Larsen, and Griffin (1985). Since its introduction, it has been used in hundreds of studies and a variety of clinical settings. Two comprehensive reviews of the scale's utility by Pavot and Diener (1993, 2008) suggest it is predictive of various life outcomes including physical and mental health, longevity, marital satisfaction, stronger social relationships, reduced risk of suicide, and alcohol and chemical abuse. Furthermore, and to the point of the current study, research suggests that judgments of life satisfaction are influenced by success or failure in important life domains. For university students, an important life domain influential in judgments of life satisfaction is academic performance (Pavot & Diener, 2008; Schimmack, Diener, & Oishi, 2002). In addition, research suggests measures of negative affect such as distress and anxiety are negatively related to life satisfaction among non-clinical populations (Arrindell, Meeuwesen, & Huyse, 1991; Pavot & Diener, 1993) including college students (Asberg, Bowers, Renk, & McKinney, 2008).

1.3. Research questions and hypotheses

Considering the existing research, as well as the unpublished interview data presented in the introduction of this paper, there is reason to suspect that CPUse, academic performance, anxiety, and Satisfaction with Life may be related. Furthermore, because of the cell phone's expanding capabilities, there is a need to consider other uses besides calling and texting such as Internet and software-based applications. Therefore, the two main research questions (RQs) were: (1) What is the relationship between total cell phone use (CPUse), Academic Performance (actual GPA), Anxiety, and Satisfaction with Life (SWL)?, and (2) What is the relationship between Texting, Academic Performance (actual GPA), Anxiety, and Satisfaction with Life (SWL)? As such, the following hypotheses (H1 = RQ 1; H1 = RQ 2; see below) were investigated (see Fig. 1):

(RQ 1 – H1). CPUse will have a negative relationship with GPA and a positive relationship with anxiety. GPA will be positively related to SWL and anxiety will be negatively related to SWL.

(RQ 2 – H1). Texting will have a negative relationship with GPA and a positive relationship with anxiety. GPA will be positively related to SWL and anxiety will be negatively related to SWL.

2. Methodology

2.1. Participants and procedures

Participants were undergraduate college students from a large, Midwestern US public university. A key variable in this study was academic performance which the researchers objectively assessed using participants' actual, cumulative college Grade Point Average (GPA). Because these are sensitive data, and collecting them involves accessing participants' official academic records, participants needed assurance that data collection, storage, and reporting would guarantee confidentiality and anonymity. Thus, participants were recruited during class time from courses which typically attract students from a diversity of undergraduate majors. Representative courses include Introduction to Sociology, General Biology, American Politics, Human Nutrition, and World History. As such, the principal investigators (PIs) visited classrooms across campus and explained the study methods to all students present. At this time, the PIs answered questions, addressed concerns, and ensured that the study's informed consent document was read, understood, and signed by those wishing to participate. After this, a survey was distributed and completed during class by all students who consented to participate. On the survey, students provided their university e-mail address which was later used to access their academic records. If students did not consent to have their GPA retrieved, they did not participate in the study. Using this method, 536 undergraduate students (n = 370 females) participated in the study.

2.2. Measures

The survey was constructed of seven separate sections; however, for this study, only four sections were used: (1) demographic information, (2) the Satisfaction with Life Scale (SWLS; Diener et al., 1985), (3) the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988), and (4) questions about cell phone and texting use (Lepp et al., 2013). In addition, academic performance was measured using each participant's actual, cumulative GPA accessed through official university records.

Demographic information included questions about sex, age, and year in college. The SWLS contains five statements about general life satisfaction (i.e., subjective well-being) using a 7-point Likert scale from "Disagree Strongly" (Coded 1) to "Agree Strongly" (Coded 7; Range = 7– 35). Higher scores on this measure indicate more life satisfaction, with a score of 20 representing the neutral point on the scale (i.e., equally satisfied and dissatisfied). Previous research demonstrates the SWLS has strong internal consistency (Coefficient Alpha = .87) and good test–retest reliability (r = .82; Diener et al., 1985). Several other studies have demonstrated similar psychometric properties (e.g., Alfonso, Allison, Rader, & Gorman, 1996; Yardley & Rice, 1991). Likewise, the SWLS performed well with this study's sample of undergraduate students (Coefficient Alpha = .84, N = 536).

The BAI contains 21 items assessing anxiety severity in adults. These items are a list of common symptoms of anxiety in which participants are asked to indicate how much they are bothered by that symptom on a 4-point Likert scale from "Not At All" (Coded

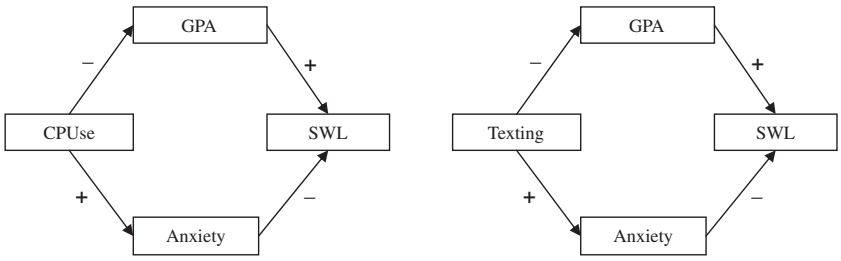

Fig. 1. Proposed conceptual framework using path analysis, which is the analysis of several multiple regression equations simultaneously using observed variables (i.e., denoted by the rectangles in the figure). The signs indicate the hypothesized relationships between the variables.

0) to "Severely" (Coded 3; Range = 0–63). Representative items include "Unable to relax," "Fear of worst happening," "Heart pounding/racing," and "Feeling nervous." Higher scores on this measure indicate greater levels of anxiety with scores between 30 and 63 indicating severe anxiety. Previous research demonstrates the BAI has strong internal consistency (Coefficient Alpha = .92) and good test–retest reliability (r = .75; Beck et al., 1988). The BAI has proven to be a valid measure of anxiety with undergraduate students (e.g., Creamer, Foran, & Bell, 1995; Fydrich, Dowdall, & Chambless, 1992; Hewitt & Norton, 1993). Likewise, the scale performed well with this study's undergraduate students (Coefficient Alpha = .92, N = 536).

The questions examining CPUse consisted of two parts: (1) total CPUse, and (2) texting using cell phones. The total cell phone question stated the following: "As accurately as possible, please estimate the total amount of time you spend using your mobile phone each day. Please consider all uses *except* listening to music. For example, consider calling, texting, Facebook, e-mail, sending photos, gaming, surfing the Internet, watching videos, and all other uses driven by 'apps' and software" (Lepp et al., 2013). Participants were then asked to fill in a blank for hours of CPUse per day and minutes per day (Total Minutes Per Day = Hours * 60 + Minutes). The texting question was as follows: "As accurately as possible, please estimate the total number of text messages that you send and receive each day." Again, participants filled in two blanks – one for texts sent and one for texts received. These two texting items were nearly perfectly correlated (Pearson correlation = .988). Content validity was considered when creating the CPUse and texting questions. That is, two focus groups of undergraduate students reviewed these questions for several validity criteria including: (1) clarity in wording, (2) relevance of the items, (3) use of standard English, (4) absence of biased words and phrases, (5) formatting of items, and (6) clarity of the instructions (Fowler, 2002). Most students provided feedback from the criteria categories of 1, 2, 3, and 6. Appropriate alterations were made to the survey based upon the responses and suggestions.

2.3. Data analysis

Descriptive statistics were used to examine the demographic data using Statistical Package for the Social Sciences (SPSS) for Windows Version 18.0. Additionally, Pearson correlations between the main variables of interest were examined prior to the path analysis, and two Multivariate Analysis of Variances (MANOVAs) were conducted to determine the influence of sex and the interaction effect of sex and CPUse/texting on GPA, anxiety, and SWL. For the path analyses (i.e., the main RQs), LISREL 8.80 Edition was used. Regarding sample size and power, Kline (1998) recommends that the sample size should be 10 times (or ideally 20 times) as many cases as parameters, and at least 200, to have sufficient power. For all the models, there were a total of eight free parameters that were estimated (i.e., four path coefficients, three equation error variances, and one independent variable variance). Thus, a sample size of at least 80 people was needed. Other research has stated that to have confidence in the goodness-of-fit test, a minimum sample size of 100–200 is recommended (Hoyle, 1995). Additionally, path analysis is an extension of multiple regression, and one recommendation is that N should be $50 + 8(k)$, or $104 + k$ when testing individual predictors (i.e., k is the number of independent variables; Tabachnick & Fidell, 2007). The proposed models have one main independent variable in each. Therefore, we concluded that overall, there were more than enough participants to have sufficient power to conduct analyses.

3. Results

3.1. Descriptive statistics, correlations, and assumption checking

Before conducting any descriptive or inferential statistics, an examination of outliers ($z \pm 2.58$) on the major variables (i.e., CPUse, Texting, GPA, anxiety, and SWL) was conducted. From the master data set (N = 536), two separate data sets were created (i.e., the cell phone data set and the texting data set), and outliers were examined in each. For the cell phone data set and texting data set, 40 (N = 496) and 46 (N = 490) cases were removed, respectively. The average age in the cell phone data set (M = 20.48, SD = 2.49) was approximately equal to the texting data set (M = 20.50, SD = 2.49). The majority of respondents in both data sets were female (n = 339 and n = 335, cell phone and texting data sets, respectively). Eighty-two different self-reported majors (including a small amount of undecided majors) were sampled. Additionally, there were approximately equal amounts of participants in each class between the data sets: Freshmen (n = 123 and n = 119), Sophomores (n = 129 for both), Juniors (n = 134 for both), and Seniors (n = 110 and n = 108).

Descriptive statistics for all the major variables are presented in Table 1. On average, students reported spending 278.67 (SD = 218.00) minutes per day using their cell phones, and sending 76.68 (SD = 74.54) text messages per day. Mean GPAs for both data sets were just above 3.00 (SD = .59). Additionally, averages for both data sets indicate mild anxiety levels (Range = 8–15; Beck et al., 1988), and higher levels of life satisfaction (Range = 26–30; Diener et al., 1985). Tables 2 and 3 include the zero-order Pearson correlations between the variables for the two data sets (i.e., CPUse and Texting). The hypothesized correlations between the major variables were in the expected direction and statistically significant ($p < .05$). The correlations between CPUse and SWL, Texting and SWL, and GPA and anxiety were not statistically significant ($p > .05$).

Table 1
Descriptive statistics for the major variables in the cell phone data set ($N = 496$) and texting data set ($N = 490$).

Variables	Cell phone				Texting			
	M	SD	Min	Max	M	SD	Min	Max
CPUse	278.67	218.00	0.00	915.00	–	–	–	–
Texting	–	–	–	–	76.68	74.54	0.00	450.00
GPA	3.06	.59	1.46	4.00	3.05	.59	1.46	4.00
Anxiety	14.50	9.40	0.00	42.00	14.36	9.36	0.00	42.00
SWL	26.38	5.13	12.00	35.00	26.38	5.12	12.00	35.00

Note. CPUse = cell phone minutes per day, Texting = texts sent per day, GPA = Grade Point Average, Anxiety = Total Beck Anxiety Inventory (BAI) score, SWL = Total Satisfaction with Life Scale score.

Table 2
Pearson correlations between the variables for research question 1 ($N = 496$).

Variable	1	2	3	4
1. CPUse	–	−.203***	.096*	.012
2. GPA		–	.004	.207***
3. Anxiety			–	−.221***
4. SWL				–

Note. CPUse = cell phone minutes per day, GPA = Grade Point Average, Anxiety = Total Beck Anxiety Inventory (BAI) score, SWL = Total Satisfaction with Life Scale score.
* $p < .05$.
*** $p < .001$.

Table 3
Pearson correlations between the variables for research question 2 ($N = 490$).

Variable	1	2	3	4
1. Texting	–	−.098*	.093*	−.010
2. GPA		–	−.007	.209***
3. Anxiety			–	−.207***
4. SWL				–

Note. Texting = texts sent per day, GPA = Grade Point Average, Anxiety = Total Beck Anxiety Inventory (BAI) score, SWL = Total Satisfaction with Life Scale score.
* $p < .05$.
*** $p < .001$.

The assumption of normality was examined in both data sets before conducting the path analyses. Some variables were found to be nonnormal. When data are nonnormal, the estimators of standard errors and model fit indices may not be accurate (Schumacker & Lomax, 2010). Therefore, it is recommended that one of the distribution free or weighted estimation procedures is used (Lomax, 1989). Thus, the path analyses were run using the Weighted Least Squares (WLS) method of estimation with the Asymptotic Covariance Matrix, which does not require that normality be satisfied.

Finally, previous research has shown sex to be a moderator in the relationship between CPUse and other variables of interest (Beranuy et al., 2009; Jenaro et al., 2007; Pierce, 2009; Walsh, White, Cox, & Young, 2011). Therefore, the influence of sex was examined prior to conducting the path analyses. Two two-factor fixed effects MANOVAs were used to examine the influence of sex and the interaction effect of sex and CPUse/texting on the dependent variables of GPA, anxiety, and SWL. CPUse and texting were divided into even tertiles. CPUse cut points were at 150 min per day and 300 min per day, and texting cut points were at 30 texts sent per day and 80 texts sent per day. In the first MANOVA (i.e., CPUse, $N = 496$), the homogeneity of covariance assumption was met ($p > .05$), and the homogeneity of variance assumption was upheld ($p > .01$). The multivariate main effect for sex was statistically significant ($p < .001$). The multivariate interaction effect of sex and CPUse was not statistically significant (Wilks' $\Lambda = .986$, $F = 1.170$, $df = 6, 976$, $p = .320$). In the second MANOVA (i.e., texting, $N = 490$), the homogeneity of covariance assumption was met ($p > .05$), and the homogeneity of variance assumption was also upheld ($p > .05$). The multivariate main effect for sex was statistically significant ($p < .001$). The multivariate interaction effect for sex and texting was not statistically significant (Wilks' $\Lambda = .976$, $F = 1.979$, $df = 6, 964$, $p = .066$). In all, there were no significant interactions between CPUse and sex or texting and sex on the main variables of interest (i.e., GPA, anxiety, and SWL). Thus, sex was not included in the following path analyses.

3.2. RQ 1: path analysis – cell phone use

Results of the path models for RQs 1 and 2 are presented in Table 4. For the total CPUse model, all paths were significant ($p < .05$) and in the hypothesized direction. The reported path coefficients are standardized regression coefficients (i.e., beta weights), which can be used to compare the relative influence of variables in the model. As can be seen in Fig. 2, the largest standardized path coefficient was −.22 from anxiety to SWL. The relative influence of GPA on SWL and CPUse on GPA were similar with standardized path coefficients of .21 and −.20 respectively. In addition, 9.58% of variability in SWL can be explained by GPA and anxiety.

The χ^2 global fit index was not significant meaning that there is no difference between the sample data and the theoretical model

Table 4
Weighted least squares estimates and selected fit indices for the cell phone ($N = 496$) and texting ($N = 490$) models.

Description	Cell phone	Texting
Paths		
CPUse → GPA	−.20***	–
Texting → GPA	–	−.10*
CPUSe → Anxiety	.10*	–
Texting → Anxiety	–	.09*
GPA → SWL	.21***	.21***
Anxiety → SWL	−.22***	−.21***
Equation error variances		
GPA	.96	.99
Anxiety	.99	.99
SWL	.90	.91
Selected fit indices		
X^2	3.57	.46
Root-mean-square error of approximation (RMSEA)	.04	.00
Standardized root-mean-square residual (SRMR)	.03	.01
Goodness-of-fit index (GFI)	1.00	1.00
Adjusted goodness-of-fit index (AGFI)	.99	1.00

Note. For the paths, the standardized estimates are reported. CPUse = cell phone minutes per day, Texting = texts sent per day, GPA = Grade Point Average, Anxiety = Total Beck Anxiety Inventory (BAI) score, SWL = Total Satisfaction with Life Scale score.
* $p < .05$.
*** $p < .001$.

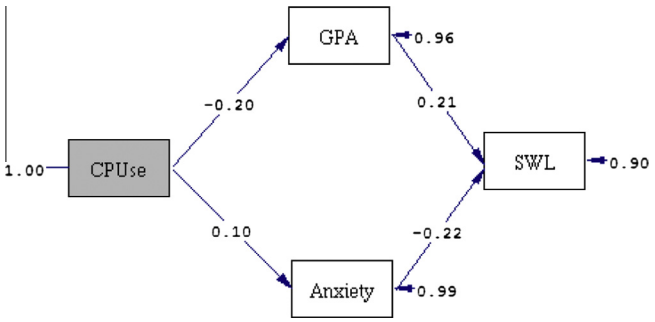

Fig. 2. Cell phone model with standardized coefficients.

(χ^2 = 3.57, *df* = 2, *p* = .168). The root-mean-square error of approximation (RMSEA) was .04, which is a measure of global fit. Values less than or equal to .05 are considered acceptable (Schumacker & Lomax, 2010). The standardized root-mean-square residual (SRMR) was .03, with the same interpretation as the RMSEA. Therefore, this model fit index also indicates a good fit. Finally, the goodness-of-fit index (GFI) was 1.00 and the adjusted goodness-of-fit index (AGFI) was .99. Values at or above .95 are considered acceptable and indicate a good fit. Overall, all model fit indices suggest a good fit, and there were no suggested modifications for subsequent models.

3.3. RQ 2: path analysis – texting

For the texting model, again all paths were significant in the model ($p < .05$) and in the hypothesized direction. The largest standardized path coefficients were −.21 from anxiety to SWL and .21 from GPA to SWL (see Fig. 3). Additionally, 8.60% of variability in SWL can be explained by GPA and anxiety. The χ^2 global fit index was not significant (χ^2 = .46, *df* = 2, *p* = .794). The RMSEA was 0, the SRMR was .01, and the GFI and AGFI were 1.00. As with the cell phone model, all fit indices suggest a good fit, and no modifications for other models were suggested.

4. Discussion

The purpose of this study was to examine the influence of two measures of CPUse (Total CPUse and Texting) on Academic Performance (GPA), anxiety, and in turn, Satisfaction with Life (SWL). The results indicated that two conceptually identical models utilizing both measures of CPUse had good overall fit. In both models, CPUse was negatively related to GPA and positively related to anxiety. Following this, GPA was positively related to SWL while anxiety was negatively related to SWL. Although causal inference is limited, these models identified a negative relationship between CPUse and SWL (subjective well-being or happiness). The relationship between CPUse and SWL was mediated through GPA and anxiety. Thus, for the population studied, high frequency cell phone users tended to have lower GPA, higher anxiety, and lower Satisfaction with Life relative to their peers who used the cell phone less often.

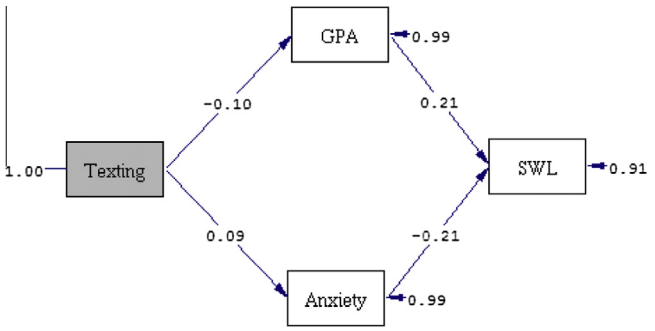

Fig. 3. Texting model with standardized coefficients.

As such, this study makes several important contributions. First, using this study's more holistic measure of total CPUse and objectively measured GPA, these results extend previous research suggesting a negative relationship between CPUse and academic performance. It may be that high frequency cell phone users, in comparison to low frequency users, spend less time focused on academic pursuits (i.e., attending class, completing homework assignments, and studying) because a larger portion of their time is consumed by CPUse. Previous research has already suggested that high frequency cell phone users are less physically active and more sedentary than low frequency users as a result of the cell phone's "ever-present invitation to sit and play" (Lepp et al., 2013, p. 7). For some students, cell phones may present a similarly tempting distraction from school work. A complementary explanation is that high frequency users are more likely to use the phone during academic pursuits such as attending class and studying. In other words, high frequency users are more likely to be multitasking and task switching while in class or studying and these behaviors are known to lower academic performance (Jacobsen & Forste, 2011; Junco & Cotton, 2011, 2012; Rosen, Carrier et al., 2013; Wood et al., 2012).

Second, this is the first study to link CPUse with a validated measure of anxiety across a wide range of cell phone users. Previous research limited the association to problematic users (Jenaro et al., 2007). Within this sample of typical college students, as CPUse increased so did anxiety. Interview data collected by the authors during an earlier study and presented in this paper's introduction, as well as work by Merlo (2008), suggest that some cell phone users may experience anxiety as a result of a perceived and perhaps overwhelming obligation to remain constantly connected to various social networks through their phones. Because the cell phone is ever-present, it may be difficult for some users to disconnect and find the solitude necessary to temporarily escape these perceived obligations. Occasional solitude can be an important component of well-being and an antidote to the pressures of daily life (Heintzman & Mannell, 2003).

Third, this research identified a mediated relationship between CPUse and subjective well-being (happiness) as measured by the Satisfaction with Life Scale (SWLS; Diener et al., 1985). Previous research has demonstrated that the SWLS is predictive of various life outcomes including physical and mental health, longevity, marital satisfaction, stronger social relationships, reduced risk of suicide, and alcohol and chemical abuse (Pavot & Diener, 1993, 2008). Identification of this mediated relationship should provide reason for high frequency cell phone users to critically reflect on their cell phone habits. Certainly more research is needed and there are likely to be other variables which mediate this relationship. For example, Konopack and McAuley (2012) identified an efficacy mediated relationship between physical activity and the SWLS while our research group identified a relationship between CPUse, physical activity, and sedentary behavior (Lepp et al., 2013). Thus, the CPUse, physical activity, SWL relationship may be a fruitful path for future research. Likewise, variables which measure social connectedness and relationship status may also mediate the relationship between CPUse and SWL.

While these contributions are novel, there are limitations to consider. Namely, the sample consisted of only college students enrolled at a single, large, public university in the Midwestern United States. While research suggests that college students across the United States use their cell phones similarly (Smith, Raine, &

Zickuhr, 2011) and that the device is an important aspect of this generation's culture and identity (Palfrey & Gasser, 2008), our ability to generalize these results to other populations is limited. Therefore, future research should include college students from different types of universities and from different geographic regions. In addition, the relationships identified in this study should be investigated in younger students including high school and junior high school as CPUse is increasingly common among these populations. Finally, the relationship between CPUse, anxiety and SWL should be studied in non-student populations and among diverse ethnicities and socioeconomic groups.

Nevertheless, this research has important practical implications, particularly for higher education administrators, campus health professionals, teachers and students. Policies regarding the appropriate use of cell phones in educational settings need to be carefully considered. There is growing evidence that college students' cell phone use is negatively associated with academic performance as well as mental and physical health (Lepp et al., 2013). Thus, the development and testing of interventions designed to reduce college students' cell phone use is warranted. Cell phone usage behaviors can be changed. For instance, research by Clayton, Helms, and Simpson (2006) found that simple prompting procedures (i.e., highly visible signs reading "Please Hang Up, I Care") significantly reduced cell phone use while driving relative to a pre-intervention baseline. On college campuses, testing the efficacy of interventions aimed at reducing cell phone use in the classroom would be a logical starting point. Certainly, the modern cell phone is a tremendous technology with the potential to improve educational outcomes, student health, and well-being. In order to realize this potential, there is a need for research that will identify the most appropriate uses of this technology. However, until these relationships are better understood, students should be encouraged to monitor their CPUse and reflect upon it critically so that it is not detrimental to their academic performance, mental health, and subjective well-being or happiness.

References

Alfonso, V. C., Allison, D. B., Rader, D. E., & Gorman, B. S. (1996). The extended Satisfaction with Life Scale: Development and psychometric properties. *Social Indicators Research, 38*(3), 275–301.

Arrindell, W. A., Meeuwesen, L., & Huyse, F. J. (1991). The Satisfaction with Life Scale (SWLS): Psychometric properties in a non-psychiatric medical outpatient sample. *Personality and Individual Differences, 12*, 117–123.

Asberg, K. K., Bowers, C., Renk, K., & McKinney, C. (2008). A structural equation modeling approach to the study of stress and psychological adjustment in emerging adults. *Child Psychiatry and Human Development, 39*, 481–501.

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology, 56*, 893–897.

Beranuy, M., Oberst, U., Carbonell, X., & Chamarro, A. (2009). Problematic Internet and mobile phone use and clinical symptoms in college students: The role of emotional intelligence. *Computers in Human Behavior, 25*, 1182–1187.

Bianchi, A., & Phillips, J. G. (2005). Psychological predictors of problem mobile phone use. *CyberPsychology & Behavior, 8*, 39–51.

Chen, Y. F., & Peng, S. S. (2008). University students' Internet use and its relationships with academic performance, interpersonal relationships, psychosocial adjustment, and self-evaluation. *CyberPsychology & Behavior, 11*(4), 467–469.

Chen, S. Y., & Tzeng, J. Y. (2010). College female and male heavy Internet users' profiles of practices and their academic grades and psychosocial adjustment. *Cyberpsychology, Behavior, and Social Networking, 13*(3), 257–262.

Clayton, M., Helms, B., & Simpson, C. (2006). Active prompting to decrease cell phone use and increase seat belt use while driving. *Journal of Applied Behavior Analysis, 39*(3), 341–349.

Creamer, M., Foran, J., & Bell, R. (1995). The Beck Anxiety Inventory in a nonclinical sample. *Behavioral Research and Therapy, 33*(4), 477–485.

Diener, E., Emmons, R., Larsen, J., & Griffin, S. (1985). The Satisfaction with Life Scale. *Personality Assessment, 49*(1), 71–75.

Fowler, F. J. Jr., (2002). *Survey research methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Fydrich, T., Dowdall, D., & Chambless, D. L. (1992). Reliability and validity of the Beck Anxiety Inventory. *Journal of Anxiety Disorders, 6*, 55–61.

Ha, J. H., Chin, B., Park, D. H., Ryu, S. H., & Yu, J. (2008). Characteristics of excessive cellular phone use in Korean adolescents. *CyberPsychology & Behavior, 11*(6), 783–784.

Heintzman, P., & Mannell, R. C. (2003). Spiritual functions of leisure and spiritual well-being: Coping with time pressure. *Leisure Sciences: An Interdisciplinary Journal, 25*, 207–230.

Hewitt, P. L., & Norton, G. R. (1993). The Beck Anxiety Inventory: A psychometric analysis. *Psychological Assessment, 5*, 408–512.

Hong, F. Y., Chiu, S. I., & Hong, D. H. (2012). A model of the relationship between psychological characteristics, mobile phone addiction and use of mobile phones by Taiwanese university female students. *Computers in Human Behavior, 28*, 2152–2159.

Hoyle, R. H. (1995). *Structural equation modeling*. Thousand Oaks, CA: Sage Publications.

Jackson, L. A., von Eye, A., Fitzgerald, H. E., Witt, E. A., & Zhao, Y. (2011). Internet use, videogame playing and cell phone use as predictors of children's body mass index (BMI), body weight, academic performance, and social and overall self-esteem. *Computers in Human Behavior, 27*, 599–604.

Jackson, L. A., von Eye, A., Witt, E. A., Zhao, Y., & Fitzgerald, H. E. (2011). A longitudinal study of the effects of Internet use and videogame playing on academic performance and the roles of gender, race and income in these relationships. *Computers in Human Behavior, 27*, 228–239.

Jacobsen, W. C., & Forste, R. (2011). The wired generation: Academic and social outcomes of electronic media use among university students. *Cyberpsychology, Behavior, and Social Networking, 14*(5), 275–280.

Jenaro, C., Flores, N., Gómez-Vela, M., González-Gil, F., & Caballo, C. (2007). Problematic internet and cell-phone use: Psychological, behavioral, and health correlates. *Addiction Research & Theory, 15*, 309–320.

Junco, R. (2012a). The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement. *Computers & Education, 58*(1), 162–171.

Junco, R. (2012b). Too much face and not enough books: The relationship between multiple indices of Facebook use and academic performance. *Computers in Human Behavior, 28*(1), 187–198.

Junco, R., & Cotton, S. R. (2011). Perceived academic effects of instant messaging use. *Computers & Education, 56*, 370–378.

Junco, R., & Cotton, S. R. (2012). No A 4 U: The relationship between multitasking and academic performance. *Computers & Education, 59*, 505–514.

Karpinski, A. C., Kirschner, P. A., Ozer, I., Mellott, J. A., & Ochwo, P. (2013). An exploration of social networking site use, multitasking, and academic performance among United States and European university students. *Computers in Human Behavior, 29*(3), 1182–1192.

Kirschner, P. A., & Karpinski, A. C. (2010). Facebook and academic performance. *Computers in Human Behavior, 26*(6), 1237–1245.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York, NY: The Guilford Press.

Konopack, J. F., & McAuley, E. (2012). Efficacy-mediated effects of spirituality and physical activity on quality of life: A path analysis. *Health and Quality of Life Outcomes, 10*, 57. URL: <http://www.hqlo.com/content/10/1/57>.

Lepp, A., Barkley, J. E., Sanders, G. J., Rebold, M., & Gates, P. (2013). The relationship between cell phone use, physical and sedentary activity, and cardiorespiratory fitness in a sample of US college students. *International Journal of Behavioral Nutrition and Physical Activity, 10*, 79. URL: <http://www.ijbnpa.org/content/10/1/79>.

Lomax, R. G. (1989). Covariance structure analysis: Extensions and developments. In B. Thompson (Ed.). *Advances in social science methodology* (Vol. 1, pp. 171–204). Greenwich, CT: JAI.

Lu, X., Watanabe, J., Liu, Q., Uji, M., Shono, M., & Kitamura, T. (2011). Internet and mobile phone text-messaging dependency: Factor structure and correlation with dysphoric mood among Japanese adults. *Computers in Human Behavior, 27*, 1702–1709.

Merlo, L. (2008). Increased cell phone use may heighten symptoms of anxiety. *Primary Psychiatry, 15*(5), 27–28.

Palfrey, J., & Gasser, U. (2008). *Born digital: Understanding the first generation of digital natives*. New York (NY): Basic Books.

Pavot, W., & Diener, E. (1993). Review of the Satisfaction with Life Scale. *Psychological Assessment, 5*(2), 164–172.

Pavot, W., & Diener, E. (2008). The Satisfaction with Life Scale and the emerging construct of life satisfaction. *The Journal of Positive Psychology, 3*(2), 137–152.

Pierce, T. (2009). Social anxiety and technology: Face-to-face communication versus technological communication among teens. *Computers in Human Behavior, 25*, 1367–1372.

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.

Rosen, L. D., Whaling, K., Rab, S., Carrier, L. M., & Cheever, N. A. (2013). Is Facebook creating "iDisorders"? The link between clinical symptoms of psychiatric disorders and technology use, attitudes and anxiety. *Computers in Human Behavior, 29*, 1243–1254.

Sánchez-Martínez, M., & Otero, A. (2009). Factors associated with cell phone use in adolescents in the community of Madrid (Spain). *CyberPsychology & Behavior, 12*, 131–137.

Schimmack, U., Diener, E., & Oishi, S. (2002). Life-satisfaction is a momentary judgment and a stable personality characteristic: The use of chronically accessible and stable sources. *Journal of Personality, 70*, 345–384.

Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling* (3rd ed.). New York, NY: Routledge, Taylor & Francis Group.
Shin, D. C., & Johnson, D. M. (1978). Avowed happiness as an overall assessment of the quality of life. *Social Indicators Research, 5*, 475–492.
Smith, A., Raine, L., & Zickuhr, K. (2011). *College students and technology*. The Pew Research Center's Internet and American Life Project. <http://www.pewinternet.org/Reports/2011/College-students-and-technology.aspx>.
Spiegelman, J., & Detsky, A. S. (2008). Instant mobile communication, efficiency, and quality of life. *JAMA, 299*(10), 1179–1181.
Stollak, M. J., Vandenberg, A., Burklund, A., & Weiss, S. (2011). Getting social: The impact of social networking usage on grades among college students. In Proceedings from ASBBS annual conference (pp. 859–865).
Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson/Allyn & Bacon.
Takao, M., Takahashi, S., & Kitamura, M. (2009). Addictive personality and problematic mobile phone use. *CyberPsychology & Behavior, 12*, 501–507.
United States v. Kramer (2011). United States Court of Appeals: 8th Circuit. Vol. 631. Federal 3d page 900.
Walsh, S., White, K., Cox, S., & Young, R. (2011). Keeping in constant touch: The predictors of young Australians' mobile phone involvement. *Computers in Human Behavior, 27*, 333–342. http://dx.doi.org/10.1016/j.chb.2010.08.011.
Wood, E., Zivcakova, L., Gentile, P., Archer, K., De Pasquale, D., & Nosko, A. (2012). Examining the impact of off-task multi-tasking with technology on real-time classroom learning. *Computers & Education, 58*, 365–374.
Yardley, J. K., & Rice, R. W. (1991). The relationship between mood and subjective well-being. *Social Indicators Research, 24*, 101–111.
Yen, C., Tang, T., Yen, J., Lin, H., Huang, C., & Liu, S. (2009). Symptoms of problematic cellular phone use, functional impairment and its association with depression among adolescents in Southern Taiwan. *Journal of Adolescence, 32*, 863–873.