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The mediating and buffering effect of academic self-efficacy on the relationship between smartphone addiction and academic procrastination

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ABSTRACT

To understand the relationship between smartphone addiction and academic procrastination and the mechanisms at work within this relationship, this study constructs a mediation model to examine the impact of college students' smartphone addiction on their academic procrastination and the mediation effect of academic self-efficacy. A total of 483 college students were surveyed using the *Smartphone Addiction Scale—Short Version*, *College Academic Self-Efficacy Scale* and *Tuckman Academic Procrastination Scale*. Correlation analysis showed that smartphone addiction was positively related to academic procrastination while being negatively related to academic self-efficacy. At the same time, academic self-efficacy and academic procrastination were negatively related. Further, mediation analysis using the PROCESS plugin in SPSS showed that smartphone addiction has a direct predictive effect on students' academic procrastination and an indirect predictive effect via academic self-efficacy after controlling for age, gender, and academic year. Specifically, academic self-efficacy was found to be a partial mediator and play a buffering role between smartphone addiction and academic procrastination.

1. Introduction

The multifunctionality of the smartphone has led to its increasing popularity and made it an indispensable part of life. According to a survey by the Pew Research Center (2015), 46% of U.S. smartphone owners believed that they could not go on living without their smartphone, and 93% of young adults (18–29 years old) said that they used smartphone at least once during learning time to avoid boredom. In addition, the percentage of adult smartphone owners exploded rapidly from 35% to 64% in the three-year period from 2011 to 2014 in the U.S. (Pew Research Center, 2015). Similarly, a Korean report in 2011 indicated that smartphone users in Korea were estimated to number over 20 million (Kwon, Lee et al., 2013), nearly half the population. By August 2019, the number of Internet users in China had reached 854 million, and 99.1% of them used their smartphone as an Internet-access device (China Internet Information Center, 2019).

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The prevalence of smartphones has made modern life much more efficient and convenient. However, their excessive use has also brought many health, social, and academic challenges (Choi et al., 2015; Khoury et al., 2019; Kwon, Kim, Cho, & Yang, 2013; Lee, Cho, Kim, & Noh, 2015; Samaha & Hawi, 2016). For instance, smartphone overuse sometimes can be unhealthy or even dangerous: mobile-phone use while driving can be a factor leading to fatal car crashes (Pennay, 2006). In another study, 35.9% of 688 undergraduates reported that they felt tired in the daytime because of their smartphone use at late night, 38.1% had decreased sleep quality, and 35.8% slept for less than 4 hours due to excessive smartphone use more than once (Boumosleh & Jaalouk, 2017). Smartphone overuse has also been reported to have negative effects on academic and labour performance. A survey of 517 high-school students found that teens who used their mobile phones while doing homework had lower grades than their counterparts who did not (Pierce & Vaca, 2007). Further, a cross-cultural study (Panek, Khang, Liu, & Chae, 2018) showed that problems resulting from smartphone overuse are not culturally specific.

The popularity of the smartphone and the issues resulting from its overuse have triggered the interest of researchers all over the world. In the literature, the phenomenon of excessive smartphone use is often referred to as "problematic smartphone use," "smartphone addiction," "smartphone addiction proneness," "smartphone dependence," "mobile-phone addiction" or "mobile-phone dependence" (e.g. Al-Barashdi; Bouazza, & Jabur, 2015; Hussain, Griffiths, & Sheffield, 2017; Kim, Lee, Lee, Nam, & Chung, 2014; Park, Kim, Shon, & Shim, 2013; Wang et al., 2018). In the current study, the term "smartphone addiction" is used. This is because "smartphone" emphasizes the multifunctionality of the cell phone, a feature which makes it addictive for humans, while the term "mobile phone" does not. Also, "addiction" is more severe than "dependence" and more accurate for the purpose of the present study.

According to the existing literature, many students suffer from uncontrolled procrastination in their learning life, and problematic smartphone use has been presumed to be a reason (e.g. Rozgonjuk; Kattago, & Taht, 2018; Ryan, Reece, Chester, & Xenos, 2016). However, few studies explore the relationship between *smartphone addiction* and students' *academic procrastination*—their tendency to delay learning tasks. In addition, students' *academic self-efficacy*—their feelings of competence in learning—has been frequently found related to their academic procrastination (e.g., Hen & Goroshit, 2014; Klassen; Kuzucu, 2009; Wu & Fan, 2017). Yet, few studies focus on the relationship between smartphone addiction and academic self-efficacy and the possible mediating role of academic self-efficacy between smartphone addition and academic procrastination.

To enhance understanding of the phenomenon of smartphone addiction in the academic setting, the present study explored the relationship between smartphone addiction and academic procrastination and the role of academic self-efficacy in mediating between the two. Meanwhile, three frequently reported factors that might significantly influence the academic self-efficacy and the academic procrastination—age, gender, and academic level—were considered as covariates and controlled in the process. In the following section, the definition of the three constructs, their affecting variables, and the relations between them will be presented.

2. Literature review and hypotheses

2.1. Smartphone addiction

In the past, the scope of *addiction*, or impulsive control disorder, was quite narrow, limited to addiction to substances such as drugs or alcohol, but then the scope has been extended to include non-substance addictions (Griffiths, 1995; Kwon, Lee et al., 2013; Kwon, Lee et al., 2013). One form of non-substance addiction is *behavioural addiction*, impulsive control disorder with a behavioural focus, such as an exercise or shopping addiction (Grant, Potenza, Weinstein, & Gorelick, 2010). *Technology addiction* is a subtype of behavioural addiction, describing the addiction to technological devices such as computers or video games (Griffiths, 1995). *Smartphone addiction* falls in the category of technology addiction. Although researchers have not reached full agreement, the concept is generally defined as an obsessive dependence on smartphones which can result in life discomfort (Al-Barashdi, Bouazza, & Jabur, 2015; Lee et al., 2015). Similar to substance addiction, smartphone addiction is characterized by tolerance, functional impairment, withdrawal symptoms, and compulsive behaviours (Al-Barashdi et al., 2015; Boumosleh; Jaalouk, 2017; Choi et al., 2015; Gökçearslan; Mumcu; Haşlaman, & Çevik, 2016; Lin et al., 2014).

2.2. Academic procrastination

Procrastination refers to a person's inclination to postpone accomplishing important tasks until they feel discomfort (Ferrari, Johnson, & McCown, 1975; Rozgonjuk, Kattago, & Taht, 2018; Solomon & Rothblum, 1984). Procrastination is widespread and has cognitive, emotional, and behavioural dimensions (Geng, Han, Gao, Jou, & Huang, 2018). *Academic procrastination* refers to an inclination to postpone that is irrelated to academic activities such as completion of assignments (Kandemir, 2014; Rabin, Fogel, & Nutter-Upham, 2011; Rothblum, Solomon, & Murakami, 1986; Schouwenburg, 2004).

Many studies have investigated the demographic factors that are related to academic procrastination. The findings on the gender differences in academic procrastination are still inconclusive in the literature (Özer, Demir, & Ferrari, 2009). Some researchers have found that academic procrastination varied across sex and that males are at higher risk to procrastinate in completing assigned learning tasks (Khan, Arif, Noor, & Muneer, 2014; Milgram, Marshevsky, & Sadeh, 1995; Özer, Demir, & Ferrari, 2009; Üniversitesi et al., 2009) . Others, however, found no gender difference with regard to academic procrastination (Beswick, Rothblum, & Mann, 1988; Özer & Ferrari, 2011). A small number of studies have examined the relationship between age and academic procrastination. The extent to which general procrastination varies by age has been controversial (Rabin et al., 2011). Some studies reported that one's tendency to procrastinate decreases with age (Beswick et al., 1988; van Eerde, 2003) while others reported no relations between the two (Haycock, McCarthy, & Skay, 1998; Howell, Watson, Powell, & Buro, 2006). In terms of academic level (grade level or academic year), Rosário

et al. (2009) conducted two survey studies on junior-high students and found that their academic procrastination was significantly positively related to their grade level. In sum, in spite of divergent results, age, gender, and academic level have been reported in the literature as factors affecting academic procrastination.

Few available studies investigate the relationship between academic procrastination and smartphone addiction. However, some studies have focused on the relationship between general procrastination and Internet addiction/problematic smartphone use/problematic Facebook use (e.g. Davis, Flett, & Besser, 2002; Geng et al., 2018; Ryan et al., 2016; Rozgonjuk et al., 2018) or between academic procrastination and problematic Internet use (Odaci, 2011). General procrastination has been found to be positively related to Internet addiction; that is, the more severe the Internet addiction was, the higher the level of procrastination would be (Davis et al., 2002; Geng et al., 2018). Further, procrastination can also increase the risk of problematic smartphone/problematic Facebook use (Rozgonjuk et al., 2018; Ryan et al., 2016). These studies shed light on our understanding of the relations between smartphone addiction and academic procrastination, given the overlap between Internet and smartphone addictions (Khoury et al., 2019; Kwon, Lee, et al., 2013) and between general procrastination and academic procrastination. In other words, it is highly possible that academic procrastination is positively associated with smartphone addiction. Thus, we hypothesize that.

H1. College students' smartphone addiction positively predicts their academic procrastination.

2.3. Academic self-efficacy

Self-efficacy—a concept from Bandura's (1986, 1997) social cognitive theory—refers to one's belief about the capacity to perform or learn in undertaking some specific task. Self-efficacy is domain-specific and context-specific (Bong & Skaalvik, 2003; Schunk & Pajares, 2002). Self-efficacy that is related to academic tasks and performance is called *academic self-efficacy*, which is described as the confidence held by an individual in attaining academic success (Bong & Skaalvik, 2003; Chemers, Hu, & Garcia, 2001; Kandemir, 2014). It is multi-dimensional and related to one's motivation, achievement, emotion, cognition and self-regulation (Bong & Skaalvik, 2003).

Gender, age, and academic level were most frequently reported as factors influencing academic self-efficacy, although the relations to gender and academic level are still contested. A meta-analysis of 187 studies revealed that gender differences in academic self-efficacy slightly favoured males ($d = 0.08$) (Huang, 2013). The researcher also found that this gender difference is domain-specific: females were more confident in language and arts while males felt more competent in mathematics, computers, and social sciences (Huang, 2013). This finding is consistent with many previous studies (Anderman & Young, 1994; Güvercin, Tekkaya, & Sungur, 2010; Pajares, 2002, 2005; Whitley Jr, 1997). As for age, students' academic self-efficacy in science has been reported to decrease with age (Güvercin et al., 2010), but gender differences in academic self-efficacy have been found to increase with age (Huang, 2013; Pajares, 2005). Regarding academic level, some researchers found it significantly negatively related to academic self-efficacy (Güngören & Sungur, 2009) while some found the two significantly positively related (Altunsoy, Çimen, Ekici, Atik, & Gökmen, 2010). Notably, some studies also reported no association between academic self-efficacy and gender or academic level (Karaarslan & Sungur, 2011; Oğuz, 2012; Turgut, 2013) and that no interactions existed between academic level and gender in relation to academic self-efficacy (Turgut, 2013).

Few available studies have investigated the relationship between smartphone addiction and academic self-efficacy. A Chinese study showed that smartphone dependence is a good predictor of secondary-vocational-school students' academic self-efficacy, which was defined in the study as self-efficacy regarding one's learning ability and learning behaviour (Yan, Guo, Hu, & Teng, 2018). Odaci (2011) found that academic self-efficacy was negatively related to problematic Internet use. One study investigating the association between academic self-efficacy and Internet use found academic self-efficacy to be a moderator or mediator between problematic Internet use and individual performance (Zhu, Chen, Chen, & Chern, 2011). Given that there is so much overlapping between Internet and smartphone addictions (Khoury et al., 2019; Kwon, Lee, et al., 2013), it is highly possible that smartphone addiction is negatively related to academic self-efficacy. This leads to the following hypothesis:

H2. College students' smartphone addiction negatively predicts their academic self-efficacy.

Many studies reported that academic self-efficacy was negatively associated with academic procrastination (e.g. Hen & Goroshit, 2014; Klassen, Krawchuk, & Rajani, 2008; Klassen & Kuzucu, 2009; Özer, Sackes, & Tuckman, 2013; Wu & Fan, 2017). For instance, Hen and Goroshit (2014) investigated the academic self-efficacy and academic procrastination of 287 undergraduate students and found a negative association between the two variables. Wu and Fan's (2017) study also showed that university students' academic self-efficacy is related to their academic delay, even after controlling for gender, GPA, and academic level. It should be noted that the relation between academic self-efficacy and academic procrastination may not always be negative: one study (Kandemir, 2014) found a positive association between the two variables. One possible explanation is that an overly high level of academic self-efficacy might decrease participants' sensitivity to task delay, which then leads to academic procrastination. Further work is required to investigate the relationship between academic self-efficacy and academic procrastination of different levels. The review on this topic leads to the follow hypothesis:

H3. College students' academic self-efficacy negatively predicts their academic procrastination.

Based on the literature and the three hypotheses above, we further proposed the following hypothesis:

H4. College students' academic self-efficacy plays a mediating and buffering role between smartphone addiction and academic procrastination.

Fig. 1 shows a diagram of the mediation mode proposed in the four hypotheses which depicts the relations between the independent, mediator, and dependent variables, and three covariates.

3. Methodology

3.1. Participants

This research was conducted in a college of science in a public University in Southeast China. The college has 1500 students of six majors at bachelor level. A total of 500 students participated in the research and completed a questionnaire. Cases of incomplete response were removed from the data set, reducing the sample size to 483. The ages of students ranged from 16 to 24, with a mean age of 20.2 (SD: 1.47). Of the respondents, 211 (44%) were male and 272 (56%) were female.

To develop ideas and hypotheses, an exploratory focus-group interview was conducted in the college before the study design was finalized. Most of the interviewees said that they spent too long time on their smartphone and that they frequently used the phone in the class and before sleep. Many said that they used their smartphone to play video games or contact friends using social media apps such as WeChat or QQ. A few of them mentioned that they also used their smartphone for online learning.

3.2. Data collection and instruments

A correlational design was utilized in the present study, and a questionnaire was used as the data collection method. The QR code of the questionnaire was displayed to students at the end of a meeting of their academic year, and those who agreed to participate scanned the code and filled out the questionnaire on their smartphone (A *QR code*, or quick response code, refers to a matrix barcode that can point to a website or, as in this study, to the webpage of a questionnaire). QR codes are commonly used in China to access online functions from a smartphone, such as making payments, paying for subscriptions and opening specific webpages. Paper copies of the questionnaire were also available, although the participants completed their questionnaires online. Consent was obtained from the participating students and the study was explained to them before they filled out the questionnaire.

The questionnaire used in this study was composed of four sections: demographic information, the *Smartphone Addiction Scale-Short Version*, the *College Academic Self-Efficacy Scale*, and *Tuckman's Academic Procrastination Scale*. Demographic information section includes age, gender, and grade. All three scales were originally developed in English and were translated into Chinese for the present study. Back translation was used to increase the accuracy of the translation (Brislin, 1970), that is, one researcher translated the instrument from English to Chinese, then a second researcher translated the Chinese version back to English, and finally a third researcher examined the equivalency between the original English version and the translated Chinese version by comparing the three versions of the instrument (original, translated, and back-translated). Any inequivalence was addressed before data collection.

Smartphone Addiction Scale-Short Version (SAS-SV). Developed by Kwon, Kim, Cho, and Yang (2013), the SAS-SV is a short version of the Smartphone Addiction Scale (SAS, Kwon, Lee et al., 2013). It comprises ten items that assess one's level of smartphone addiction. Possible scores range from 10 to 60. Participants rate themselves on a six-point Likert scale, ranging from 1 - Strongly Disagree to 6 - Strongly Agree. In the present study, the Cronbach's alpha coefficient of the SAS-SV was 0.84.

College Academic Self-Efficacy Scale (CASES). The CASES was developed by Owen (1988) specifically to evaluate the self-efficacy of college students in academic settings. The original questionnaire consists of 33 items. One item, "performing simple math computations," was deleted in the present study because the term "simple math computation" is vague, and ability such as "simple computations" are too easy for most students in the college of science, reducing the total number to 32. Its rating scale was converted from

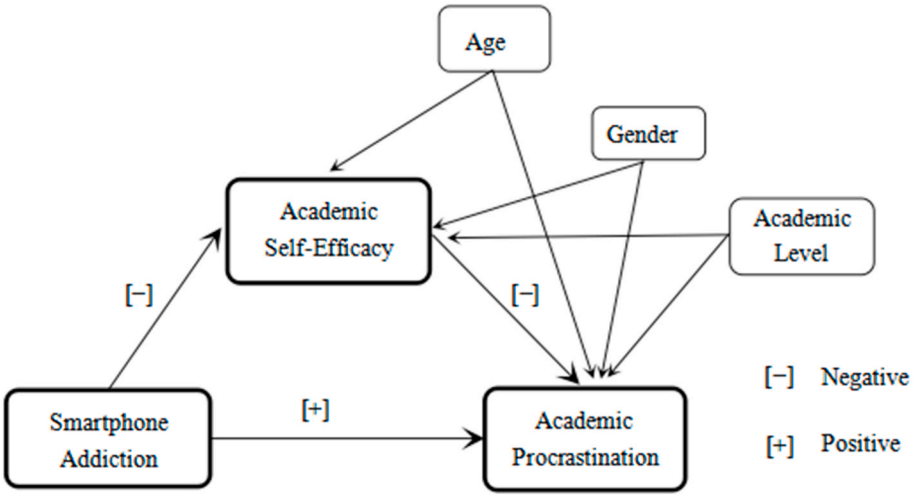

Fig. 1. The relationships examined in the study.

the original five points to six points before administration, ranging from 1 – *Strongly disagree* to 6 – *Strongly agree*. The conversion was made to maintain consistency throughout the questionnaire. Possible scores range from 32 to 192 after point conversion. In the present study, the Cronbach's alpha coefficient of the CASES was 0.93.

Tuckman's Academic Procrastination Scale. Developed by Tuckman (1991), this scale comprises 16 questions and measures one's level of academic procrastination behaviours. Its rating scale was also converted from the original four points to six points before administration to maintain consistency with the other two scales, ranging from 1 – *Strongly disagree* to 6 – *Strongly agree*. Possible scores range from 16 to 96 after point conversion. In the present study, the Cronbach's α of this scale was 0.89.

3.3. Data analysis

SPSS was used to analyze the data. To ensure the validity of data analyses, Harman's single-factor test using principal-component factor analysis was first performed to test the common method bias (CMB). CMB is defined as the artificial co-variance between the dependent variable and the independent variable that is attributable to the measurement method instead of the true relationships between the two types of variables (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Zhou & Long, 2004). To be clearer, using the same type of data source, the same measurement, or the same data collection environment might cause artificial co-variance between the predictor variable and the criterion variable and exert an unreal predictive relationship between the two (Podsakoff et al., 2003; Zhou & Long, 2004). The variance or the faked co-variance that is attributable to CMB is called common method variance (CMV; Podsakoff et al., 2003), which is deemed as one type of systematic error and should be controlled in the research study (Zhou & Long, 2004). All the data in the present study were collected using a self-report questionnaire, in the same environment, and during the same period of time, and thus CMV might be a problem (Podsakoff et al., 2003).

To test the extent of the CMV of the present study and whether it threatened the validity of the data analyses in the present study by generating a large artificial co-variance, Harman's single-factor test using principal-component factor analysis, one of the most widely used CMV-evaluation techniques because of its ease and convenience of use, was employed (Podsakoff et al., 2003; Zhou & Long, 2004). This test was conducted on all the 58 items in the questionnaire associated with the three variables. The results show that 13 factors had Eigen values greater than one. The 13 factors accounted for 62.48% of the total variance, and the first factor only for 25.64% which is far less than 40%, a cutoff value dividing large or small CMV (Li, 2018); since the variance attributable to the first factor is less than 40%, it can be said that no general factor is apparent and that the CMV of the present study is small. In other words, the co-variance between the dependent variable and the independent variable in the present study was largely attributable to their nature not to the measurement method used in the data collection process.

After CMV evaluation, a series of descriptive analyses was carried out to examine the central and dispersion tendency of the data. Then, Pearson product-moment correlation coefficients between variables were calculated to examine the relationships between the independent, the mediator, and the dependent variable. Finally, a mediation analysis conducted using the PROCESS plugin in SPSS was conducted to further test the four hypotheses of the present study.

Table 1
The descriptive statistics of the three variables.

Variable	*N*	*M*	*SD*
SmA	483	34.4	8.67
Male	211	35.2	8.04
Female	272	33.9	9.08
AcaLevel			
1	114	33.1	8.07
2	123	35.4	7.78
3	124	36.4	8.59
4	122	32.7	9.60
AcaSE	483	126	21.7
Male	211	126	21.5
Female	272	126	21.9
AcaLevel			
1	114	130	20.6
2	123	122	19.2
3	124	120	21.6
4	122	132	23.0
AcaPro	483	51.5	12.3
Male	211	50.5	11.8
Female	272	52.3	12.5
AcaLevel			
1	114	49.0	12.7
2	123	52.9	11.8
3	124	55.0	12.2
4	122	49.0	11.3

Note: SmA = Smartphone Addiction, AcaSE = Academic Self-Efficacy, AcaPro = Academic Procrastination, AcaLevel = Academic Level, 1 = Freshmen, 2 = Sophomore, 3 = Junior, 4 = Senior.

4. Results

4.1. Descriptive and correlation analysis

The descriptive analyses results of college students' smartphone addiction, academic self-efficacy, and academic procrastination have been summarized in Table 1.

Pearson product-moment correlation coefficients were computed to assess the relations among the three variables. Smartphone addiction was found to be positively and significantly correlated with college students' academic procrastination behaviours ($r = 0.558$, $p < .01$). Smartphone addiction and academic self-efficacy were significantly but negatively correlated ($r = -0.312$, $p < .01$). Significant negative correlation was also found between academic self-efficacy and academic procrastination ($r = -0.571$, $p < .01$). The correlation results are presented in Table 2.

4.2. Mediation analysis

The PROCESS plugin (version 3.3; Hayes, 2019) was used to perform the mediation analysis with smartphone addiction as the independent variable, academic procrastination as the dependent variable, and academic self-efficacy as the mediation variable (model#4). According to the literature review, the three most frequently reported factors affecting the dependent and mediation variable—age, gender, and academic level—were considered as covariates in the present study. In addition, students' academic level—freshmen, sophomore, junior, or senior—was transformed into dummy variables before being entered into the mediation model as covariates. The results (see Table 3) indicate that smartphone addiction significantly predicts academic procrastination ($B = 0.77$, $t = 14.32$, $p < .001$), and the prediction remains significant even when academic self-efficacy is entered ($B = 0.60$, $t = 12.27$, $p < .001$). Smartphone addiction was found to significantly and negatively predict academic self-efficacy ($B = -0.71$, $t = -6.44$, $p < .001$); further, academic self-efficacy was found to significantly and negatively predict academic procrastination ($B = -0.24$, $t = -12.32$, $p < .001$). In addition, both the direct effect of smartphone addiction on academic procrastination and the mediating effect of academic self-efficacy had bootstrap confidence intervals (95%) with no zero between their lower and upper limits (see Table 4). This suggests, after controlling for age, gender, and academic level, both that smartphone addiction can directly predict academic procrastination and that smartphone addiction can predict academic procrastination indirectly via academic self-efficacy. The direct effect (0.60) and the mediation effect (0.17) respectively accounted for 77.84% and 22.16% of the total effect.

When the association between smartphone addiction and academic self-efficacy was examined, the results also showed that academic level contributed to the variance in academic self-efficacy (Table 2). The academic self-efficacy of junior-year students was significantly lower than that of senior-year students ($B = -8.57$, $t = -2.77$, $p < .01$). Table 2 also showed that male students had lower levels of academic procrastination than female students when the association between smartphone addition and academic procrastination was examined ($B = -2.83$, $t = -3.05$, $p < .01$). Moreover, the relatively lower level of academic procrastination of male students was still significant even when academic self-efficacy was entered into the model ($B = -2.49$, $t = -3.08$, $p < .01$).

5. Discussion

5.1. Discussion of the results

The findings of this investigation are in keeping with the hypotheses of the present study and with previous research. First, these results agree with H1 and also the findings of other studies, in which a predictive relation between smartphone addiction and academic procrastination does exist (e.g. Davis et al., 2002; Geng et al., 2018; Rozgonjuk et al., 2018). This finding implies that the individual tends to delay facing difficult tasks yet indulges in entertaining experiences provided by their smartphone (Davis, 2001; Davis et al., 2002; Geng et al., 2018; Odaci, 2011; Rozgonjuk et al., 2018; Ryan et al., 2016). As posited by Davis et al. (2002), tasks in the work or learning setting are usually cognitively stressful, and people tend to avoid such stressful work instinctively by engaging in some type of enjoyable or relaxing activity such as surfing online. Davis (2001) also believed that procrastination is caused by task avoidance resulting from problematic smartphone use. As suggested by Rozgonjuk et al. (2018), problematic smartphone use is one maladaptive strategy for coping with stressful work, which might lead to many dysfunctional behaviours, such as procrastination.

Second, the results of this study are also consistent with H2 and those of other studies that suggested that smartphone addiction negatively predicts one's academic self-efficacy (e.g. Chen, Hsiao, Chern, & Chen, 2014; Odaci, 2011; Yan et al., 2018; Zhu et al., 2011). This result indicates that college students who were more addicted to smartphone use felt less academically competent. A

Table 2
Pearson's *r* of the Three Variables.

Variables	SmA	AcaSE	AcaPro
SmA	1		
AcaSE	-.312**	1	
AcaPro	.558**	-.571**	1

Note: SmA = Smartphone Addiction, AcaSE = Academic Self-Efficacy, AcaPro = Academic Procrastination, *** = $p < .001$.

Table 3
Mediation analysis results for the three variables.

Regression Equation		Fitting Indices				Significance
Outcome Variables	Predictor Variables	*R*	R^2	*F(df)*	*B*	*T*
AcaSE		.36	.13	$11.94_{(6)}$***		
	Age				.12	.09
	Gender					
	M-F				1.42	0.75
	AcaLevel[a]					
	1				-.54	-.10
	2				−7.75	−1.94
	3				−8.57	−2.77**
	SmA				-.71	−6.44***
AcaPro		.71	.50	$67.35_{(7)}$***		
	Age				-.29	-.52
	Gender					
	M-F				−2.49	−3.08**
	AcaLevel[a]					
	1				−1.65	-.73
	2				-.93	-.54
	3				.60	.45
	AcaSE				-.24	−12.32***
	SmA				.60	12.27***
AcaPro		.58	.34	$40.46_{(6)}$***		
	Age				-.32	-.50
	Gender					
	M-F				−2.83	−3.05**
	AcaLevel[a]					
	1				−1.52	-.58
	2				.95	.48
	3				2.68	1.76
	SmA				.77	14.32***

Note: SmA = Smartphone Addiction, AcaSE = Academic Self-Efficacy, AcaPro = Academic Procrastination, ** = $p < .01$, *** = $p < .001$, M-F = male compared with female, AcaLevel = Academic Level, [a] = all grades below compared with senior students, 1 = freshmen, 2 = sophomore, 3 = junior.

Table 4
Total effect, direct effect, and indirect effect among the variables.

	Effect Size	Boot *SE*	Boot CI lower limit	Boot CI upper limit	Relative Effect Size
Total Effect	.77	.05	.67	.88	
Direct Effect	.60	.05	.50	.70	77.84%
Indirect Effect	.17	.03	.11	.24	22.16%

Note: Boot SE = Boot Standard Error, Boot CI = Boot Confidence Interval, Lower limit & upper limit = The lower limit & upper limit of 95% Boot confidence interval, Relative Effect Size = Direct effect size or indirect effect size divided by total effect size.

possible explanation for this might be that students with obvious symptoms of academic procrastination symptoms have difficulty controlling their smartphone-use behaviours and in engaging in academic activities, which ultimately undermine their confidence in their own learning ability (Yan et al., 2018).

Third, these results are in accord with H3 and those studies indicating that there is a negative association between academic self-efficacy and academic procrastination (e.g. Hen & Goroshit, 2014; Klassen; Kuzucu, 2009; Özer, Sackes, & Tuckman, 2013; Wu & Fan, 2017). In other words, students who felt more confident in completing academic tasks were less likely to procrastinate in completing their academic work. One possible explanation is that the lack of confidence may delay one from taking action to complete the task (Wu & Fan, 2017). As suggested by Klassen et al. (2008), sometimes the cause of academic procrastination is not lack of knowledge and skills but lack of confidence to successfully implement that knowledge and those skills.

The negative relationship between academic self-efficacy and academic procrastination may be explained by a model documented in Steel (2007), the formula of which is:

$$\text{Utility} = \frac{\text{E} \times \text{V}}{\Gamma \text{D}}$$

In this formula, "utility" is used to describe the amount of desire to complete the task. The larger the utility, the more motivation one would have to complete the task; otherwise, procrastination occurs (in terms of the present study, academic procrastination). "E" is short for "expectancy" and refers to confidence in completing the task (in terms of the present study, academic self-efficacy). "V" stands for "value" and means the value of the target task. "Γ" is defined as sensitivity to the delay, that is, how sensitive people can be to perceive their procrastination. "D" refers to the time needed to complete the task. From the formula, it can be inferred that high

academic self-efficacy (large "E") in completing the academic task can cause utility to increase, which will bring about high motivation to complete the academic task, in other words, less academic procrastination; in contrast, low academic self-efficacy (small "E") in performing the task can produce less utility, which will result in higher academic procrastination.

Fourth, these results mirror H4 and the previous studies implying that self-efficacy partially and negatively mediates the association between Internet addiction and procrastination (e.g., Geng et al., 2018). This implies that the college students who felt more academically confident were less likely to procrastinate in completing learning tasks because of smartphone obsession. As indicated by Geng et al. (2018), the impact of Internet addiction on people's procrastination is mediated by their core self-evaluation, the most important indicator of which is self-efficacy. That is, a person's addictive behaviour undermines their self-efficacy and then further intensifies their procrastinating behaviours. Geng et al. (2018) further posited that enhancing one's self-efficacy and self-control can decrease the effects of Internet addiction on their procrastination. In other words, self-efficacy can become a buffer against procrastination resulting from Internet addiction. In this study, it is college students' academic self-efficacy that buffers against their academic procrastination related to smartphone addiction.

It is worthwhile to note that academic self-efficacy only partially mediated the relationship between smartphone addiction and academic procrastination in the present study. The mediation analysis showed that smartphone addition accounted for most of the variance in academic procrastination (77.84%), which means that the mediating effect of academic self-efficacy was not predominant (only 22.16%). In other words, although college students with a high level of academic self-efficacy were less likely to procrastinate in completing their academic work because of smartphone obsession, a high level of smartphone addiction could still greatly intensify their delay in completing learning tasks.

Fifth, the results indicate that the academic year of college students predicts the variance in academic self-efficacy. Senior-year students in the present study felt more competent in completing academic tasks than their junior-year peers. This result is inconsistent with one previous study, which found that academic self-efficacy decreases with academic year from sixth to eighth grade (Güvercin et al., 2010), but in cord with another study, which showed that biology teacher candidates' academic self-efficacy increases as their grade level (Altunsoy et al., 2010). One possible explanation for the negative association between academic level and students' academic self-efficacy in the present study is that senior-year students usually have fewer courses than junior-year students and thus feel more competent in completing academic tasks. The results also indicate that male students were less likely to procrastinate in completing their academic work than female students. This result is contrary to those of previous studies, which found that females are at lower risk to procrastinate than males (Milgram et al., 1995; Özer et al., 2009). It is possible that academic procrastination is also domain-specific. All the participants in the present study were pursuing degrees that fall in the category of science and technology. Male students in these disciplines might be more academically proactive than female students.

5.2. Implications

In terms of theoretical implications, this study is unique in specifically linking smartphone addiction to academic procrastination, which deepens the understanding of the impact of smartphones on college students' procrastination behaviours in academic settings. In addition, the mediating and buffering effect of academic self-efficacy identified in the present study suggests that college students' smartphone-addiction behaviours might reduce their confidence in their academic capacity, which ultimately aggravates their academic procrastination. In terms of practical implication, the relations between the three variables presented in this study might help practitioners understand more about the mechanism of college students' academic procrastination and so prepare them to better help students improve their performance at university.

5.3. Limitations and future directions

This study is subject to certain limitations. First, it employed a cross-sectional design. Second, all the participants were from one college, which might undermine the generalizability of the research findings. Future researchers could use a longitudinal survey design to collect data over a period of time and recruit participants from different institutions. Moreover, they could explore which dimension of academic self-efficacy mediates the association between smartphone addiction and academic procrastination. Nonetheless, the prevalence of smartphones holds the potential to provide multiple and convenient opportunities for students to learn online. Future research is needed to examine how smartphone addiction might be channelled to bring benefits to students' learning and academic productivity.

6. Conclusion

This study explores the relationships between smartphone addiction and academic procrastination and the buffering role of academic self-efficacy in mitigating between the two. The results indicate that college students who were more addicted to their smartphone tended to procrastinate more in completing their academic work. Moreover, students who felt less academically competent had a stronger tendency to procrastinate than their peers who felt more competent, even though they might have the same level of smartphone use. Notably, most variance in academic procrastination was still attributable to smartphone addiction, although academic self-efficacy did play a role, which demonstrates that students' smartphone obsession intensified their tendency to procrastinate.

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CRediT authorship contribution statement

Ling Li: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing, Supervision, Project administration. **Haiyin Gao:** Conceptualization, Methodology, Formal analysis, Writing - original draft, Data curation, Investigation. **Yanhua Xu:** Methodology, Software, Resources, Writing - review & editing, Supervision.

Declaration of competing interest

None.

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