Investigating predictors of smartphone dependency symptoms and effects on academic performance, improper phone use and perceived sociability

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Abstract: This study investigates the relationships between predictors (i.e., personal traits and mobile activities) of smartphone dependency and its impacts on improper phone use, academic performance and perceived sociability. Using a stratified sampling method, a web survey obtained data from 438 undergraduate smartphone users in Singapore. PLS results show that improper phone use is a critical factor which mediates the effects of smartphone dependency symptoms on grade point average and perceived sociability. Youths who feel higher leisure boredom tend to have more smartphone dependency. Female users are more likely to have smartphone dependency symptoms than males. The results also show that using mobile phones for videos and mobile gaming are better predictors of smartphone dependency symptoms than using it for social media and traditional phone activities. Theoretical and practical implications are discussed.

Keywords: gender; GPA; leisure boredom; perceived sociability; sensational seeking; smartphone dependency.

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1 Introduction

Mobile phones have become the most prevalent communication devices which are utilised for interpersonal communication, socialisation, and professional tasks. According to International Telecommunication Union's report (2014), global mobile-cellular penetration rate reaches 96% in 2014 and the Asia-Pacific region leads the growth. With 3G/4G network advancements, affordable smartphones which integrate feature phones' communication functions, mobile internet, and mobile applications diffuse rapidly in recent years. Industry reports forecast that nearly 63% of all mobile phone users globally will own a smartphone by 2020 (GSMA Intelligence, 2015). Among various demographics, youths and teens lead the growth of smartphone ownership worldwide (Ericsson, 2014; Nielsen Newswire, 2012). However, the increasing significance of smartphone activities among the youth is likely to result to a high degree of dependency.

Following the lines of game and internet addiction studies, scholars who consider mobile addiction pathological define it as a maladaptive pattern of mobile device use, resulting in psychological impairment (Leung, 2008a, 2008b). Some argue that mobile addiction shows less severe pathological symptoms than substance addictions such as alcohol and gaming addiction (Carbonell, Oberst and Beranuy, 2013). There are no definite criteria to classify mobile addiction across age groups. When social interaction of digital natives is usually interwoven with mobile phones, Hyman (2013) argues that staying constantly in touch with social circles is an emerging norm rather than an addiction. This study selects to investigate smartphone dependency in order to avoid the inherently negative notion of mobile addiction which lacks measurements to detect addicts in different age groups and contexts.

More and more young people are used to keep perpetual contact of mobile phones, which shapes their social connectivity and turns into dependency of these personal gadgets (Rice and Hagen, 2010). Excessive mobile phone use has received increasing media and research attention which primarily focusses on contributing factors and negative outcomes of mobile addiction on teenagers and youths (Leung, 2008a; Hyman, 2013). Young age is found to predict elevated actual use of mobile phones and show more dependency symptoms (Billieux, van der Linden and Rochat, 2008). Many studies have examined the relations between young people's personal traits and their addiction to feature phones (Bianchi and Phillips, 2005; Harrison and Gilmore, 2012) or text messaging (Atchley and Warden, 2012; Igarashi et al., 2008; Lu et al., 2011). However, only few scholarly studies investigate smartphone dependency's predictors, symptoms, and impacts, even though some emphasise that smartphone users tend to have a higher level of mobile dependency than feature phone users (Lin, Chiang and Jiang, 2013; Salehan and Negahban, 2013; Shih et al., 2012).

Overall, this study has three objectives:

1 To propose a research model examining how personal attributes and use of mobile phone activities can be associated with smartphone dependency and improper phone use which affect young students' academic performance and perceived sociability.

2 To empirically test the proposed model using young smartphone users' data.

3 To provide insights for academia and practitioners about the impacts and implications for theories and health policies.

2 Theoretical background

According to Griffiths (1996), when maladaptive and excessive use of technologies cause problems, it is regarded as technological addiction, a subset of behavioural addiction which refers to bodily and psychological dependence on an object (Chóliz, 2010). As mobile communication has interwoven into daily routines, users become increasing reliance on these personal devices. Along with various benefits, concerns about addictive and improper use of mobile phones are growing because of its accompanied risks (Leung, 2008b). In the past decade, many studies have examined predictors, symptoms and negative outcomes of mobile addiction (Leung, 2008a, 2008b; Takao, Takahashi and Kitamura, 2009; Oulasvirta et al., 2012; Park et al., 2013). Prior mobile addiction research initially bases their theoretical foundation on the findings of internet addiction studies as they share some similar syndromes (Chiu, Hong and Chiu, 2013). The key indicators of internet addiction include amount of time spent and the types of online activities engaged in (Chou, 2001). Internet addicts not only show persistent use and emotional attachment but also immerse in virtual activities and neglect realities (Kim and Haridakis, 2009). Due to the prevalent use of smartphone and mobile internet, mobile and internet dependency are gradually interwoven with each other. Chiu, Hong and Chiu (2013) find that mobile phone addiction among Taiwanese college students is positively associated with internet addiction.

According to Chóliz (2010), symptoms of excessive mobile phone usage are shown by costly phone bills, problems with parents, disruption to school work and daily activities, the need for frequent usage, and constant upgrade to latest phone models. College student who have mobile dependency usually keep up constant interaction with others, feel as though they are losing control of life without mobile phones and get drawn away from co-present others easily (Rice and Hagen, 2010). Bianchi and Phillips (2005) develop mobile phone problem use scale, which is further adapted by Leung (2008a, 2008b). He defines mobile addiction as a maladaptive pattern of mobile device use, resulting in psychological impairment. His mobile addiction symptoms include four dimensions: 'inability to control craving', 'loss in productivity', 'anxiety' and 'withdrawn/escape'. Overuse of mobile phones not only arouses users' affective and social issues but also causes clinical problems, like psychological distress (Chóliz, 2010). However, Carbonell, Oberst and Beranuy (2013) argue that conscious use of mobile phones may lead to problematic use rather than addiction as its syndrome is different from pathological symptoms caused by substance addictions.

Addiction signifies abnormality and personal weakness, while dependency on new technologies is normal (Cuban, 2010). Prior studies examined addictions to feature phones, primarily focussing on addiction symptoms or negative impacts on adolescents or college students (Beranuy et al., 2009; Chóliz, 2010; Leung, 2008a, 2008b). The levels of mobile dependency may lead to good or bad outcomes. This study focusses on examining youths' mobile dependency as dependence, a neutral term, occurs on a continuum (Edwards and Gross, 1976) and only severe or overdependence may result in harmful consequences (Jaff et al., 1980). Moreover, mobile overdependence can mean differently to different social groups in different contexts. When young users use mobile phones to keep constant connectivity with social networks, their norm may be seen as overdependence by their other counterparts (Hyman, 2013). This study postulates that mobile dependency is an appropriate concept to examine the reliance on using mobile devices for communication and gratifications.

Feature phones, with basic call and SMS functions, have already played an essential part in users' lives (Kolsaker and Drakatos, 2009) and resulted in users' close emotional attachment to the artefacts (Vincent, 2006). Advanced features of smartphones used inaccessible wireless environment further increase users' reliance on these devices (Hyman, 2013). Young people who are used to keep constant connectivity with social networks are vulnerable groups to resist excessive smartphone usage (Hyman, 2013). However, little scholar research has investigated their smartphone dependency behaviour (Lin, Chiang and Jiang, 2013), even though young people have become the driving force of the rapid adoption of smartphone worldwide (Ericsson, 2014; Nielsen Newswire, 2012).

3 Research model and hypotheses

Based on previous studies, this study identifies psychological attributes (i.e., leisure boredom and sensation seeking), gender and smartphone activities (i.e., mobile social media, mobile gaming, mobile video and traditional phone use) as possible predictors affecting young people's smartphone dependency. Moreover, we also present how smartphone dependency symptom is associated with academic performance (in terms of grade point average (GPA)), improper phone use and sociability.

3.1. Leisure boredom

Leisure boredom is a subjective perception that leisure experiences are not frequently exciting, varied or novel (Iso-Ahola and Weissinger, 1990). Young people tend to have free time for unstructured socialising which is theoretically associated with high levels of boredom (Leung, 2015), a risk factor for addiction (Moore and Ohtsuka, 2000). When people have too much time and experience high levels leisure boredom, they are likely to engage in deviant activities such as drug (Iso-Ahola and Crowley, 1991) and alcohol (Orcutt, 1984) abuse.

In Leung's study (2008b), leisure boredom is identified as a predictor for feature phones' improper use and mobile addition symptoms such as inability to control craving and productivity loss. He finds that Hong Kong adolescents who encounter higher levels of leisure boredom are more likely to report improper phone use. However, the relationships between leisure boredom and using mobile activities (e.g., texting, photos,

games and reading mobile news) are insignificant in his study. However, as noted by Lepp et al. (2015), there is a need to clarify the role of leisure boredom to smartphone dependency because past studies were conducted at a time where users mostly used feature phones (e.g. Sánchez-Martínez and Otero, 2009; Toda et al., 2006). Hence, the following hypothesis is proposed:

H1a: Higher leisure boredom positively affects smartphone dependency symptoms.

3.2. Sensation seeking

According to Whiteside and Lynam (2001), sensation seeking refers to a tendency to enjoy and pursue exciting activities and openness for new experiences. Zuckerman (1979) measures individual differences in sensation seeking based on four dimensions: thrill and adventure seeking, experience seeking, disinhibition and susceptibility to boredom. Young people are inclined to seek out risks as fun-seeking behaviours (Jessor and Jessor, 1977). As motivations to select leisure activities are associated with their arousal levels, sensation-seeking plays a key role in deviant leisure participation (Gordon and Caltabiano, 1996).

Sensational seeking is found to have a significant correlation with addictions (Stacy, Newcomb and Bentler, 1991). According to Whiteside and Lynam (2001), people who have high levels of sensation seeking use mobile phone while driving more frequently. In Leung's study (2008b), adolescents who score high on sensation seeking exhibit a significant higher tendency to get addicted to feature phone use. As young people tend to experiment with rules and risks, when dealing with leisure boredom, they are likely to depend on using smartphone activities to seek for fun, diversity and excitement. Thus, we propose:

H1b: Higher sensation seeking positively affects smartphone dependency symptoms.

3.3. Gender

In prior studies, women tend to have more intensive actual use of mobile phones (Jenaro et al., 2007; Sánchez-Martínez and Otero, 2009; Walsh et al., 2011) and get addicted to them more easily than men (Billieux, van der Linden and Rochat, 2008; Jenaro et al., 2007; Mok et al., 2015). Female teens in Switzerland are significantly more prone to intensively using text messages than males (Geser, 2006). Leung (2008b) finds that female adolescents in Hong Kong are more vulnerable to excessive use of feature phones. In a UK survey, more women report being afraid of losing cell phones than men (SecurEnvoy, 2012). Similarly, Emanuel et al. (2015) found that females tended to feel safer having their mobile phones with them than males. Toda et al. (2006) attribute females' mobile dependency to their preferences for indirect communication. According to Lee et al.'s (2014) dark side of smartphone usage study, the positive relationships between two psychological traits (i.e., social interaction anxiety and need for touch) and compulsive usage are greater for women than men. Females are also found to perceive their smartphone use as more problematic than men (Carbonell, Oberst and Beranuy, 2013). Hence, this study proposes:

H2: Females are more likely to have smartphone dependency symptoms than males.

3.4. Smartphone activities

Carbonell, Oberst and Beranuy (2013) emphasise the significance to clarify that mobile phone users are addicted to some activities on the device, instead of the artefact itself. Many studies find that young people's excessive use of SMSs is positively associated with mobile phone addiction (Igarashi et al., 2008; Perry and Lee, 2007). The larger number of text messages sent, the more addiction symptoms exhibited by young people (Lu et al., 2011), when youths feel information-based rewards in text messages are lost quickly, they respond to them quickly, especially to close ties (Atchley and Warden, 2012). In addition to voice calls and SMSs, smartphones offer online information and entertaining activities and mobile applications. According to Lin, Chiang and Jiang (2013), young people who use smartphones tend to show more dependency than nonsmartphone users. They also find that mobile social media, mobile gaming and mobile videos are most popular smartphone activities. Mobile social media in this study include widely adopted social network sites and fast-diffused mobile instant messaging (MIM) (e.g., WhatsApp, Line, and WeChat). Salehan and Negahban (2013) attribute using social networking applications on smartphones as a significant predictor for mobile addiction. After MIM rapidly displaces SMSs in recent years, young smartphone users become more dependent on the free and user-friendly smartphone IM applications (Sultan, 2014). Mobile games give users greater convenience to access these services anytime, anywhere, which is likely to increase users' dependency levels. Watching mobile videos is an important leisure activity among youths when they perceived popularity among peers (Lin and Chiu, 2014). However, Jeong et al. (2016) found that high use of social networking sites tends to have a greater effect on smartphone addiction than mobile games. Based on the prior studies, the following hypotheses are proposed:

H3c: The use of mobile social media positively affects smartphone dependency symptoms.

H3b: The use of mobile gaming positively affects smartphone dependency symptoms.

H3a: The use of mobile videos positively affects smartphone dependency symptoms.

H3d: The use of traditional phone activities (i.e., calls and SMS) positively affects smartphone dependency symptoms.

3.5. Impacts of smartphone dependency symptoms

Studying outcomes of mobile phone use should examine a broader context beyond adverse consequences of dysfunctional phone use, like understanding impacts on personal performance or psychological health (Carbonell, Oberst and Beranuy, 2013). Prior studies on problematic mobile phone use tend to regard it as a dependent variable defined similarly to mobile addictions (Bianchi and Phillips, 2005; Billieux, 2012; Billieux, van der Linden and Rochat, 2008; Jenaro et al., 2007; Martinotti et al., 2011; Roberts, Pullig and Manolis, 2015; Takao, Takahashi and Kitamura, 2009). It is essential to distinguish between problematic and excessive use of the mobile phone (Billieux, 2012).This study conceptualised that smartphone dependency symptoms affect improper phone use. This is on the premise that their dependency on smartphones can lead to their

inappropriate behaviours in different occasions. In the study of Leung (2008b), improper use of mobile phones was measured by inappropriately using mobile phones for voice calls or SMS during class and using a smartphone's camera to stealthily take pictures. Additionally, smartphone users can also inappropriately use social media during class that can lead to distraction (Abe and Jordan, 2013).

Leung (2008b) also suggests and examines the impacts of mobile dependency on young students' academic performance. When students have improper mobile phone use, like sending texts and checking social media while studying, these disturbing behaviours tend to negatively affect their learning and academic performance (as measured by their grade point average, i.e., GPA) (Junco and Cotten, 2011; 2012). Spanish high school students who use mobile phone intensively are likely to experience school failure (Sánchez-Martínez and Otero, 2009). In addition, high frequency of mobile phone use and texting among American college students are found negatively related to GPA (Lepp, Barkley and Karpinski, 2014).

In terms of sociability, Rice and Hagen (2010) think that college students experience a form of social dependency on mobile devices. College students usually think that using mobile phones can strengthen relationships and connectivity with family members and friends (Wei and Lo, 2006). However, many raise concerns about the interference of mobile phone use with school life and social environments (Selwyn, 2003). Mobile phone use is generally regarded as a strong relation to risky or antisocial behaviours and dependence symptoms (Yang et al., 2010). People who are susceptible to mobile phone overuse tend to crave for constantly communicating with peers and to develop potential relationships (Billieux, 2012). Although most studies emphasise negative outcomes of mobile dependency, Singaporean students in junior colleges report that using smartphones, with self-control in some activities (e.g., MIM, social media and gaming), will improve their efficiency and convenience in learning and social life (Lin et al., 2014). Therefore, this study seeks to expand prior research to examine the relationships among smartphone dependency symptoms, improper mobile phone use, academic performance and perceived sociability, and thus propose the following hypotheses:

H4a: Higher smartphone dependency symptoms increase improper phone use.

H4b: Higher smartphone dependency symptoms reduce GPA.

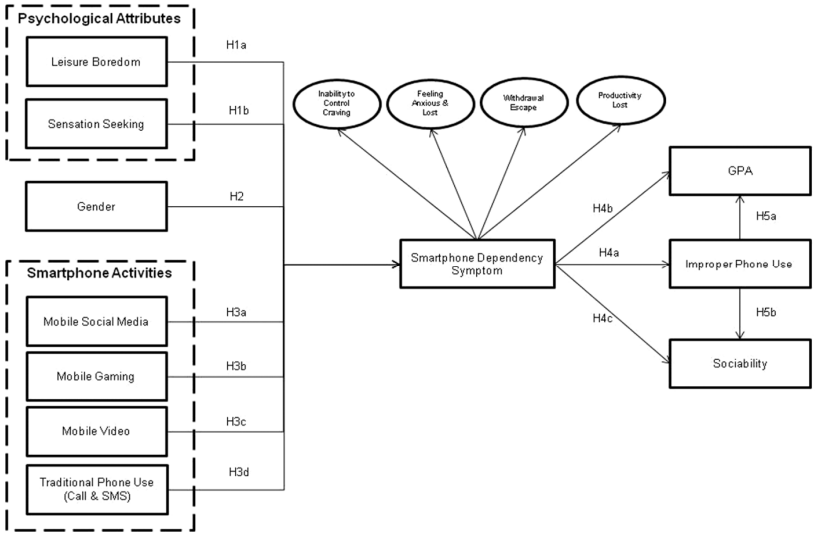
H4c: Higher smartphone dependency symptoms reduce perceived sociability.

H5a: Improper smartphone use reduces GPA.

H5b: Improper smartphone use reduces perceived sociability.

Figure 1 shows the research model which covers the variables in this study and as well as the predicted relationships between the variables.

Figure 1 Smartphone dependency research model



4 Methodology

4.1 Country selection

Youths and teens are driving the growth of smartphone adoption in South East Asia (Ericsson, 2014). Due to high mobile penetration and smartphone ownership, youths in Singapore are likely to be influenced by using mobile phone in this connected society. As of February 2016, the mobile population penetration rate in Singapore reached 148.8%, with more than 8 million 3G/4G mobile phone users (IDA, 2016). Young Singaporeans reached the highest level of smartphone ownership at 92% (Blackbox Research, 2012). Hence, this study conducted a web survey in a Singapore comprehensive university to understand youths' smartphone dependency.

4.2 Measurement

Measurement scales were adapted from prior studies and made minor modifications to fit the context for this study. In pre-test, we used a convenient sampling of undergraduate students in communication classes to assess the internal consistency of the measurement scales. The measurement of smartphone dependency symptom was adapted Leung's (2008a, 2008b) 17-item Mobile Phone Addiction Index. This formative second-order construct is composed of four first-order reflective dimensions:

1 'inability to control craving'

2 'feeling anxious and lost'

3 'withdrawal/escape'

4 'productivity loss'

After dropping one item due to low factor loading below 0.70, the overall construct's Cronbach's alpha (0.93) suggests strong internal consistency.

Leisure boredom was measured with a 6-item modified scale by Leung (2008a). After eliminating two low factor loading items, the Cronbach's alpha value (0.81) of the remaining four items shows strong internal consistency. To assess sensation seeking, a 4-item scale was adopted from Leung (2008a). Its Cronbach's alpha was high at 0.81. We adapted Leung's (2008b) 3-item scale to measure improper mobile phone use and add one question of using mobile social media on inappropriate occasions. Its Cronbach's alpha (0.71) suggests adequate internal consistency. A 5-point Likert-type scale was used to measure each item of the aforementioned variables. To assess perceived sociability, a 9-item scale was developed based on Zywica and Danowski (2008). After factor analysis, we deleted five items, and the Cronbach's alpha for the remaining items was high at 0.79. Each item was rated on a 4-point scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree).

Measure for smartphone activities was developed by this study. Smartphone activities (mobile social media, mobile gaming and mobile videos) were measured using 5-point scale (1 = never, 2 = at least once during the last 3 months, 3 = more than once a month, 4 = more than once a week, 5 = more than once per day). Respondents were asked to rate their frequency of using social media and MIM, online and offline mobile games and downloaded and online mobile videos, in addition to time spent on voice calls and numbers of SMSs. All items have significant factor loadings of at least 95% confidence interval. As for GPA, respondents were asked to provide their last score by using a 5-point ordinal scale (1 = below 3, 2 = 3.0–3.49, 3 = 3.5–3.99, 4 = 4.0–4.49, 5 = 4.5 and above). In this university's grading system, a higher GPA denotes better academic achievement. Appendix A presents the factor loading values of the final set of items.

4.3 Data collection

After receiving the Institutional Review Board's approval, this study used a stratified sampling method to select 2,000 undergraduate students in a comprehensive university in Singapore. Undergraduate students represent the youth in Singapore as their ages fall between 15 and 35 years (Ministry of Culture, Community and Youth, 2014). The selected respondents received an e-mail invitation with the link to the online questionnaire in April 2012. A voucher of USD $7.9 was given as an incentive to increase the response rate. Within3 weeks, we gathered data from 638 undergraduate students based on school quotas, yielding a response rate of 31.9%. After removing incomplete and invalid answers, the final sample size is 438. In terms of gender, 52.8% of respondents were females and 47.2% were males. Majority of the respondents were Chinese (91.7%), followed by Malay (3.2%), Indian (2.8%) and others (2.4%). Their average age was 22.29 years (SD = 1.63). The mean number of years of using mobile phones was 8.6 (SD = 2.23). Most of the respondents reported having a GPA of 4.0–4.49 (33.1%), followed by those with 3.5–3.99 (32.9%).

4.4 Measurement model

Partial least square (PLS) was utilised to test the hypotheses and validate the model. Predominantly used for marketing and business-related studies, PLS is appropriate to simultaneously analyse multiple independent and dependent variables of a phenomenon

(Hair, Ringle and Sarstedt, 2013). Henseler et al. (2014) emphasises that PLS is a valuable tool for exploratory research due to its flexibility in sample size, data distribution and inclusion of variables measured with dichotomous (i.e., gender) and ordinal values (i.e., GPA).

Using Smart PLS version 2.0.M3 (Ringle, Wende and Will, 2005), we first examined the measurement model and assessed reliability and validity of the items. Then we evaluated each hypothesis and calculate the R^2. Prior to path analysis, the proposed smartphone dependency model was evaluated by examining the quality of the measurements. Table 1 shows the values of composite reliability (CR) and average variance extracted (AVE) for the variables with reflective measurements. A reflective construct is acceptable when its CR value is above 0.70 and its AVE is above 0.50 (Hair et al., 1998). Additionally, reflective constructs satisfy the AVE and CR requirements while formative constructs have statistically significant factor loadings of at least 95% confidence interval (or $p < 0.05$).

Table 1 Assessment of reflective variables

Variables	*AVE (>0.50)*	*CR (>0.70)*
Psychological attributes		
Leisure boredom	0.62	0.87
Sensation seeking	0.63	0.87
Smartphone dependency symptoms		
Inability to control craving	0.65	0.92
Feeling anxious and lost	0.65	0.88
Withdrawal/escape	0.83	0.94
Productivity lost	0.79	0.92
Improper phone use	0.53	0.82
Perceived sociability	0.61	0.86

AVE, average variance extracted; CR, composite reliability

Next, we assessed the discriminant validity of the reflective constructs. To achieve discriminant validity, the square root of AVE should exceed inter-construct correlations between the construct and any other construct (Chin, 1998). In Table 2, the diagonal elements for each reflective construct exceed the values from the off-diagonal elements, indicating their discriminant validity.

Table 2 Discriminant validity assessment

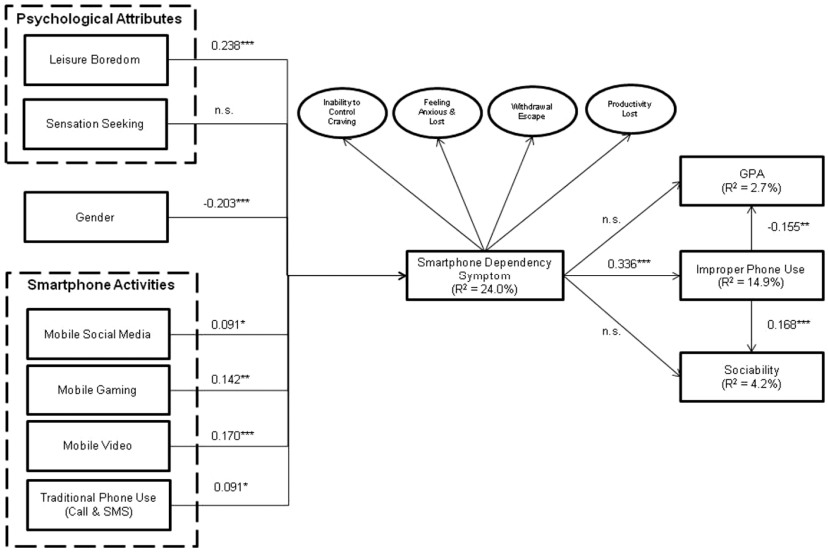
	1	*2*	*3*	*4*	*5*
1. Leisure boredom	**(0.79)**				
2. Sensation seeking	0.09	**(0.79)**			
3. Smartphone dependency symptom	0.27	0.10	**(0.70)**		
4. Improper phone use	0.20	0.38	0.39	**(0.74)**	
5. Perceived sociability	0.02	0.40	0.13	0.19	**(0.78)**

Note: The non-diagonal elements are the latent correlations while the diagonal elements (in bold) are the square roots of the AVEs.

5. Results

The structural model was evaluated by examining the path coefficients, *t*-statistics, and coefficient of determination (R^2). We assessed the predictive power of the model and analysed the relationships among variables. The statistical tests reach a significance level of 0.05 to assess the significance of the paths in this model. The analysis reveals that the predicting power of gender, psychological attributes and smartphone activities approximately account for 24% of the variance of smartphone dependency symptom (R^2 = 0.24). The R^2 values for improper phone use, GPA and perceived sociability are 14.9, 2.7 and 4.2%, respectively. Figure 2 shows the results plotted in the smartphone dependency model after PLS data analysis.

Figure 2 Data analysis results



*p < 0.05, **p < 0.01, ***p < 0.001.

Note: ns, not significant

The results support 8 out of the 12 hypotheses. Figure 2 shows model analysis results. In terms of psychological attributes, leisure boredom positively predicts smartphone dependency symptoms (β = 0.238, p < 0.001), which supports H1a. However, sensation seeking is found not a significant predictor of smartphone dependency symptoms, thus rejecting H1b. The path from gender to smartphone dependency symptoms indicates a negative value (β = –0.203, p < 0.001), thus providing support to H2 that female respondents tend to show more smartphone dependency than males. When examining smartphone activities, the results show that increasing use of mobile social media (β = 0.091, p < 0.01), mobile gaming (β = 0.142, p < 0.01), mobile videos (β = 0.170, p < 0.001) and traditional phone use (i.e., call and SMS) (β = 0.091, p < 0.01) all cause heavier dependency symptoms. Thus, H3a, H3b, H3c and H3d are all supported.

In addition, the model shows that smartphone dependency symptoms significantly predict improper phone use (β = 0.336, p < 0.001), thus providing support to H4a. However, smartphone dependency symptoms have no significant effect on both GPA and

perceived sociability. H4b and H4c are rejected. In comparison, improper phone use negatively affects GPA (β = –0.155, $p < 0.01$) but positively affect perceived sociability (β = 0.168, $p < 0.001$). H5a is supported but H5b is rejected. Table 3 summarises the results of hypothesis testing.

Table 3 Summary of hypothesis testing

Hypothesis		*Path coefficient (β)*	*Decision*
H1a	Leisure boredom positively affects dependency symptoms	0.238***	Accept
H1b	Sensation seeking positively affects smartphone dependency symptoms	ns	Reject
H2	Females are more likely to have smartphone dependency symptoms than males	–0.203***	Accept
H3a	The use of mobile social media positively affects smartphone dependency symptoms	0.091*	Accept
H3b	The use of mobile gaming positively affects smartphone dependency symptoms	0.142**	Accept
H3c	The use of mobile videos positively affects smartphone dependency symptoms	0.170***	Accept
H3d	The use of traditional phone activities positively affects smartphone dependency symptoms	0.091*	Accept
H4a	Higher smartphone dependency symptoms increase improper phone use	0.336***	Accept
H4b	Higher smartphone dependency symptoms reduce GPA	ns	Reject
H4c	Higher smartphone dependency symptoms reduce perceived sociability	ns	Reject
H5a	Improper smartphone use reduces GPA	–0.155**	Accept
H5b	Improper smartphone use reduces perceived sociability	0.168***	Reject

*p < 0.05, **p < 0.01, ***p < 0.001; ns, not significant; GPA, grade point average

It is interesting to see that smartphone dependency symptoms have no significant effect on GPA and perceived sociability. In an alternative model where phone problem use is not included as a variable, the path between smartphone dependency to GPA (β = 0.080, $p < 0.05$) and perceived sociability (β = 0.145, $p < 0.001$) is significant. It seems that improper phone use mediated these variables. In order to fully grasp the role of improper phone use as a mediator, we performed mediation analysis following Bontis, Booker and Serenko's (2007) guidelines. The Sobel test was used to examine the significance of the mediation effects (MacKinnon, 2008). The Sobel test results show that improper phone use is a significant mediator between smartphone dependency symptoms to GPA (z = –2.40, $p < 0.01$) and between smartphone dependency symptoms to perceived sociability (z = 1.67, $p < 0.05$). Further analyses reveal that improper phone use fully mediates the interaction between smartphone dependency to GPA and sociability. Overall, the results suggest that improper use is a critical factor to predict the impacts of smartphone dependency symptoms on GPA and perceived sociability. That is, with the

mediating effect of improper phone use, smartphone dependency symptoms will not result in a decrease in GPA and increase in perceived sociability.

5 Discussion

Compared with feature phones, multifunctional smartphones have a great potential to cause overdependence and problematic phone use among youths (Lin, Chiang and Jiang, 2013; Salehan and Negahban, 2013). Our research goal is to incorporate smartphone dependency symptoms and improper phone use in the examination of how young smartphone users' personal traits (i.e., leisure boredom, sensational seeking and gender) and smartphone activity usage (i.e., mobile social media, mobile gaming, mobile videos, voice calls and SMSs) affect their academic performance and perceived sociability. Except sensational seeking, all personal traits and smartphone activities can predict smartphone dependency symptoms. Improper phone use is found a crucial mediating factor between smartphone dependency and the effects on GPA and perceived sociability.

5.1 Discussion of key findings

Similar to previous studies (Junco and Cotten, 2011; 2012), this research finds that improper phone use has an adversary effect on school performance. When young students show improper smartphone use behaviours (e.g., making/receiving calls and text messages, using mobile social media and stealthily taking photos) on inappropriate occasions (e.g., classes and meetings), according to the results, their academic performance will become worse. Although this study hypothesises that improper phone use that is utilising smartphone improperly with bad phone etiquette will negatively affect sociability, the results indicate positive effect and reject H5b. College students believe that mobile phone use can strengthen relationships with close ties (Wei and Lo, 2006). Since this study measures self-perceptions of sociability, instead of real social relations, this can be explained as those who misuse smartphones on inappropriate occasions keep constant social connectivity through these devices and view their indecorous behaviours as being advantageous to make more friends quickly and easily. The craving to utilise smartphones whenever and wherever they want is stronger than constraints of social norms and images perceived by others. They break rules of etiquette to stay connected. This is indeed an alarming sign when young people who lose self-control in using smartphone continue such unbefitting usage because they misperceive these improper behaviours can benefit their social interactions and relations.

This study also identifies leisure boredom as a significant psychological attribute which positively affects youths' smartphone dependency symptoms, just like what is found in the Leung (2008b). When young people feel abundant free time for unstructured socialisation, they tend to feel higher levels of boredom, a risk factor for heavier dependency. Hong Kong adolescents who encounter higher levels of leisure boredom are more likely to report improper use of feature phones (Leung, 2008b). According to Gordon and Caltabiano (1996), people usually experience leisure boredom in urban areas. In cities like Singapore where lots of people use smartphones in a ubiquitous wireless environment, mobile activities which displace other media consumption and some social activities have occupied young people's plentiful leisure time. Those who easily feel leisure activities unexcited and unfulfilled fit the profile of smartphone addictive

personality. It is crucial for parents and educators to guide youths to engage in various compelling leisure activities in order to reduce their dependence on smartphones.

The results show that the more frequently young people use smartphone activities, the higher probability they will experience dependency symptoms. There is no surprise to find out positive relationships between using popular mobile activities (i.e., social media, mobile videos and gaming) and smartphone dependency. As users are addicted to certain mobile activities, instead of the artefact itself (Carbonell, Oberst and Beranuy, 2013), it is pivotal to further examine different effects of the smartphone activities on youths' dependency symptoms. The findings reveal that using mobile videos and mobile gaming can predict smartphone dependency symptoms more than mobile social media (Social Network Service (SNS) and MIM) and traditional phone activities (voice calls and SMSs). The results can be understood by mobile activities' characteristics (e.g., immersiveness, stickness, and temporal linearity). Compared with SNS and text messaging, watching mobile videos and playing mobile games which can engage users more in media-rich content, well-crafted plots and interactivity have higher levels of immersiveness and stickness. Their consumption requires users' longer time spent and temporal linearity to follow storylines or interact with games until outcomes disclose (e.g., ending or scores). These explain why mobile videos and mobile gaming are the smartphone activities closely associated with overdependence. In other words, if parents or teachers notice adolescents or teens spend lots of time on using the two smartphone activities, they should feel even more concerned than their excessive use of SNSs, MIMs or SMSs which have been found addictive in past studies (Harrison and Gilmore, 2012; Igarashi et al. 2008; Jeong et al., 2016; Lu et al., 2011; Perry and Lee, 2007; Salehan and Negahban, 2013; Sultan, 2014). In addition to personal traits, observing young students' consumption of smartphone activities can provide useful information to predict smartphone overdependence. The findings can help concerned parents and teachers to monitor youths' smartphone usage behaviours and patterns in order to prevent them from mobile addictions.

Gender differences exist in smartphone dependency. In this study, young females are more inclined to experience dependency symptoms than males. These findings are consistent with previous studies on feature phones (Billieux, van der Linden and Rochat, 2008; Jenaro et al., 2007; Takao, Takahashi and Kitamura, 2009; Walsh et al., 2011). For example, female adolescents in Hong Kong are more vulnerable to excessive use of mobile phones (Leung, 2008b). After smartphone being prevalent in use, women are found more nomophobia than men as the former feels more fearful of being out of touch of mobile phone contact (SecurEnvoy, 2012). Also, females perceive their smartphone use as more problematic than men (Carbonell, Oberst and Beranuy, 2013). These results can be understood by women's preferences for indirect mediated communication (Toda et al., 2006), social use of mobile phones (Bianchi and Phillips, 2005), and their contradictory psychological traits of need for touch and social interaction anxiety (Lee et al., 2014). Young females especially rely on multifunctional smartphones to communicate, to maintain relationships, to socialise and to seek for information and entertainment; hence, they develop strong emotional attachments to these gadgets and may become over depend on them.

5.2 Limitations

This study has several limitations. First, it uses undergraduate students as samples, which is often criticised due to lack of external validity (Gordon, Slade and Schmitt, 1986). However, the student data are suitable in this study as they represent young adults in Singapore who are the driving force for smartphone adoption and are likely to spend excessive time on smartphone activities and are vulnerable to negative impacts of overdependence (Atchley and Warden, 2012; Bianchi and Phillips, 2005; Leung, 2008a, 2008b; Walsh et al., 2011). Second, this study depends exclusively on survey respondents' self-reports. Their reports of perceived psychological characteristics (e.g., leisure boredom and dependency symptoms) may be subjective. However, in this case, self-reports may be more accurate assessments than outside observers because individuals still have better insights about personal beliefs and feelings. Third, although conducting a survey is appropriate to identify relationships among predictors of smartphone dependency symptoms and improper phone use as well as their impacts, it cannot fully explicate reasons why some paths show significance but others do not. As suggested by Sanakulov and Karjaluoto (2015), qualitative methods (e.g., in-depth interviews, focus groups and observation) can also be used to deepen the current understanding of behaviours arising from mobile phone adoption such as smartphone dependency. Finally, the results can be generalised in similar contexts where have high mobile penetration, high smartphone ownership and ubiquitous wireless and 3G/4G mobile networks. In comparison, the consequences of using smartphone activities (i.e., mobile video, mobile gaming and mobile social media) may not be as influential in other countries which have less advanced mobile environments. Thus, future research may investigate how mobile penetration, smartphone ownership and wireless accessibility affect dependency symptoms and improper phone use.

5.3 Contributions and implications

As for theoretical contributions, this study develops a model to investigate the relationships of predictors (personal traits and smartphone activities) and smartphone dependency symptoms as well as further examine improper use and outcomes (GPA and perceived sociability). One of our significant theoretical contributions is to identify improper mobile phone use as the key factor which can worsen young people's studying but enhance their self-perceptions of sociability. Although smartphone dependency positively predicts improper phone use, the former with the mediating effect of the latter will not be able to affect GPA and perceived sociability. Although high frequency of cell phone use (Lepp, Barkley, and Karpinski, 2014; Sánchez-Martínez and Otero, 2009) and improper mobile phone (Junco and Cotten, 2011; 2012) are found negatively associated with academic performance, to our best knowledge, no prior research has found the mediating effect of improper phone use between smartphone dependency and its impacts on GPA and sociability. Therefore, this study suggests parents and teachers to pay more attention to smartphone usage on inappropriate occasions than smartphone dependency symptoms (i.e., inability of control craving, escape/withdrawal, productivity loss and feeling lost and anxious) because improper phone use can directly deteriorate students' academic performance and reinforce young students' perpetual contact behaviours, especially when they regard constant smartphone connectivity as being beneficial to friend making and popularity. Further research can incorporate social predictors

(e.g., peer/family connectedness, peer influence, engagement/disengagement offline) as relationships plays an important role in youths' life. Meanwhile, other relevant consequences (e.g., well-being, social capital and psychological and physical impairment) of smartphone dependency and improper phone use can be further examined. Moreover, future research may focus on smartphone overdependence users and develop a new index to measure their symptoms in response to smartphone activities.

As smartphone has been prevalently used and closely interwoven into many aspects of people's daily life, its overdependence and improperness should be regarded as important public health issues as they result in health problems and social costs. The findings of the present study have crucial practical implications. They provide insights into possible paths through which personal traits and smartphone activity usage might facilitate smartphone dependency symptoms and generate improper phone use. First, young people, especially females, are most likely to be at risk of negative effects of problematic mobile phone use and will need guidance to avoid academic and relationship after-effects. After realising the impacts of psychological predictors and mobile activity usage on smartphone dependency, health authorities and educators can use these measurements in the screening of potential problematic users, inform at-risk people of their inclinations and offer the support of school counsellors. Second, schools can play an active part in creating compelling health promotion programs to increase young students' knowledge and awareness of the risks of smartphone overdependence. Health education can teach them how to make smarter smartphone consumption choices and use these devices with self-control within reasonable time and on appropriate occasions. Finally, higher education administrators and health professionals should make policies and implement effective interventions to take preventive and corrective actions against improper smartphone use in educational settings as it will deteriorate academic performance as well as mental and physical health (Lepp, Barkley and Karpinski, 2014; Lepp et al., 2013). After taking these measures, young people will be likely to develop healthy and responsible smartphone behaviours without adverse effects caused by dark side of smartphone usage.

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Appendix A: survey items

Items	*Factor loading*
Smartphone dependency symptoms	
Inability to control craving (Leung 2008a, 2008b)	
1. You have been told that you spend too much time on your mobile phone	0.85
2. Your friends and family complained about your use of the mobile phone	0.81
3. You have tried to hide from others how much time you spend on your mobile phone	0.76
4. You find yourself engaged on the mobile phone for longer period of time than intended	0.78
5. You can never spend enough time on your mobile phone	0.79
6. You have attempted to spend less time on your mobile phone but are unable to	0.84
Feeling anxious and lost (Leung 2008a, 2008b)	
7. When out of range for some time, you become preoccupied with the thought of missing a call	0.71
8. You feel anxious if you have not checked for messages or switched on your mobile phone for some time	0.84
9. You find it difficult to switch off your mobile phone	0.85
10. You feel lost without your mobile phone	0.81
Withdrawal/escape (Leung 2008a, 2008b)	
11. You have used your mobile phone to talk to others when you were feeling isolated	0.94
12. You have used your mobile phone to talk to others when you were feeling lonely	0.94
13. You have used your mobile phone to make yourself feel better when you were feeling down	0.85
Productivity lost (Leung 2008a, 2008b)	
14. You find yourself occupied on your mobile phone when you should be doing other things, and it causes problem	0.90
15. Your productivity has decreased as a direct result of the time you spend on the mobile phone	0.89
16. There are times when you would rather use the mobile phone than deal with other more pressing issues	0.87
Psychological attributes	
Leisure boredom (Leung 2008a)	
1. For me, free time just drags on and on	0.80
2. Free time is boring	0.75
3. In my free time I usually don't like what I'm doing but I don't know what else to do	0.81
4. My friends and I often talk about how bored we are	0.79

Appendix A: survey items (continued)

Items	*Factor loading*
Sensation seeking (Leung 2008a)	
1. I would like to explore strange places	0.70
2. I like to do frightening things	0.73
3. I like new and exciting experiences, even if I have to break the rules	0.88
4. I prefer friends who are exciting and unpredictable	0.86
Smartphone activities	
Mobile social media (self-generated items)	
1. Chat rooms and instant messengers (e.g., WhatsApp, Line)	0.54***
2. Facebook, Twitter, Blog or other social media	0.66***
Mobile video (self-generated items)	
1. Use downloaded audio visual content	0.32*
2. Enjoy audio visual content online (e.g., YouTube)	0.81***
Mobile gaming (self-generated items)	
1. Online gaming	0.65***
2. Offline gaming	0.52**
Traditional phone use (self-generated items)	
1. How many minutes on average do you talk with someone on the mobile phone per day (include both incoming and outgoing calls)?	0.89***
2. How many text messages do you send and receive on average per day?	0.34*
Improper phone use (items 1–3: Leung 2008b; item 4: self-generated item)	
1. Make/receive calls on inappropriate occasions such as in class, meetings, libraries or in theatres	0.72
2. Make/receive text messages on inappropriate occasions	0.76
3. Stealthily snap pictures without permissions when nobody notices	0.71
4. Use mobile social media on inappropriate occasions	0.82
Perceived sociability (Zywica and Danowski, 2008)	
1. I have more friends than most people	0.80
2. I am very sociable	0.85
3. I prefer parties with lots of people	0.68
4. I make friends very easily and quickly	0.79
Gender	NA
GPA	NA

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; NA, not applicable