



A quantitative analysis of factors related to Taiwan teenagers' smartphone addiction tendency using a random sample of parent-child dyads

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ABSTRACT

The portability, sophistication and connectivity prompt users to revolve around multiple applications on the phones at all times. Teenagers are of particular concern because they are usually overoptimistic about their online activity management but underestimate the negative impacts. This study aims to address individual and parental factors related to teenagers' (mainly aged 13 to 18) smartphone addiction tendency (SAT) with a representative sample of parent-child dyads around Taiwan. We try to draw a holistic view of how Taiwan youngsters use their smartphones and how their parents mediate that use by surveying all possible factors related to that use. According to the analytical results, we ascertained that smartphone ownership and dissimilar purposes for surfing the Internet are associated with students' SAT. Online games and trade are related to younger students' SAT, while SNSs is associated with older students' SAT. Additionally, teenagers' cybersecurity knowledge regarding smartphones is negatively related to their SAT. Lastly, we found parent-reported mediation strategies are barely effective, and parents are even unaware of older students' smartphone use. The implications for suitable interventions in family and school contexts are discussed followed by the analyses.

1. Introduction

Because of the well-deployed telecommunication infrastructure and the user-friendly designs of smartphones, the smartphone has become one of the information communication technologies in widespread use (Cho, 2015). Research has shown that spending substantial amounts of time using smartphones is problematic for some individuals (Haug et al., 2015; Mok et al., 2014). The excessive use of smartphones may be associated with certain negative outcomes, including academic failure, ill health and life imbalance (Chung et al., 2018; Hawi & Samaha, 2016; Kee, Byun, Jung, & Choi, 2016; Samaha & Hawi, 2016). Teenagers are of particular concern in regard to the influence of smartphone overuse; they are often overoptimistic about their online activity management but underestimate the negative impacts. For example, teenagers use smartphones for a longer time than adults expect (Kwon, Kim, Cho, & Yang, 2014), and they have low risk perceptions when using the Internet (Lareki, Martínez de Morentin, Altuna, & Amenabar, 2017). Smartphone addiction was found to be significant in adolescents with lower levels of self-control (Kim, Min, Min, Lee, & Yoo, 2018), and high-risk smartphone-addicted adolescents showed severer levels of behavioral and emotional problems (Lee, Lee, & Lee, 2016).

Although the precise definition of smartphone addiction was not yet determined by academics, some research has already focused on its

correlates and possible causes. The common driving factor in smartphone addiction is domesticity. Some factors, such as feeling stressed for not meeting expectations (Chiu, 2014) or bearing specific psychosocial traits molded by the family (Bian & Leung, 2014; Mok et al., 2014), are inherent to individuals. Some factors are linked to parents. Past studies revealed that household income, parents' educational levels, a parent's smartphone addiction tendency and parental mediations are associated with teenagers' smartphone addiction (Hwang & Jeong, 2015; Lee et al., 2016; Park & Park, 2014). Since parents and young users themselves play a vital role in smartphone addiction, parent-child dyadic data facilitate our understanding of teenagers' smartphone addiction.

This study aims to address parental and individual factors related to teenagers' (mainly aged 13 to 18) smartphone addiction tendency with a representative sample of parent-child dyads in secondary education around Taiwan. It is also part of a government grand survey project that tries to draw a holistic view of how Taiwan youngsters use their smartphones and how their parents mediate that use by surveying all possible factors related to that use. In particular, teenagers' knowledge of smartphone cybersecurity, which has not been studied before to our knowledge, is investigated as well. Admittedly, the discussion of factors related to SAT in the current study is broad rather than deep. However, a study with extensive coverage of factors provides directions for better

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interventions by not confining the research foci. The great breadth of investigated factors also serves as a base for further study.

In this study, we organize the research primarily around three aspects. The first is the relationship between Internet content preferences and teenagers' SAT, particularly for the students in secondary education. Second, teenagers' individual factors related to their SAT will be explored. In addition to gender and age, ownership of smartphones, timing of first accessing the Internet, and level of smartphone cybersecurity knowledge will be investigated. Subsequently, we examine teenagers' SAT from the perspectives of parents. Not least among our interests are household income, parental mediations and parents' awareness of their children's SAT. The findings will inform us of possible factors related to teenagers' SAT and thus have some implications for suitable interventions in family contexts.

2. Research questions derived from literature

There is no clear definition of smartphone addiction in the field of behavioral addiction (Al-Barashdi, Bouazza, & Jabur, 2015). Past studies often relate smartphone addiction with some specific characteristics. Chóliz (2012) associated smartphone addiction with three constructs: lack of control, tolerance and abstinence. Lin et al. (2014) indicated that smartphone addiction involves compulsive behaviors, tolerance, withdrawal, and functional impairment. Lin, Pan, Lin, and Chen (2017) further developed a ten-item 4-point Likert scale inventory involving the aforementioned four symptoms and adopted 24 as cutoff point to diagnose smartphone addiction with the aid of psychiatrists' diagnostic interview. Kwon et al. (2013) held that smartphone involves daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse, and tolerance. Kwon et al. (2014) further developed a ten-item 6-point Likert scale inventory involving the aforementioned six symptoms and adopted 31 and 33 as cutoff points to diagnose males' and females' smartphone addiction respectively through receiver operating characteristics (ROC) analysis. The current study does not aim to diagnose smartphone addiction among teenagers. Instead, we try to analyze possible factors related to teenagers' smartphone addiction. As a result, smartphone addiction tendency (SAT) is adopted.

2.1. Content to which smartphone users are addicted

The utilization of mobile phones is quite different from what it was two decades ago, at which time phone use was merely for communication; it was clearly instrumental. Today, the portability, sophistication and connectivity prompt users to revolve around multiple applications on the phones at all times. Users could be on the go accessing information and amusing themselves. The media effect is contingent upon the types of content with which users engage (Calvert & Wilson, 2008). The various functions embedded in the smartphones might therefore be highly associated with smartphone addiction (Bian & Leung, 2014; Kim, 2013; Lee, 2014; Samaha & Hawi, 2016).

Several prior studies addressed what content on smartphones to which users, from preteens to adults, have been (probably) addicted. In Korea, when controlling some users' characteristics (having low self-control and being stressful), the sixth graders who use phones for social networking sites (SNSs) and games are shown to be likely to be addicted to smartphones, but those using phones for academic purposes are not (Jeong, Kim, Yum, & Hwang, 2016). For British students in secondary education, Lopez-Fernandez, Honrubia-Serrano, Freixa-Blanxart, and Gibson (2014) reported that above 70% of the smartphone addicts use the smartphones mainly for social purposes and nearly 20% for recreational purposes. In contrast, for Korean students in secondary education, Bae (2017) indicated that what is associated with smartphone addiction is searching for information, seeking entertainment and playing games rather than using SNSs. Bian and Leung (2014) revealed that, after adjusting for the psychological traits (shyness and

loneliness), Chinese university students' SNS-using, video-taking, video-watching and game-playing are highly related to SAT, but calls-making or texting are not. Lee (2014) indicated that frequent use of social networking applications is related to smartphone addiction among African American college students when treating the five personality traits as covariates. In contrast, Lin and Chiang (2017) noted that, compared to using phones for social media, using phones for watching videos and playing games are more associated with smartphone dependency for Singaporean undergraduates when partialling out users' psychological traits. With Dutch participants aged between 15 and 88, keeping constant the age, emotional intelligence, social stress and self-regulation, van Deursen, Bolle, Hegner, and Kommers (2015) concluded that both "process" and "social" smartphone usage are significantly correlated with addictive smartphone behavior. Process usage refers to favorable media consumption, and social usage is defined as relationship-building with others. For adult users, the smartphone addiction management systems developed by Lee, Ahn, Choi, and Choi (2014) revealed that, in Korea, potential addicts make more use of social network applications compared to non-addicts.

While different population characteristics were included in past research, using smartphones for purposes of entertainment or socialization is more or less associated with smartphone addiction (Jeong et al., 2016). Nevertheless, entertainment might include various types of smartphone use such as game-playing or video-watching. Socialization could be making calls, making friends or using SNSs. Additionally, "trade" constitutes an element of teenagers' Internet use according to the 6-T Internet attitude model (Chou, Wu, & Chen, 2013). The 6-T model comprises Tool, Toy, Telephone, Territory, Treasure of information and Trade. These dimensions refer to multiple functions of the Internet. They are recreation, communication, self-expression, information-seeking and online commercial activities. More specifically, trade implies online transactions such as buying or selling goods on the Internet. While most dimensions of the 6-T Internet attitudes were investigated, the relationship between trade and smartphone addiction has not been explored.

What remains unclear is which types of content smartphone users are particularly addicted to, including socialization-, recreation-, communication-, transaction- and education-related activities. To investigate the relationship between specific content consumption and smartphone addiction among Taiwan teenagers, the first research question is:

RQ1. To what Internet content are young smartphone users in Taiwan possibly addicted?

2.2. Individual factors related to teenagers' SAT

Gender differences in smartphone addiction are highlighted in past studies. The gender difference might be derived from motivational aspects and social stress (Billieux, Van Der Linden, D'Acromont, Ceschi, & Zermatten, 2007; van Deursen et al., 2015). For example, males often use the Internet for entertainment and females for socialization (Weiser, 2000). Males are more likely to use the mobile phones for business and females for social purposes (Bianchi & Phillips, 2005). Males are more vulnerable to negative achievement events and females are more susceptible to negative interpersonal events (Troisi, 2001).

The empirical studies on smartphone addiction mostly concern university students (Aljomaa, Qudah, Albursan, Bakhiet, & Abduljabbar, 2016; Hawi & Samaha, 2016; Mok et al., 2014; Nayak, 2018). Among the studies addressing gender differences in teenagers, Hong Kong female teenagers were revealed to be prone to smartphone addiction compared to their male counterparts (Leung, 2008), as was found in the Spanish study on teenagers (Sánchez-Martínez & Otero, 2009). Recently, research has shown females' proneness to smartphone addiction in samples of Spanish and Korean teenagers (Chóliz, 2012; Lee & Lee, 2017). Even for younger teenagers, the same finding was

revealed by Jeong et al. (2016) who recruited Korean sixth graders as participants. In contrast, Nikhita, Jadhav, and Ajinkya (2015) found that Indian males incline to smartphone addiction more easily compared with females among 8th to 10th graders. The same finding was mentioned by Işıklar, Şar, and Durmuşçelebi (2013) when recruiting high school students in Turkey. While gender difference in smartphone addiction among teenagers is not conclusive, there is definitely a need to include gender analyses. In response, we created the second research question.

RQ2. What is the gender difference in SAT among Taiwan teenagers?

In addition to gender, we are interested in three other individual factors that have not been investigated before. One is the ownership of the smartphone, another is the timing of first accessing the Internet, and the last is cybersecurity knowledge regarding smartphones. The widespread availability of low-cost smartphones allows smartphone users to penetrate all ages. It is not unusual for a teenager to own a smartphone even if the school generally forbids smartphone use on campus. Parents not only rely on smartphones to communicate with their children but also exploit the smartphone as a supplement to their companionship with their children. According to the past studies, Cotten, Shank, and Anderson (2014) indicated that owning the cell phones increases the odds of multitasking in social networking and chatting among middle school students. Lemola, Perkinson-Gloor, Brand, Dewald-Kaufmann, and Grob (2015) reported that smartphone ownership is related to more electronic media use in bed before sleep and later bedtimes. With a sample of smartphone users aged from 13 to 69, Hussain, Griffiths, and Sheffield (2017) demonstrated that the time spent on the smartphones is positively related to the duration of smartphone ownership. Furthermore, Chang et al. (2019) confirmed that fifth graders' smartphone ownership is a risk factor of smartphone addiction. Hence, our third research question follows directly from the thought that owning a smartphone might hasten the progress of smartphone addiction among teenagers.

RQ3. What is the relationship between the smartphone ownership and SAT?

While the effects of accessing mobile devices are not well-understood, past studies have suggested adverse consequences of digital media consumption for teens and adolescents (Lissak, 2018). Divan, Kheifets, Obel, and Olsen (2012) noted that children exposed to cell phones at an early stage are more likely to develop problematic behavior later. Researchers noted the impacts, from distraction to distress, derived from the use of interactive screen media among young children (Radesky, Schumacher, & Zuckerman, 2015). Panek (2014) also pointed out that self-controlled young adults use less social media when they are introduced to social media at a later age. By the same token, we have the fourth research question as we suspect that teenagers who learn to use the Internet at younger ages have something to do with SAT.

RQ4. What is the relationship between the timing of first accessing the Internet and SAT?

There is a growing anxiety about online safety as teenagers use technology (Davidson & Martellozzo, 2013; Davies, 2011; Lareki et al., 2017; Soldatova & Rasskazova, 2016). Soldatova and Rasskazova (2016) indicated that teenagers were further exposed to online risks when they spent more time on the Internet. The research question, which aimed to identify the relationship between SAT and cybersecurity knowledge, was principally triggered by the myriad of studies documenting the negative association between academic performance and smartphone overuse (Hawi & Samaha, 2016; Nayak, 2018; Samaha & Hawi, 2016). Adding the acknowledgement that Internet addiction proneness is negatively related to cybersecurity awareness (Hadlington & Parsons, 2017), and media multitasking is positively associated with risky cybersecurity behavior (Hadlington & Murphy, 2018), we are

interested in how teenagers' SAT relates to their cybersecurity knowledge regarding smartphones.

RQ5. What is the relationship between teenagers' SAT and their cybersecurity knowledge regarding smartphones?

2.3. Parental factors related to teenagers' SAT

Parental neglect, including leaving children alone or being indifferent to their health condition, often relates to teenagers' smartphone addiction (Kwak, Kim, & Yoon, 2018). As a smaller extent of parental neglect, parents provide food, treatment and education for their children with poor quality of communication with their children. The prior study indicated that there is disagreement between parents' perceptions and their children's SAT (Youn et al., 2018). In this circumstance, it is necessary to investigate whether parents are aware of a child's SAT. Therefore, the sixth research question is as follows.

RQ6. What is the relationship between parents' perceptions of children's SAT and child-reported SAT?

Parents' neglect might derive from having a heavy workload and thus may have something to do with household income. In contrast, parents of low income families may not afford smartphones or the smartphone applications, leading to low SAT (Al-Barashdi et al., 2015; Park & Park, 2014). Past studies on how household income is related to smartphone overuse were mixed. The earlier studies indicated positive relations (Nikken & Schols, 2015; Park & Park, 2014; Sánchez-Martínez & Otero, 2009; Zulkefly & Baharudin, 2009), but the latest literature exhibited no relations (Aljomaa et al., 2016; Cho & Lee, 2017). The inconclusive findings prompted the seventh research question.

RQ7. What is the relationship between household income and children's SAT?

Past studies have shown that parental mediation is a negotiated outcome between parents and children (Smahelova, Juhová, Cermak, & Smahel, 2017). Several factors, such as parents' perceptions of their children's digital skills, will dictate how parents mediate children's smartphone use (Livingstone, Mascheroni, & Staksrud, 2017). Parental mediation of children's media use is often categorized into restrictions, co-use (co-view) and instructions (Livingstone & Helsper, 2008). In the meta-analysis conducted by Collier et al. (2016), different types of parental mediations have distinct effects on children's time spent on electronic media such as television and video games. In specific, restrictive mediation has a small and negative effect, and co-viewing has a small and positive effect. However, instructive mediation is not significant (Collier et al., 2016).

Time limits or location restrictions serve as the relatively popular but effortless method of restrictive mediation for parents to regulate children's technology use (Goh, Bay, & Chen, 2015) since parents need not attend to the content mediated by the technology. Parents could impose the restrictions on smartphone use for either rewards or punishments (Samaha & Hawi, 2016). Prior studies afford us lessons on the ineffectiveness of time limits on Internet use from children's self-reported surveys. Lee and Chae (2007) indicated that child-perceived time limits did not alter elementary school students' Internet usage. Len-Ríos, Hughes, McKee, and Young (2016) noted that imposing limits on social media use for middle schoolers are not associated with less media consumption. Panek (2014) had a similar finding that university student-perceived time limits on consumption of Internet/social media had no impact on their social media use.

Co-use is another often-use tactic for parents to manage children's technology use. Parents share media time with their children. Unlike co-viewing television, parents and their children may not share the same smartphone screen. Instead, they more often than not use their own smartphones independently. Co-using smartphones refers to parents' accompanying children's smartphones use. Parents may or may not

monitor the content on children's smartphones while children are using the smartphones. Parents act either as helpers in guiding children's online activities or as buddies in sharing each other's online activities (Zaman, Nouwen, Vanattenhoven, de Ferrer, & Looy, 2016). In this circumstance, being a buddy, a parent's involvement might be misconstrued as an implicit approval of prolonged use (Lee et al., 2016).

As for parental instructions, Kalmus, Blinka, and Ólafsson (2015) indicated that instructive mediation is linked negatively to excessive Internet use based on a sample of children aged 11–16 years old, especially when the children experienced online harm. Hefner, Knop, Schmitt, and Vorderer (2018) also found that instructive mediation along with co-use had negative associations with children's problematic smartphone use based on a sample of children aged 8–14 years old.

In contrast to the great number of studies on parental mediation of television and Internet use, there are relatively few studies on smartphone mediation (Hefner et al., 2018; Meeus, Eggermont, & Beullens, 2018; Vaala & Bleakley, 2015). While the study conducted by Hefner et al. (2018) analyzed the effectiveness of parent-reported mediation on children's smartphone use, it is a pity that instructive mediation and co-use were combined as a factor in their study. How parent-assumed and research-recognized tactics relate to children's SAT was not fully investigated in past research and thus is one of our research foci. We therefore have the eighth to tenth research questions:

RQ8. What is the relationship between parent-reported time limits and their children's SAT?

RQ9. What is the relationship between parent-reported co-use and their children's SAT?

RQ10. What is the relationship between parent-reported instruction and their children's SAT?

2.4. Difference between senior and junior high school students

Early US study revealed that older adults are less likely to develop problematic mobile phone use (Smetaniuk, 2014). Relying on the Dutch sample, van Deursen et al. (2015) took a similar stand that older adults possess less likelihood of developing addictive smartphone behaviors. For adolescents, De-Sola Gutiérrez, Rodríguez de Fonseca, and Rubio (2016) concluded that the total time spent on the cell-phones decreased with age through the literature review. Haug et al. (2015) indicated that smartphone addiction is less prevalent among older students with a Swiss sample. Nevertheless, the association between age and smartphone addiction was not founded in the US and German adolescent sample respectively (Barnes, Pressey, & Scornavacca, 2019; Randler et al., 2016).

Recognizing the possible impact of age, we would like to compare the differences between senior and junior high school students' SAT. We also want to explore the difference between senior and junior high school students' knowledge of smartphone cybersecurity. The result may lend itself to the development of related educational interventions, especially when junior and senior high schools are distinct education systems in Taiwan.

RQ11. Is there a significant difference between senior and junior high school students' SAT?

RQ12. Is there a significant difference between senior and junior high school students' knowledge of smartphone cybersecurity?

The research model is illustrated in the following figure.

3. Research methods

3.1. Participants

The population for the current study is students in secondary

education and their parents in Taiwan. We attempted to recruit a representative sample by stratified random sampling. In Taiwan, the student-class ratio in junior high schools is about 40 to 1 and that in senior high schools is approximately 50 to 1 currently. With an expectation to collect 1800 valid parent-child-paired questionnaires, we decided to distribute 3600 paired copies in each school levels. We rounded the required numbers of classes based on the frequency distribution of students in different regions around Taiwan. Eventually, we distributed 4200 paired questionnaires to 105 junior school classes and 4550 paired copies to 91 senior high school classes. All the junior and senior high schools in Taiwan were numbered. We approached schools according to the specific numbers generated by a computerized random number generator. After getting schools' permissions to administer the surveys, a box of enveloped questionnaires was delivered to each school with instruction leaflets. The questionnaires for students and their parents were enveloped separately. After signing the informed consent forms, students and their parents responded to the questionnaires voluntarily and independently without receiving any compensation. We later paired the collected questionnaires with the numbers encoded on the questionnaires.

There were 713 valid paired parent-child questionnaires collected from 54 junior high schools. The response rate is 16.98%. Among the valid data, 55.54% (N = 396) were female students and 44.46% (N = 317) were males. Seventh graders were 29.87% (N = 213), eighth graders were 34.92% (N = 249), and ninth graders were 32.54% (N = 232) of the sample, and the remaining were missing values.

There were 731 valid paired parent-child questionnaires collected from 41 senior high schools. The response rate is 16.07%. Among the valid data, 57.87% (N = 423) were female students and 42.13% (N = 308) were males. Tenth graders were 19.97% (N = 146), eleventh graders were 38.30% (N = 280), and twelfth graders were 40.36% (N = 295) of the sample, and the remaining were missing values.

3.2. Instrument

The research instrument received institutional review board approval at National Chiao Tung University before being distributed to the targeted samples (Application No. NCTU-REC-105-051). The descriptive questionnaires were the main instrument for understanding teenagers' SAT and its related individual and parental factors.

For students, the demographic data, smartphone ownership, timing of first accessing the Internet, the Internet content preference, knowledge of smartphone cybersecurity and SAT were investigated. Students could select at most five from the nine different purposes for surfing the Internet (see Fig. 1). The answers were later dummy coded 0 if not chosen and coded 1 if chosen. The timing of first accessing the Internet was demarcated into six options and coded 1 to 6. The greater the number, the more lately a student learn to access the Internet. The six options included before primary school level, 1st to 2nd grade, 3rd to 4th grade, 5th to 6th grade, junior high school and senior high school level. There are five multiple choices questions concerning users' knowledge of smartphone cybersecurity. These 5 questions were chosen and revised from 70 self-developed questions by five domain experts such as in-service teachers and professors in information science. Location privacy awareness, app installations and smartphone phishing were included. These questions were also pilot-tested among other students in secondary education. The item reliability, validity and discrimination were established. The five questions are appended in the appendix, and a sample question is depicted in Fig. 2. The total number of questions students answer correctly was counted as their knowledge of smartphone cybersecurity.

The last section of the student questionnaire was the short-form smartphone addiction inventory developed by Lin et al. (2017). Based on these 10 questions, students self-reported their degree of agreement with the depicted symptoms by selecting one of four Likert-type options, with 1 representing "strongly inconsistent", and 4 representing

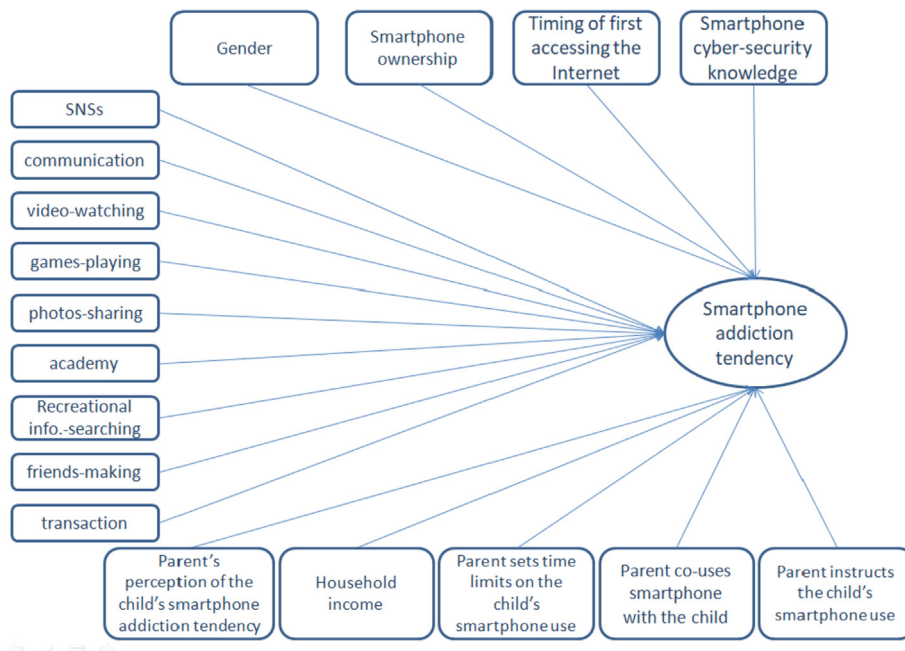


Fig. 1. Research Model with content preference (left), individual factors (top), and parental factors (below).

Which of the following is a potential unsecure source of installing the applications on the smartphones?	
A.	The app stores managed by the operation system companies such as Google App.
B.	The app stores managed by the telecommunication industry such as China Telecom
C.	The app stores managed by smartphone manufacturer such as Acer.
D.	The android package kit on the file-sharing websites.
E.	I do not understand this question.

Fig. 2. Illustration of a question on smartphone cybersecurity.

“strongly consistent.” For example, the first question asks a student to rate their agreement with having been hooked on smartphones longer and longer. In the study by Lin et al. (2017), a four-factor model can be generated and a summated score was used to indicate a student's SAT.

For parents, their genders, household income, education attainment, the way they regulate children's smartphone use and their awareness of their children's SAT were collected. To avoid parents' impatience in answering the questionnaires, parents simply responded yes or no to whether they instruct, co-use or set a time limit on their children's smartphone use. Household income was demarcated into six options and coded 1 to 6. The greater the number, the higher household income a respondent possesses. The six options included less than 0.5 million, 0.5 to 1.14 million, 1.15 to 1.5 million, 1.51 to 3 million, 3 to 5 million and more than 5 million new Taiwan dollars. (Note: the ratio of the US dollar to the new Taiwan dollar is approximately 30). Additionally, we inquired whether parents deemed their children potential smartphone addicts. Parents selected their level of agreement, with 1 representing “strongly disagree”, and 4 representing “strongly agree.” This question was adopted to check whether any discrepancy existed between parents' perceptions and their children's self-reported SAT.

The statistical analyses were implemented with the statistical package, Stata 14. Statistical significance was set as $p < .05$.

4. Research results

4.1. Multiple regression on SAT

The 10 items from the smartphone addiction inventory were subjected to confirmatory factor analysis with maximum likelihood estimation. Four factors (compulsive behavior, functional impairment, withdrawal and tolerance) were generated as the prior study depicted. The Cronbach's alphas showed modest reliability ($\alpha_s > .69$). The fit indices support the validity of the model (CFI = .98, RMSEA = 0.05, RMR = 0.02). The summated score of the 10 items, ranging from 10 to 40, were used as a student's SAT. The SAT was subsequently considered a function of the student's gender, smartphone ownership, timing of first accessing the Internet, knowledge of smartphone cybersecurity, Internet content preference, household income, a parent's perception of the child's smartphone addiction and parental mediations. Distinct multiple regression analyses were conducted for students in junior and senior high schools with the standard errors adjusting for dependence among the students in the same school (code: vce(cluster school)). In the current study, the respondents are independent across schools, but not necessarily within schools since students from the same schools may conform to the social norms they have established. The code specifies that the standard errors in the analysis allow for within-cluster correlation, relaxing the requirement of independent observations in regression analyses (Rabe-Hesketh & Skrondal, 2012). The significant F-test for both analyses showed that the proposed relationship is statistically reliable ($F(18,53) = 9.75, p < .01; F(18,40) = 5.95, p < .01$). There was no sign of multicollinearity ($1.02 \leq VIFs \leq 1.42$). The analytical results are presented in Table 1.

4.2. Independent t-tests

In the present study, students answered 5 items on smartphone cybersecurity knowledge and 10 items on SAT. The summated score for cybersecurity knowledge ranged from 0 to 5 and that for SAT ranged from 10 to 40.

For junior high school students, the mean score for knowledge of smartphone cybersecurity was 3.02 with a standard deviation of 1.21.

Table 1
Multiple regression.

	Junior high school students			Senior high school students		
	β	Robust SE	p-value	β	Robust SE	p-value
Purposes of using the Internet						
for SNSs (e.g., Facebook)	1.18	0.72	.11	1.53***	0.38	< .01
for communication (e.g., Line)	0.39	0.52	.46	0.50	0.44	.26
for watching the video (e.g., YouTube)	-0.08	0.71	.91	-1.17*	0.50	.03
for playing games	1.36**	0.48	< .01	0.32	0.50	.53
for sharing photos (e.g., Instagram)	0.24	0.55	.66	0.52	0.49	.29
for academy	-1.84**	0.54	< .01	-1.63**	0.46	< .01
for recreational information	-0.35	0.57	.54	0.20	0.43	.65
for making friends	1.62	0.87	.07	-0.78	0.77	.32
for transactions	1.39*	0.64	.03	0.90	0.46	.06
Individual Factors						
Student gender (male = 1)	-0.48	0.49	.34	-0.17	0.49	.73
Smartphone ownership	2.52**	0.89	< .01	4.91*	2.39	.05
Timing of first accessing the Internet	-0.04	0.23	.88	-0.08	0.17	.65
Smartphone security knowledge	-0.36*	0.17	.03	-0.38*	0.17	.03
Parental Factors						
Parent's perception of a child's SAT	0.73**	0.26	< .01	-0.01	0.21	.96
Household income	0.13	0.22	.57	-0.02	0.20	.94
Time limits	-1.36**	0.49	< .01	-0.20	0.44	.65
Co-use	1.14	0.63	.08	-1.04	0.64	.11
Instruction	-0.20	0.56	.73	0.09	0.60	.88
R- squared			10.25%			7.84%

Note: The asterisks represent conventional significance at different levels. One asterisk means $p < .05$, two asterisks mean $p < .01$, and three asterisks mean $p < .001$.

The mean score for SAT was 21.50 with a standard deviation of 6.31. For senior high school students, the mean score for knowledge of smartphone cybersecurity was 3.21 with a standard deviation of 1.20. The mean score for SAT was 21.78 with a standard deviation of 5.64.

The independent t-tests showed that senior high school students have better knowledge of smartphone cybersecurity ($\Delta M = 0.19$, $t_{(1442)} = 3.00$, $p = 0.003$). On the other hand, there was no significant difference in teenagers' SAT between junior and senior high school students (see Table 2) ($\Delta M = 0.28$, $t_{(1442)} = 0.89$, $p = 0.374$).

5. Discussion

5.1. The content on the smartphones to which teenagers are possibly addicted

Our first research question is to determine what specific content on the smartphone to which teenagers are (not) possibly addicted. For all the students in secondary education, those accessing the Internet for academic purposes have a smaller likelihood of smartphone addiction compared to those accessing the Internet for non-academic purposes. This finding is consistent with the finding by Jeong et al. (2016). It definitely excites educators in the face of the negative association between smartphone addiction and poor academic performance. Teenagers are more than welcome to access the Internet to assimilate diversified ideas or to carry out academic work. Neither parents nor educators need to worry that teenagers may become addicted to the smartphone use for academic purposes.

For junior high school students, using the Internet to play games is linked to a higher SAT score compared with using the Internet not for games. This result can be deemed an elaboration of the finding in the

Table 2
Summary of the differences.

	Range	difference	p
Smartphone cybersecurity knowledge	[1,5]	$M_{senior} - M_{junior} = 0.19$.003
Smartphone addiction tendency	[1,40]	$M_{senior} - M_{junior} = 0.28$.374

study by Bae (2017) that combined junior and senior high school students in a survey sample. Game-playing has long been a potential problem for teenagers. Recognizing the link between game-playing and smartphone addiction, parents need to exert extra caution when younger children are indulged in playing games. Parents' grasp of the game content may be helpful in preventing their junior high children from addiction. Parents are suggested to explain the pros and cons of games and plan multiple leisure activities for their children.

An uncommon finding is that junior high students exploiting the Internet for trade (transactions) are associated with a higher degree of smartphone addiction. While online trade as a risk factor seems to be a new finding in research on smartphone addiction, online trade has played a role in forming students' Internet attitudes (Chou, Chou, & Chen, 2016; Chou et al., 2013). Online trade was found to be associated with Internet addiction among university students previously (Kuss, Griffiths, & Binder, 2013). Younger teens' engagement in online trade thus cannot be overlooked. The popularity of multiple online payment gateways precipitates users' engagement in online trade. The curated products, the convenience, and the pleasure of making good deals are all possible boosts. In online trade, teenagers may be sellers or buyers. Whichever role a teenager plays, further research is needed to determine the possibility of smartphone addiction by online trade.

The content on the smartphones that senior high school students are possibly addicted to is different from junior high school students. Game-playing and trade are not related to their SAT. Instead, students accessing the Internet for SNSs possess a greater SAT score than those not accessing the Internet for SNSs. It is not surprising that SNS use is related to smartphone addiction since SNS has become a portal for miscellaneous activities (Davies, 2011). To a limited extent, the current result confirms the previous finding by Lopez-Fernandez et al. (2014) but contradicts the finding by Bae (2017). However, these authors combined senior and junior high school students in the research sample and therefore disregarded the moderating role of age. In contrast, the present study differentiates students from different schooling levels, and it thus provides direction for coherent education interventions or instructional material development. The related educational programs or instructional materials for younger students can focus on guidelines for game-playing and trade. Rather, the materials for the older students

have to place emphasis on the possible negative consequence of using SNSs.

To our surprise, senior high school students who access the Internet for watching online videos are related to smaller SAT scores than those not accessing the Internet for video-watching. People who love to watch online videos may remain online for several hours, especially when binge-watching dramas. A plausible explanation for the negative association in the present study is that the small screen embedded on the smartphone is usually not suitable for watching videos. It is hence negatively related to smartphone addiction. However, such a finding does not preclude teenagers' odds of Internet addiction. It would be of great value if further studies investigate how video-watching relates to possible smartphone addiction and Internet addiction simultaneously.

5.2. Individual factors related to smartphone addiction

Regarding the second research question, the analyses revealed that gender is not associated with teenagers' SAT. The gender difference is not in line with the past studies. Some prior studies showed gender differences in males' favor (Işiklar et al., 2013; Nikhita et al., 2015), and some were in females' favor (Chóliz, 2012; C.; Lee & Lee, 2017; Leung, 2008; Sánchez-Martínez & Otero, 2009). The population characteristics may be a source of the heterogeneity. The barrier against taking advantage of smartphones has diminished for people of all kinds as the technology has evolved. Consequently, males and females are equally susceptible to smartphone addiction. Gender insensitivity would be good news in the development of instructional materials because instruction designers usually do not demarcate the materials for different genders.

Interesting results were revealed with the third and fourth research questions. It is the ownership of the smartphones, not the timing of first accessing the Internet, that has a significant relationship with SAT. As a result, being afraid of excessive smartphone use should not be concerns for parents in deciding when to have their children learn/use the Internet. In contrast, handing a smartphone to the child might be an issue if parents cannot be on guard when their children are using the smartphones because the current and prior studies noted that smartphone ownership is associated with smartphone addiction (Chang et al., 2019). Our result further showed that the multiple functions furnished by smartphones are related to children's possible addiction.

As for the fifth research question, similar to the negative link between academic performance and SAT shown in past research, the present study shows a negative association between knowledge of smartphone cybersecurity and SAT. Put another way, the greater the knowledge of smartphone cybersecurity, the smaller the susceptibility to smartphone addiction. Alternatively, teenagers possessing a higher degree of SAT have less knowledge of smartphone cybersecurity. Either interpretation is remarkable because insufficient smartphone cybersecurity knowledge places users in danger. Users can lose data, property or privacy, and even incur trouble for others. The current finding adds a new perspective to the past research indicating that knowledge of cybersecurity is inversely related to Internet addiction (Hadlington & Parsons, 2017). It thus accentuates cybersecurity education. Early education in cybersecurity related to phone use in particular can establish a foundation beforehand and probably mitigate teenagers' susceptibility to smartphone addiction.

5.3. Parental factors related to smartphone addiction

For the parental factors related to children's smartphone addiction, household income had no relation to children's smartphone addiction. We originally suspected that parents of higher income may afford purchasing children smartphones and various applications on the smartphone, and we also speculated that parents of higher income may have heavier workloads and thus use smartphones in lieu of parenting or disregard their children's smartphone use. This conjecture is not

affirmed. A plausible reason is that smartphones in Taiwan are not considered luxury items but must-have items. The low-cost smartphones, numerous complimentary apps and widespread telecommunication infrastructure make smartphone consumption much easier currently. The result in the current study agrees with the latest findings in studies by Aljomaa et al. (2016) and Cho and Lee (2017). It reminds future researchers of examining other factors when investigating smartphone addiction.

In the current study, parents' perceptions of children's SAT agree with junior high school student-reported SAT but not with senior high school student-reported SAT. This finding may help epitomize the ineffectiveness of parental mediation for children at different ages. According to the present analyses, none of the three parental mediation approaches have associations with senior high school students' SAT. Only setting time limits may serve its purpose in abridging junior high students' smartphone usage because setting time limits is inversely related to SAT score. Indeed, parents probably set the time limit to regulate junior high school children's smartphone use because they are somewhat aware of their children's SAT. For the senior high school students, the finding that setting a time limit is ineffective is in line with past studies. Past studies showed that child-perceived time limits set by parents had no association with Internet/SNS usage for adolescents (Len-Ríos et al., 2016; Panek, 2014). Furthermore, our finding is not stale because we attempt to associate parent-reported time limits with children's smartphone use. The finding suggests that parents need to attend more to what senior high school children are doing with the smartphones, especially their SNS activities. With pocket-sized smartphones, senior high school children are sophisticated enough to circumvent parents' mediation. Teenagers' compliance with parental mediation becomes increasingly strategic as they grow up (Davies, 2011).

Beyond time limits on children's smartphone use, we do not recommend parents co-use the media with children without discussing content. As noted by Hefner et al. (2018), co-use along with instructive mediation lends support to mitigate teenagers' problematic smartphone use. Although parental instructions for children's smartphone use have no association with their SAT in the current study, we suspect that children's intake of parental instructions depends on their online experience (Kalmus et al., 2015). If parents' wordy instructions have nothing to do with their children's main purpose for smartphone use, then parental instructions may be ignored. Parents being a good model of technology use would be a better policy in regard to mediating children's smartphone use (Hefner et al., 2018).

5.4. Difference between senior and junior high school students

The analytical results show that junior high school students have poorer knowledge of smartphone cybersecurity. In a prior study, Lareki et al. (2017) noted that young teenagers perceive their behavior with digital technologies as less risky. This finding raises concerns in teenagers' smartphone use. It is advised that parents educate teens on cybersecurity with smartphones when they are young based on our findings.

There is no significant difference in teenagers' SAT between junior and senior high school students. The use of smartphones has permeated all ages. As evidenced by the present results, junior and senior high school students are both susceptible to smartphone addiction. The SAT of younger children, such as elementary school students, would be an interesting topic to explore in future research.

6. Conclusion and research limitations

In this study, we unearthed several interesting facts about teenagers' smartphone addiction tendency. First, in addition to exploring age and gender differences, we ascertained that dissimilar purposes for surfing the Internet have something to do with the SAT of students at different

levels of education. Online games and trade are related to junior high school students' SAT, while SNSs are associated with senior high school students' SAT. Parents and teachers are recommended to guide or help students maintain the habit of using the smartphone for academic purposes. On the other hand, parents and teachers are recommended to remind students of the potential risks of using the smartphone for entertainment. The foci of instructional interventions can be designed accordingly. Second, parents ought to think twice before handing a smartphone to a child if parents cannot be on guard during children's smartphone use since smartphone ownership is highly associated with SAT. Third, teenagers' cybersecurity knowledge regarding smartphones is negatively related to their SAT. This finding highlights the importance of cybersecurity education embedded in secondary education. Lastly, we found parents are not aware of senior high school students' smartphone use, and parent-reported mediation strategies were barely effective. Imposing time limits likely works in restraining junior high school students' SAT only inasmuch as parents are cognizant of their children's smartphone use.

There are directions for future research suggested by the limitations of the current study. The current study attempts to grasp the idea of how parental mediation is related to teenagers' SAT. However, merely the opinions of one parent from each family were collected. To alleviate parental impatience to answer the survey questions, we investigated three types of parental mediation through simple questions. Researchers interested in this topic are suggested to take miscellaneous parental mediation into account. A parent's agreement that the child is a smartphone addict is definitely not a comparable measure to student-reported SAT scale, we suggest parents rate the SAT scale for comparison in the further research. Additionally, it cannot be emphasized more that these cross-sectional surveys depicted the status quo. As Livingstone et al. (2017) noted, we recommend that a qualitative study conflating parents' and children's viewpoints corroborate the statistical results. On a related note, the current study is tied to smartphone use. As the technology evolves, teenagers' preferences for interactive devices and the purposes for surfing the Internet may change. Teenagers' addiction tendency to different devices and the related factors definitely merit additional research.

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Appendix. Questions of smartphone cybersecurity knowledge

- Which of the following is not the potential risk of disclosing the name and location when using smartphone applications?
 - Knowing one is left alone and unable to reach help, those bent on committing robbery are more likely to do it.
 - People will send advertisement messages to my smartphones.
 - Those who want to abduct kids will have access to the disclosed information and go kidnap the kid at the location he/she has revealed.
 - The thief can steal something from your house when you are not home.
 - I do not understand this question.
- Which of the following is a potential insecure source of installing the applications on the smartphones?
 - The app stores managed by the operation system companies such as Google App.
 - The app stores managed by the telecommunication industry such as China Telecom.

- The app stores managed by smartphone manufacturer such as Acer.
 - The android package kit on the file-sharing websites.
 - I do not understand this question.
- An amusing online game introduced by your friend demands your email account. What are you supposed to do when your friend suggested you to set up an email account by registering on the website offering free email accounts?
 - Fill in your personal information on the website accordingly to get an email account.
 - Fill in false personal information on the website to get an email account.
 - Think twice when filling in the personal information on the website.
 - Choose a reliable website and fill in the personal information cautiously by looking into the other websites offering free email accounts.
 - I do not understand this question.
 - What are you supposed to do when you receive an unknown email inviting you to click the hyperlink to get the autographs of the celebrities?
 - I should not click the hyperlink arbitrarily because this could be a malicious email.
 - Click the hyperlink as soon as possible in case of limited autographs.
 - Share the hyperlink to the fans of the celebrities.
 - Click the hyperlink and fill in the personal information of my parents and siblings to increase the likelihood of getting the autographs.
 - I do not understand this question.
 - Which of the following is not the characteristic of a shortened URL?
 - It is easy for memorizing and sharing.
 - It is less wordy in comparison with the original URL.
 - It is a meaningless code.
 - The same URL may correspond to different shortened URLs.
 - I do not understand this question.

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