Socioeconomic Influence on Adolescent Problematic Internet Use through School-related Psychosocial Factors and Pattern of Internet Use

by

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Statement of Originality

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Abstract

Unlike other problem behaviors, the existing scientific literature on adolescent problematic Internet use (PIU) does not provide a comprehensive picture of the possible dynamics between important aspects of life in the shaping of PIU, in spite of the plentiful studies focusing on specific categories of variables. Particularly, how socioeconomic background could exert direct influence or indirect influence through any potential mediators in various environments, such as school and family on PIU was unknown. This absence of a macro-perspective of the problem largely hindered education and public health policy decision making. Without such information, adolescents from particular social strata who require additional assistance to tackle PIU might remain unidentified. Therefore, this study aimed at closing this research gap on the possible dynamics among the relevant important variables in relation to PIU. Based on Problem Behavior Theory, a conceptual model of PIU with three layers of variables, namely socioeconomic variables, school-related psychosocial variables and pattern of Internet use, was formulated. The conceptual model was tested using self-report data from a cross-sectional survey of 744 students from two Hong Kong secondary school. Path analysis was conducted to yield a fitting explanatory model of PIU with the adopted relevant variables. Findings suggested two different potential roles played by socioeconomic background in determining PIU. First, it potentially exerts influence as an antecedent through other intermediary determinants, such as educational stress and relationship with teachers. Specifically, while higher family income and higher father education were found to be risk factors of PIU, a better-educated mother was identified to be a protective factor. Second, it potentially moderates other parts of the mechanism that shapes PIU. In particular, it was found that parental education and family income significantly moderates the association between amount of Internet use and severity of PIU. In summary, findings of this study preliminarily revealed the potential effects of socioeconomic background on PIU as antecedents through various

paths of influence and as moderators. Public health policies could accordingly be more focused on adolescents belonging to specific social strata who require additional assistance with regard to PIU. Also, school policies and parenting strategies could be better informed with reference to the relevant psychosocial variables and pattern of Internet use.

Keywords: socioeconomic background, school psychosocial environment, pattern of Internet use, problematic Internet use

Table of Contents

List of Abbreviations

BIC	Bayesian Information Criterion
CD	Coefficient of determination
CFI	Comparative fit index
CI	Confidence interval
df	Degree of freedom
FIML	Full information maximum likelihood
HK	Hong Kong
IAT	Internet Addiction Test
LL	Lower limit
MICE	Multivariate imputation by chained equations
MLMV	Maximum likelihood with missing values
OR	Odds ratio
PC	Personal computer
PIU	Problematic Internet use
RMSEA	Root mean square error of approximation
TLI	Tucker-Lewis Index
UL	Upper limit

List of Figures

List of Tables

Chapter 1: Introduction

There is a huge variety of terminology and conceptualizations of problematic Internet use (PIU) in the existing literature (Byun et al., 2009; Young, 2004). When first introduced, 'Internet addiction' was the most common term (Young, 1998a, 1998b), because the proposed diagnostic criteria were based on those adopted for pathological gambling (Young, 1998a, 1998b). Nevertheless, due to prolonged absence of an official diagnosis, researchers switched to using other terms or definitions such as 'problematic Internet use' (Goldsmith & Shapira, 2006) and 'compulsive Internet use' (Greenfield, 1999) to avoid confusion with well-established psychiatric disorders.

Although various views about the problem exist and each perspective has its unique emphases, advocates of these competing definitions agree on one common aspect: harm to the individual. For instance, excessive Internet users tend to have poorer time management (Tsimtsiou et al., 2014), less social activities (De Leo & Wulfert, 2013) and lower life satisfaction (Li, Garland, & Howard, 2014) etc. Accordingly, in this report, PIU is defined as: *'The excessive use of the Internet that causes disturbances or harm to the individual'*, where 'Internet use' is referred to as access to the internet for information, entertainment or other purposes with any devices. For the sake of consistency, the term 'problematic Internet use' (PIU) would be adopted throughout the report.

1.1. Current Knowledge of PIU

Evidence for the relationship between various psychiatric disorders and PIU has been well established (Carli et al., 2013). Although there is no strong evidence for a causal relationship, PIU is generally understood as negatively related, if not detrimental, to the

mental health of adolescents (Ko, Yen, Yen, Chen, & Chen, 2012; Ko, Yen, Yen, Chen, & Weng, 2008; Ko, Yen, Liua, Huang, & Yen, 2009). It has been consistently reported that prevalence of PIU among school-aged adolescents was the highest across the globe (Spada, 2014). This is possibly related to the stage of psychological development of adolescents, at which vulnerability to various addictive behaviors is considerably higher (Baumrind, 1987; Chassin, Hussong, & Beltran, 2009; Kandel, Kessler, & Margulies, 1978). In view of the potential harm to adolescents' mental health, parents, teachers and numerous other parties are in urgent need for additional information to tackle PIU.

1.1.1. Established Risk Factors

A wide range of variables have been studied as risk or protective factors of PIU. As reviewed by Kuss, Griffiths, Karila, & Billieux (2014), male gender, loneliness, particular personality traits, various means and motives of Internet access were found associated with PIU. In a systematic review conducted by Lam (2014), psychopathologies of the participants, family and parenting factors, and others such as Internet usage, motivation, and academic performance were reported as potentially relevant in the shaping of PIU over a period of time.

1.1.2. Environmental Risk Factors Under-Researched

Unfortunately, in the existing literature, the notion of prevention has not been given sufficient discussion for parents and educators to make reference to. More specifically, there is currently a gap of knowledge on how a counter-PIU environment could be fostered for adolescents at various levels, such as school environment and the community, etc (Kuss et al., 2014). In fact, only in recent years were family factors given more emphases in research studies (Lam, 2015; Li et al., 2014). However, many other important aspects of adolescents' life as well as social factors that are potentially relevant to the shaping of PIU still remain under-investigated, such as the school environment and socioeconomic status (Kuss et al., 2014). Even more importantly, no study has included a wide variety of variables in the

analysis simultaneously to provide preliminary findings for the development of a comprehensive theory of the possible dynamics between the environment, characteristics of the adolescent and PIU.

1.2. Aim of the Study

Such an insufficiency of knowledge largely hindered education and public health policy making as well as individual school practices regarding adolescent PIU. Without an understanding of the possible mechanism determining PIU as a consequence of the dynamics among a variety of relevant environmental and personal factors, no scientifically-based intervention strategies could be formulated to tackle the problem. Hence, in this investigation, socioeconomic background, school-related psychosocial variables and pattern of Internet use were examined together as potentially important factors which relate with one another to further develop the theory of PIU. Theoretical understanding aside, examination of these variables could facilitate the prevention and management of adolescent PIU in three ways. First, by including socioeconomic indicators, adolescents belonging to specific social strata that were potentially at higher risks of PIU could be identified; second, by adopting school-related psychosocial variables, individual school policies regarding Internet use of students could be better informed; and third, by including Internet use pattern variables, it could be revealed what types of Internet use should be regulated. Besides, the inclusion of these three aspects covers many of the adolescents' environmental exposures and daily life and is facilitative of developing even more comprehensive theory of PIU in the future.

In summary, this study aimed to reveal the possible mechanism by which PIU was shaped in adolescents to inform education and public health policies of the government as well as individual school practices. It could provide preliminary evidence for multivariate relationships between PIU and multiple relevant factors of different aspects in a theoretically

organized manner, including socioeconomic background, school-related psychosocial factors and pattern of Internet use. It could therefore suggest plausible causal relationships between variables for future investigations on similar topics.

1.3. Potential Influences from Socioeconomic Background

Identification of socioeconomic indicators associated with PIU could locate groups of adolescents in society who are at higher risk and require additional assistance. Although little research has investigated socioeconomic background as associated with PIU (Hur, 2006), it has consistently been identified to be strongly associated with other adolescent delinquent behaviors (Agnew, Matthews, Bucher, Welcher, & Keyes, 2008; Nye, Short, & Olson, 1958). It exerts influence by dictating adolescents' sociocultural and psychosocial exposures in their everyday life (Haj-Yahia, Leshem, & Guterman, 2011; Sommers, Fagan, & Baskin, 1993). In this study, family income, parental education and neighborhood (housing) were examined, with reference to previous studies that included these socioeconomic variables as potential determinants of health outcomes (Chung, Mercer, Lai, Yip, Wong & Wong, 2015). Since combining these variables to represent an overall socioeconomic status will inevitably be accompanied by a loss of information, they were respectively included in the analyses.

1.3.1. Family Income

Mixed findings on the association between family income and PIU were reported in previous studies. In a Turkish study of 4,311 adolescents, Ak, Koruklu, and Yılmaz (2013) reported a positive association between family income and PIU ($\beta = 0.097$, $p < 0.001$). Similar findings were obtained by Cao, Sun, Wan, Hao and Tao (2011) in a Chinese sample of 17,599 adolescents. To the contrary, Leung and Lee (2012) identified a negative association between the two in 718 Hong Kong adolescents ($\beta = -0.11$, $p < 0.05$). Direction of influence of family income on PIU is therefore uncertain and requires further research to confirm. In general, it is hypothesized that with a higher family income and thus easier access

to the Internet and more advanced Internet devices, the risk of PIU might be higher due to higher gratification from Internet use.

1.3.2. Parental Education

Similar to family income, mixed results were reported for parental education. Heo, Oh, Subramanian, Kim, and Kawachi (2013) analyzed data from a national survey of 57,857 Korean adolescents and found a significantly lower level of PIU in adolescents whose parents attained high school (β = -0.39, 95%CI [-0.71, -0.08]) or college education (β = -0.44, 95%CI [-0.79, -0.11]) compared with those whose parents attained middle school education or below. However, in a later review by Li et al (2014), although two Chinese studies reported negative associations between father's education and PIU, three others identified positive relationship between parental education and PIU. In this study, parental education is hypothesized to be positively associated with PIU because of the higher Internet literacy and the better knowledge of how to have fun with it.

1.3.3. Neighborhood

Research examining the neighborhood's effect on PIU was scarce. However, extensive research has been conducted to examine the relationship between neighborhood and other delinquent behaviors and confirmed that prevalence of such behaviors varied by neighborhood (Chung & Steinberg, 2006; Simcha-Fagan & Schwartz, 1986). In many countries, such effect could be represented by the type of housing, e.g. public or private, which somewhat reflects the socioeconomic status of the neighborhood (Lynch & Kaplan, 2000). In Hong Kong for example, public housing generally represents a lower socioeconomic position (Ou et al., 2008). It is hypothesized in this study that public housing is associated with a higher risk of PIU in adolescents due to the lack of venues and inconvenience for alternative leisure activities.

1.4. School-related Psychosocial Variables

School-related psychosocial variables are important because they might somehow be readily amenable by school teachers to prevent or tackle PIU in adolescents. Numerous proposed intervention strategies for different problem behaviors were designed with various school-related psychosocial factors as entry points, for example, peer relationship (Skrine, Turnbull, Kazimirski, & Pritchard, 2013), teacher rapport (Clunies-Ross, Little, & Kienhuis, 2008; Martinussen, Tannock, & Chaban, 2011), as well as educational stress management (Forman, 1993; Haggerty, 1996).

1.4.1. Peer Relationship

The association between peer relationship and PIU has been well researched. A consistent negative association was observed. For instance, peer problems were found to be associated with PIU by Critselis and Janikian (2014) in a Cypriot sample of 805 adolescents (*OR* = 7.14 [1.36, 37.5]). Also, good friendship was reported as a protective factor of PIU by Kamal and Mosallem (2013) (good friend relations: *OR* = 0.2, 95%CI [0.1, 0.3]), and H. Wang, Zhou, Lu, Wu, and Deng (2011) (poor classmate relations: *OR* = 2.42, 95%CI [1.55, 3.77]).

1.4.2. Relationship with Teachers

Relatively few studies examined relationship with teachers as potentially associated with PIU. Wang et al. (2011) reported that a worse relationship with teachers was also associated with higher likelihood of PIU (*OR* = 1.49, 95%CI [1.02, 2.17]). Nevertheless, Park (2009) examined the same association without identifying any significant relationship.

1.4.3. Educational Stress

In recent years, educational stress has been given more emphasis in research. A Korean study of 512 adolescents in 2015 by Jun and Choi (2015) reported a positive effect of educational stress on PIU mediated by negative emotions. Also, a Singaporean study of 1,437

adolescents reported small positive correlations between educational stress and PIU (Chong, Chye, Huan, & Ang, 2014). These findings seem to support a positive relationship between educational stress and PIU.

1.5. Pattern of Internet Use

Since PIU was defined as an excessive use of the Internet that causes harm to adolescents' daily life, there was a behavioral component in the issue. It is important to understand what kind of Internet use causes harm and what amount of Internet use is excessive such that it causes harm. Therefore, amount of Internet use and four most prevalent purposes of Internet use among adolescents aged 10-14 were investigated (Hong Kong Census and Statistics Department, 2015a).

1.5.1. Social Media Use

Evidence for the positive association between social media use and PIU was well established. In a longitudinal study of 417 Hong Kong adolescents by Leung (2014), baseline social media use predicted PIU a year after (ΔR^2=0.02, $p < 0.001$). In the Dutch sample of 3,105 adolescent, Kuss, Rooij, Shorter, Griffiths, and Mheen (2013) also identified a positive association between the two.

1.5.2. Online Gaming

Excessive online gaming has been extensively studied as a separate behavioral problem from PIU (Kuss & Griffiths, 2012). In this study however, the focus was placed on how online gaming interact with other variables and shaped PIU. A positive association has consistently been identified. For instance, Kuss et al. (2013) reported positive association between online gaming and PIU in a sample of 2,257 English university students, while Teng, Li, and Liu (2014) also identified a positive correlation between the two in a Chinese sample of 211 male adolescents.

1.5.3. Online Music and Video Entertainments

Little research and evidence on the association between online music / video entertainments and PIU are available. In an online survey, Pontes, Szabo, and Griffiths (2015) reported no relationship between the online music and PIU but a positive association between online video / movie and PIU (r = 0.08, 95%CI [0.02, 0.14]). Further research is needed to confirm the potential association.

1.5.4. Academic Internet Use

There is little research on the association between academic use of the Internet and PIU as well. In a study of Cypriot adolescents, Critselis and Janikian (2014) did not identify a significant relationship between the two (OR = 0.62, 95%CI [0.22, 1.75]). However, since PIU has been consistently found associated with poor academic performance (Jang, Kim, & Choi, 2012; Xu, Shen, Yan, Hu, & Yang, 2012), there is possibly also an association between academic Internet use and PIU. This, nonetheless, requires further research to confirm.

1.5.5. Amount of Internet Use

Amount of Internet use was usually measured with the time spent online and it has almost always been found associated with PIU (Kuss et al., 2014). The consistency of such findings is natural based on the common understanding of PIU. Since PIU is defined as excessive use of the Internet that causes harm, additional Internet use should considerably increase the harm to adolescents.

1.6. Potential Dynamics between These Variables

While these aforementioned variables are potentially associated with PIU respectively, they probably also correlate with one another. For example, peer relationship has consistently been found positively associated with online social media use, while both of them were found associated with PIU respectively (Košir, Horvat, Aram, Jurinec, & Tement,

2016). In other words, some of the variables might exert indirect influences on PIU through other variables. Therefore, merely examining the association between all the variables with PIU could not facilitate the construction of a full picture of the plausible causal mechanism. Variables should be further organized based on a theoretically sound framework to reflect the potential pattern of influence.

1.7. Conceptual Framework

1.7.1. Problem Behavior Theory

The guiding theoretical framework of this study was Problem Behavior Theory by Jessor and Jessor (1977), which was commonly adopted in research studies on adolescent delinquencies, for example, risky sex (Fielder, Walsh, Carey, & Carey, 2013; Helms, Sullivan, Corona, & Taylor, 2013), cigarette smoking (Klassen, Smith, & Grekin, 2013; Yang, Cheng, Ho, & Pooh, 2013), drug abuse (Chapman & Wu, 2013; Yan Wang et al., 2014) and dissatisfactory academic performance (Nebbitt, Lombe, Lavelle-McKay, & Sinha, 2014). According to Jessor et al. (2003), as much as fifty percent of variance in problem behaviors could be explained by the theory. Variables were classified into antecedent background variables, social psychological variables and social behavioral variables as shown in Figure 1. Within each of these types of variables, they were further organized into various systems. It was theorized that dynamic interactions existed between different variables in the systems and could lead to variations in the propensity towards the investigated behavior (Jessor et al., 2003). The driving mechanism of influences and relationships between variables within the PBT framework is social learning and social control. This is because the nature of the behavioral outcomes are problem behaviors that arouse concerns from others and are generally undesirable by the social norm to which adolescents make reference regarding their own behavior. Occurrence of these behaviors inevitably triggers certain social control

responses. Numerous previous studies on PIU have adhered to similar driving mechanisms (Ko et al., 2009).

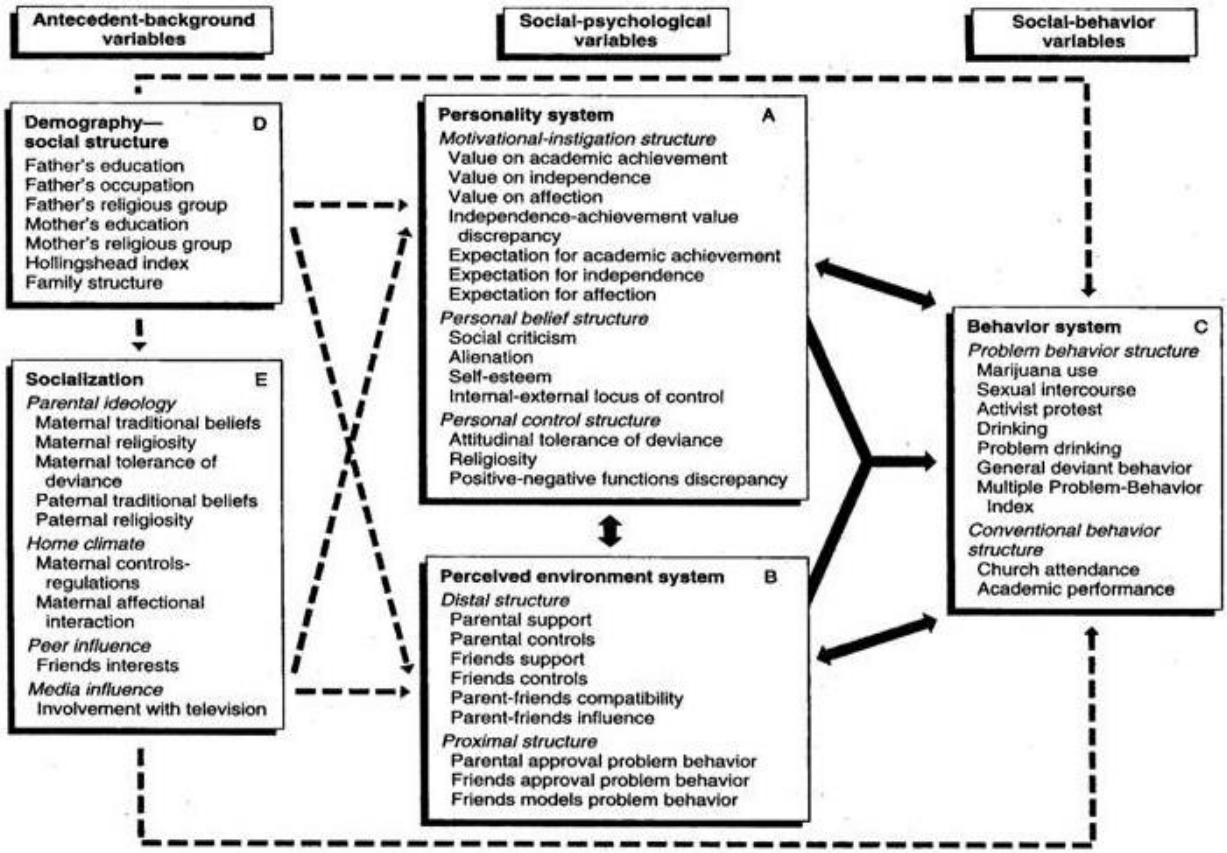

Figure 1. Conceptual Structure of Problem Behavior Theory (Jessor & Jessor, 1977)

There were two reasons for the adoption of Problem Behavior Theory. First, PIU has been identified as consistently associated with other problem behaviors. It was highly possible that the casual mechanism determining other problem behaviors could be applied to PIU (Ko et al., 2008; Walther, Morgenstern, & Hanewinkel, 2012; Yau et al., 2014; Yen, Yen, Chen, Tang, & Ko, 2009). Besides, Jessor (1991) also suggested in a review that PIU should be included as a problem behavior as defined in the theory.

Second, it enhanced comparability of the study findings with previous studies since Problem Behavior Theory was a dominant theoretical framework in research on PIU (Barlou,

2013; De Leo & Wulfert, 2013; Ko et al., 2008). Findings that were based on similar train of thoughts should be facilitative of further synthesis in improving theories and increasing knowledge about PIU in general.

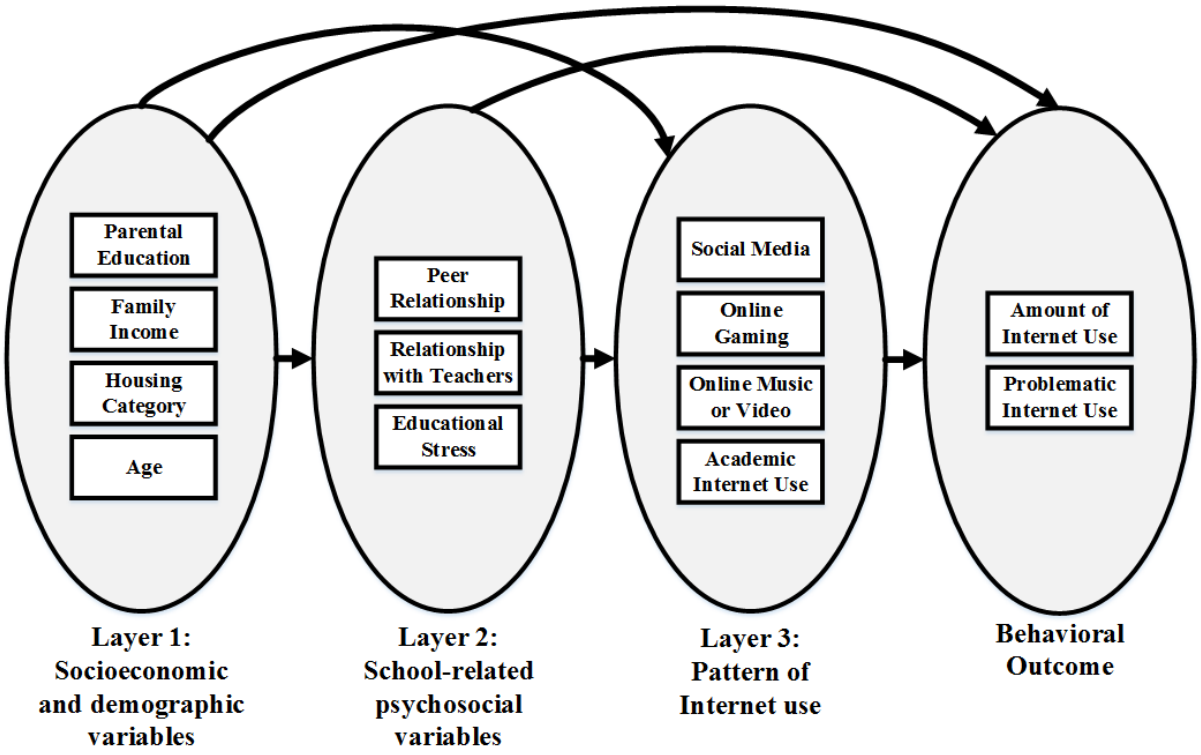

Figure 2. Conceptual Framework of Current Study

1.7.2. Current Conceptual Framework

As shown in Figure 2, the organization of the wide variety of variables in this current study based on the causal proximity to the behavioral outcome (i.e. PIU) was inherited from Problem Behavior Theory. Specifically, causally remote background variables, such as socioeconomic indicators, might probably not have direct influences on problem behaviors, such as PIU.

Hence, there might be other different types of variables such as psychosocial variables and purposes of Internet use mediating the influences. Similar categorization of

variables was adopted to adhere to the rationale behind the working mechanism of the causal structure of Problem Behavior Theory. Based on such organization, a conceptual framework was formulated. There were three ‘layers’ of interacting variables in the conceptualized causal mechanism. First, socioeconomic variables and age were categorized as an exogenous layer of variables, which was most remote from PIU and it resembled the antecedent and background variables in Problem Behavior Theory. Second, school-related psychosocial variables were incorporated as representing the Problem Behavior Theory’s social psychological variables specifically in the school environment. Third, pattern of Internet use was included as the last layer which had more direct causal influences on PIU. Lastly, the dynamic interactions between variables of each layer were conceptualized as jointly affecting the degree of PIU.

Chapter 2: Method

2.1. Study Population

Hong Kong secondary school students from Form 1-4 (equivalent to 7th-10th grade in the US) was chosen as the study population. There were two major reasons. First, abundant research has already been conducted in the same population. For instance, Yu and Shek (2013) launched a large-scale 3-year longitudinal study with 3,325 students from 28 schools in Hong Kong, revealing positive effects of youth developments on PIU in adolescents. More recently, Wang, Wu, and Lau (2016) applied a health belief model and examined the presence of peers with PIU as an associated factor of PIU based on a sample size of 9,518, providing insightful implications to future educational practices in the Hong Kong secondary school context. With the already sizeable amount of accumulated information about the population, findings could be more context-specific and could provide more insightful implications on the specific population if the same study population was studied.

Second, a relatively high prevalence rate also motivated the choice of Hong Kong adolescents as study population. In 2012, Shek and Yu (2012) reported a prevalence of 26.4% in secondary 1 (equivalent to 7th grade in the US) students based on the 10-item Young's Internet Addiction Test (Shek, Tang, & Lo, 2008). In other words, one in every four Hong Kong adolescents of similar age had PIU. As PIU had been identified to be consistently associated with other psychiatric comorbidities (Ho et al., 2014; Lam, Peng, Mai, & Jing, 2009), more information was urgently warranted for government and school policy formulation to prevent PIU and related mental health issues in Hong Kong adolescents.

2.2. Participating schools

Students from two secondary schools (School A and School B hereafter) participated in this current study. The schools were respectively selected from two districts of Hong Kong that were socioeconomically distant from each other. Around five hundred responses from School A in a district with higher overall socioeconomic status was solicited and served as the main dataset for statistical model construction. On the other hand, School B in a less socioeconomically advanced district provided around two hundred forty responses and served mainly as the validating dataset for a preliminary comparison between the mechanisms shaping PIU in two distinct socioeconomic environments. Please refer to Figure 3 for details of the analytic procedures of the investigation.

Specifically, School A was an all-girls' school located in Central & Western district, while School B was a co-educational school located in Sham Shui Po. As revealed in the data, a majority of the students live in the same district of their own school (See Table 3). According to the Hong Kong Census and Statistics Department (2015b), Central & Western district was estimated to be the second wealthiest (out of 18) district in terms of median monthly household income (HK$35,000), whereas Sham Shui Po was reported to be the poorest (HK$19,000). In addition, Central & Western district has long been Hong Kong's major central business region with modernized infrastructure and well-organized district planning and management. Sham Shui Po, on the contrary, was once an important center of manufacturing industries in the mid-20th century. Since the later decline of manufacturing industries in the 1980s, it has become notorious in recent years for numerous social problems such as poverty, poor housing environment, poor hygiene and lack of public facilities (Cheng, 2012). Table 1 illustrated the comparison between the two districts based on publicly available statistics. Overall speaking, Central & Western district is far more advanced than Sham Shui Po in terms of general socioeconomic status.

Table 1

Comparison between the Two Districts from Which the Two Participating Schools were Recruited Respectively

	Central & Western	Sham Shui Po
Median age	40	43
Median monthly household income (HK$)	35,000	19,000
Percentage of owner-occupier households (%)	57.6	39.2
Percentage of population aged 65 or above (%)	14.0	16.7
Percentage of population with bachelor's degree or above (%)	43.1	21.4
Full-time students as percentage of population (%)	18.4	16.0

Note. Information reported by Hong Kong Census and Statistics Department (2015b)

2.3. Data Collection

A self-administered questionnaire was distributed and collected upon informed consent during the students' morning reading class in March (School A) and April (School B) 2016. Among the 769 students invited, 744 completed and returned the questionnaire, constituting a response rate of 96.75%. Data entry was then independently conducted by an undergraduate student helper under close supervision by the investigator. This study was approved by the Human Research Ethics Committee of The Education University of Hong Kong (Ref: 2015-2016-0010).

2.3.1. Study Outcome

PIU was measured with the summative score of a Chinese adolescent version of the 20-item Internet Addiction Test (IAT) with a 5-point Likert scale (from 1= 'never' to 5='always') originally developed by Young (1998a) and later validated in the Hong Kong adolescent population by Lai et al (2013), who reported an excellent Cronbach's α of 0.93. While the factorial structure of IAT has long been contested (Faraci, Craparo, Messina, & Severino, 2013; Lortie & Guitton, 2013), a number of studies supported unidimensionality of IAT (Hawi, 2013; Khazaal et al., 2008; Pontes, Patrão, & Griffiths, 2014) and many studies accordingly adopted the IAT summative score as a valid measure of the degree of PIU (Kuss

et al., 2013). Hence, this practice was followed in this study to enhance comparability of results. In the current investigation, Cronbach's α of IAT was 0.91.

2.3.2. Socioeconomic Indicators (Layer 1)

Four socioeconomic indicators were adopted. First, parental education (father and mother respectively) was solicited with the options of 'master's degree or above', 'bachelor's degree', 'non-degree tertiary education', 'high school graduate', 'middle school graduate', 'primary school or lower' and 'other/unknown'. Second, self-rated family income was obtained with 'very high', 'quite high', 'fairly high', 'average', 'fairly low', 'quite low' and 'very low' as options. Third, housing type was solicited and categorized as 'public', 'subsidized', 'private (tenant)', 'private (owner)', 'parents' dormitory' and 'others'.

2.3.3. Psychosocial Variables in School (Layer 2)

Four school-related psychosocial variables were included in the analyses. First, relationship with peers measured with a 9-item peer-subscale of a life satisfaction scale in Chinese developed by Tian and Liu (2005) with a 6-point Likert scale ranging from 1 = 'strongly agree' to 6 = 'strongly disagree'. The Cronbach α of this subscale was reported to be 0.70. However, a pilot test of the questionnaire with 50 adolescents before data collection revealed that Cantonese speaking Hong Kong adolescents did not manage to distinguish between 'relatively agree' and 'quite agree' or 'relatively disagree' and 'quite disagree'. Therefore, the Likert scale was changed to 4-point with both pairs of the options combined as 'quite agree' and 'quite disagree'. Similar to the IAT, the summative score was computed to provide a measure of the relationship with peers. Cronbach's α of the scale was 0.83 in the current investigation. Second, a proxy measure of the relationship with teachers was solicited by asking participants to rate it on a scale of 0 to 10, respectively representing 'extremely poor' and 'extremely close'. Third, educational stress was measured with the Educational Stress Scale developed by Sun, Dunne, Hou, and Xu (2011) which was a 16-item 5-point

Likert scale instrument ranging from 1 = ‘absolutely disagree’ to 5 = ‘absolutely agree’ with a Cronbach α of 0.81 upon initial validation. The summative score was used to provide a measure of educational stress. In this investigation, the Cronbach’s α was reported to be 0.89.

2.3.4. Pattern of Internet Use (Layer 3)

Two questions on the average number of hours spent online on weekdays and weekends respectively were used to obtain weekly use of the Internet, while a single-item 7-point Likert scale question, ranging from 1= ‘never’ to 7 = ‘always’, was used to measure the frequency of Internet use for each of the four different purposes of use, namely online gaming, social media browsing (including online messaging), music or movie entertainment, and academic purposes. Similar measurement of frequency of Internet uses has been adopted by previous studies (Fusilier & Durlabhji, 2005). It was conceptualized that the purposes of Internet use jointly determined the usual amount of Internet use and thus had an indirect effect on PIU.

2.3.5. Other Demographics

For a more detailed description of the sample characteristics, other demographics were collected. Previous academic ranking in class, history of psychiatric diagnoses such as ADHD, anxiety disorder and depression, devices for Internet access, ownership of personal computers, and Internet uses required by school were obtained and tabulated as descriptive results.

2.4. Statistical Analyses

There were three sub-studies under the current investigation. First, statistical model construction was conducted with the data from School A (with higher socioeconomic status than School B) to explore how different socioeconomic backgrounds within the same school could affect PIU through psychosocial variables in school and pattern of Internet use. Second,

the data from School B (with lower socioeconomic status) were used to validate the model obtained in the first study. Based on the goodness-of-fit statistics, further analyses on how the model structure in School B were potentially different were conducted. This approach was based on the rationale that if the model was applicable to a very different school, it might also be applicable to many other schools, enhancing the generalizability of results. Third, motivated by the results from the first and second studies, an extended analysis on socioeconomic background as moderators between weekly Internet use and PIU was conducted. Figure 3 showed the analytic flow of the entire investigation.

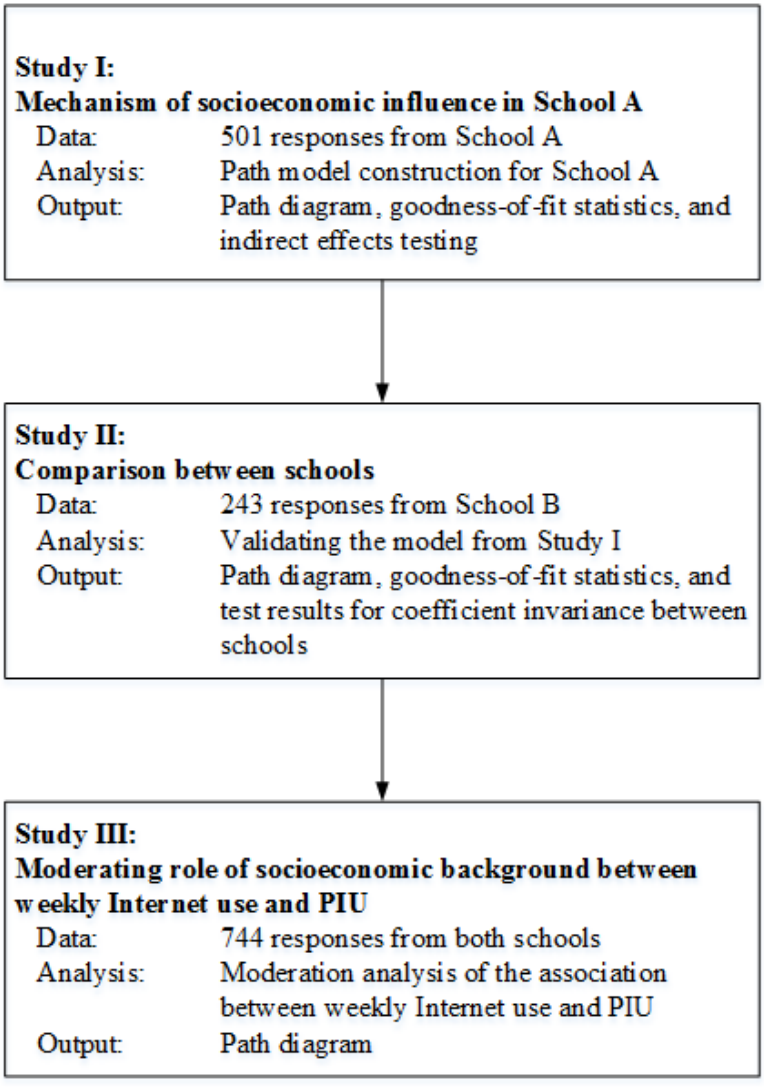

Figure 3. Analytic Plan of the Entire Investigation

2.4.1. Study I: Mechanism of Socioeconomic Influence in School A

Based on the conceptualization of the potential mechanism of the shaping of PIU discussed in earlier sections, a path model was estimated with full information maximum likelihood (FIML) method with the data from School A to investigate how each socioeconomic indicator affected PIU. Multivariate adjustment for age and gender was made for each endogenous variable. For operational purpose, a continuous score was assigned to ordinal variables as a proxy measure while residing in public housing was coded as a dummy variable in the analyses. Table 2 showed the score assignment for each variable.

Table 2

Continuous Proxy Scores Assigned to Specific Levels of Ordinal Variable

Variable	Ordinal levels	Continuous score assigned
Father's/Mother's Education	Primary School	1
	Middle School	2
	High School	3
	Non-degree Tertiary	4
	Bachelor's	5
	Master's or above	6
Self-rated family income	Very Low	1
	Quite Low	2
	Fairly Low	3
	Average	4
	Fairly High	5
	Quite High	6
	Very High	7
Purposes of Internet use (i.e. social media use, online gaming, online music or video entertainments and academic Internet use)	Never	1
	Seldom	2
	Occasional	3
	Sometimes	4
	Often	5
	Usually	6
	Always	7

Model construction was based on causal proximity of the layers of variables with PIU. Socioeconomic indicators were adopted as exogenous antecedents (layer 1).

Standardized path coefficients were then estimated to examine their potential effects on school-related psychosocial variables (layer 2), pattern of Internet use (layer 3) and, ultimately, PIU.

In an initial model, all possible paths were estimated between each layer of variables. Also, error covariance between all endogenous variables within the same layer were estimated as well. All insignificant paths except those leading from age (for multivariate adjustment) were subsequently deleted to yield a simplified model. Modification indices were then examined to detect any omitted paths that might improve model fit. Further elimination of insignificant paths in the updated model was conducted one by one based on likelihood ratio test results. Goodness-of-fit statistics were tabulated for each step of model update. Lastly, according to the final model specification, indirect effects through each specific path leading from socioeconomic variables and to PIU were tested.

2.4.2. Study II: Comparison of Mechanisms between Schools

The model obtained in Study I was tested with the data from School B. Goodness-of-fit statistics were examined to evaluate the applicability of the model in the data from School B. In addition, Wald tests for parameter invariance between schools were conducted for each model coefficient to detect any significant difference between the schools in terms of the strength of associations among variables.

In both Studies I and II, sensitivity analyses were conducted to ensure robustness of results given potential confounding effects of gender and psychiatric diagnosis.

All path analyses were conducted using STATA 13 (StataCorp, 2013).

2.4.3. Study III: Moderating Role of Socioeconomic Background between Weekly Internet Use and PIU

Motivated by the findings in Studies I and II, further analyses were conducted to examine possible moderation effects from the socioeconomic background on the association

between weekly Internet use and PIU. Such moderation was estimated using a specialized statistical software, VS, recently developed by Chan, Kwan, and Choi (2016). For operational purpose, missing values were imputed before the analyses with multivariate imputation by chained equations (MICE) implemented using the MICE package developed by van Buuren and Groothuis-Oudshoorn (2011) for the R statistical computing environment (R Core Team, 2014).

Chapter 3: Results and Interpretations

3.1. Descriptive Results

Table 3 showed the sociodemographic characteristics of the sample stratified by schools. Bivariate association tests (*t* tests for continuous variables and chi-square tests for categorical) were also conducted to detect any difference between the two schools. It was found that socioeconomic status differed substantially between them. For instance, while around 70% of the students from each school rated their family income as average, much more students of School A chose 'fairly high' (14.5% versus 3.4%) and 'quite high' (3.1% versus 1.3%). Similar contrasts were identified for housing types and parental education. In general, this reflected the huge socioeconomic difference between the two schools.

Table 3

Sociodemographic Characteristics of the Sample

	School A *n* = 501	School B *n* = 243	Total *N* = 744	*p* value
Age (*SD*)	13.93 (1.34)	14.90 (1.57)	14.24 (1.49)	<0.001
Gender				
Female	501(100.0)	75 (32.2)	576 (78.5)	<0.001
Male	0 (0.0)	158 (67.8)	158 (21.5)	
School Year (%)				
Form 1 (7th Grade in the US)	125 (25.0)	57 (23.5)	182 (24.5)	0.294
Form 2 (8th Grade in the US)	121 (24.2)	67 (27.6)	188 (25.3)	
Form 3 (9th Grade in the US)	131 (26.1)	72 (29.6)	203 (27.3)	
Form 4 (10th Grade in the US)	124 (24.8)	47 (19.3)	171 (23.0)	
District (%)				
Sham Shui Po	1 (0.2)	191 (80.9)	192 (26.3)	<0.001
Central & Western	254 (51.3)	0 (0.0)	254 (34.7)	
Southern	172 (34.7)	1 (0.4)	173 (23.7)	
Others	68 (13.8)	44 (18.7)	112 (15.3)	
Self-rated family income (%)				
Very Low	8 (1.7)	6 (2.5)	14 (1.9)	<0.001

Quite Low	8 (1.7)	11 (4.7)	19 (2.6)	
Fairly Low	42 (8.7)	41 (17.4)	83 (11.5)	
Average	337 (69.8)	166 (70.3)	503 (70.0)	
Fairly High	70 (14.5)	8 (3.4)	78 (10.8)	
Quite High	15 (3.1)	3 (1.3)	18 (2.5)	
Very High	3 (0.6)	1 (0.4)	4 (0.6)	
Father's Education (%)				
Primary School	30 (6.1)	33 (14.0)	63 (8.7)	<0.001
Middle School	53 (10.8)	54 (23.0)	107 (14.7)	
High School	134 (27.2)	45 (19.1)	179 (24.6)	
Non-degree Tertiary	21 (4.3)	2 (0.9)	23 (3.2)	
Bachelor's	54 (11.0)	5 (2.1)	59 (8.1)	
Master's or above	32 (6.5)	3 (1.3)	35 (4.8)	
Other/Unknown	168 (34.1)	93 (39.6)	261 (35.9)	
Mother's Education (%)				
Primary School	26 (5.3)	39 (16.2)	65 (8.9)	<0.001
Middle School	48 (9.8)	55 (22.8)	103 (14.1)	
High School	174 (35.4)	43 (17.8)	217 (29.6)	
Non-degree Tertiary	39 (7.9)	1 (0.4)	40 (5.5)	
Bachelor's	39 (7.9)	4 (1.7)	43 (5.9)	
Master's or above	24 (4.9)	1 (0.4)	25 (3.4)	
Other/Unknown	141 (28.7)	98 (40.7)	239 (32.7)	
Type of Housing (%)				
Public	88 (18.0)	124 (52.3)	212 (29.2)	<0.001
Subsidized	25 (5.1)	7 (3.0)	32 (4.4)	
Private Tenant	95 (19.4)	52 (21.9)	147 (20.2)	
Private Owner	238 (48.7)	16 (6.8)	254 (35.0)	
Parents' Dormitory	7 (1.4)	2 (0.8)	9 (1.2)	
Others	36 (7.4)	36 (15.2)	72 (9.9)	

Note. p value are for bivariate association tests (*t* tests for continuous variables and chi-square tests for categorical)

Table 4 showed a summary of the school-related psychosocial variables in the sample stratified by schools. In general, students from School A perceived better academic competence in themselves ($p < 0.001$), a better relationship with peers ($p < 0.001$) but at the same time heavier educational stress ($p < 0.001$). Nevertheless, no significant difference was identified in the Internet Addiction Test score ($p = 0.149$) and relationship with teachers ($p = 0.200$).

Table 4

School-related Psychosocial Characteristics of the Sample

	School A (*n*=501)	School B (*n*=243)	Total (*N*=744)	*p* value
Educational stress (*SD*)	57.07 (9.39)	51.18 (10.31)	55.20 (10.06)	<0.001
Relationship with peers (*SD*)	28.5 (3.83)	26.97 (4.13)	28.00 (4.00)	<0.001
Relationship with teachers (*SD*)	6.38 (1.57)	6.21 (1.74)	6.33 (1.62)	0.200
Internet Addiction Test Score (*SD*)	45.57 (12.52)	44.05 (13.89)	45.09 (12.97)	0.149
Academic performance (%)				
Ranks lower than 150th	2 (0.4)	11 (4.7)	13 (1.8)	<0.001
Ranks 121st - 150th	15 (3.1)	7 (3.0)	22 (3.1)	
Ranks 101st - 120th	57 (11.8)	15 (6.5)	72 (10.1)	
Ranks 81st - 100th	68 (14.1)	44 (19.0)	112 (15.7)	
Ranks 41st - 80th	146 (30.2)	90 (38.8)	236 (33.0)	
Ranks 21st - 40th	99 (20.5)	37 (15.9)	136 (19.0)	
Ranks 20th or higher	95 (19.7)	27 (11.6)	122 (17.1)	
History of psychiatric diagnoses (%)				
Attention Deficit - Hyperactivity Disorder	15 (3.0)	18 (7.6)	33 (4.5)	0.010
Depression	5 (1.0)	5 (2.1)	10 (1.4)	0.388
Anxiety disorder	9 (1.8)	7 (3.0)	16 (2.2)	0.473

Note. p values are for bivariate association tests (*t* tests for continuous variables and chi-square tests for categorical)

Table 5 showed the Internet use patterns of the participants. Overall speaking, students from School A had better access to the Internet than their counterparts from School B. Also, students from School A use the Internet more frequently for social media browsing ($p < 0.001$), academic purposes ($p < 0.001$) and for music or movie entertainments ($p = 0.012$). They were however less frequently using the Internet for online gaming ($p < 0.001$). School-required Internet use was more prevalent in School A than in School B as well, with more students indicated use of the Internet for 'homework' ($p < 0.001$), 'submission of assignments' ($p < 0.001$), 'projects' ($p < 0.001$), 'application of activities' ($p = 0.084$). Regarding the daily time spent online, students from School B reported longer hours using the Internet on both weekdays ($p = 0.007$) and weekends ($p = 0.005$).

Table 5

Internet Use Pattern of the Sample

	School A *n*=501	School B *n*=243	Total *N*=744	*p* value
Personal Computer Ownership (%)				
No PC at home	4 (0.8)	24 (10.0)	28 (3.8)	<0.001
Has his/her own PC	199 (40.5)	95 (39.7)	294 (40.3)	
Needs to share with siblings	76 (15.5)	53 (22.2)	129 (17.7)	
Needs to share with parents	58 (11.8)	13 (5.4)	71 (9.7)	
Needs to share with whole family	150 (30.5)	39 (16.3)	189 (25.9)	
Others	4 (0.8)	15 (6.3)	19 (2.6)	
Major Devices for Internet Access (%)				
Home personal desktop computer	259 (52.0)	117 (48.5)	376 (50.9)	0.422
Net Café computers	1 (0.2)	14 (5.8)	15 (2.0)	<0.001
Laptop computers	218 (43.8)	55 (22.8)	273 (36.9)	<0.001
Mobile phones	462 (92.8)	180 (74.7)	642 (86.9)	<0.001
Tablets	202 (40.6)	33 (13.7)	235 (31.8)	<0.001
Purposes of Internet use (*SD*)				
Social media browsing	5.19 (1.61)	4.13 (1.74)	4.85 (1.72)	<0.001
Online gaming	3.16 (1.70)	4.41 (1.92)	3.57 (1.87)	<0.001
Listening to music or watching videos	5.40 (1.49)	5.10 (1.56)	5.30 (1.52)	0.012
Academic purposes	4.99 (1.27)	3.81 (1.53)	4.62 (1.46)	<0.001
Required Internet use in school (%)				

Homework	390 (78.3)	94 (39.2)	484 (65.6)	<0.001
Projects	436 (87.6)	133 (55.2)	569 (77.0)	<0.001
Examination	45 (9.0)	16 (6.6)	61 (8.3)	0.333
Submission of assignments	163 (32.7)	21 (8.7)	184 (24.9)	<0.001
Receiving circular to parents	9 (1.8)	13 (5.4)	22 (3.0)	0.014
Application for activities	81 (16.3)	27 (11.2)	108 (14.6)	0.084
Internet use on weekdays (hours (*SD*))	2.55 (2.16)	3.05 (2.48)	2.71 (2.28)	0.007
Internet use on weekends (hours (*SD*))	4.80 (3.56)	5.69 (4.27)	5.08 (3.81)	0.005

Note. p values are for bivariate association tests (*t* tests for continuous variables and chi-square tests for categorical)

3.2. Path Analyses

3.2.1. Study I

3.2.1.1. Results of analyses. Table 6 showed the correlation matrix of the adopted observed variables with the data from School A. Model construction was conducted through the steps of modification as shown in Table 7, where goodness-of-fit statistics were also presented. Figure 4 showed the final path model with standardized coefficients for data from School A. All the paths shown in the model were statistically significant. Root mean square error of approximation (RMSEA) of the final model was reported as 0.000 (95% CI [0.000,0.024]) and likelihood ratio chi-square was 41.23 (df = 46; p = 0.672), while Tucker-Lewis Index (TLI) was 1.020 and coefficient of determination (CD) 0.203. These goodness-of-fit statistics results suggested very good fit of the model to the data**.**

As shown in the model structure in Figure 4, only father's education among other socioeconomic indicators seemed to have a direct effect on PIU. On the other hand, all indirect paths leading from socioeconomic indicators to PIU were tested. Table 8 showed the 7 identified significant indirect paths based on the specifications of the model structure. Five of them led from self-rated family income through relationship with teachers, social media use, online music or video entertainment, academic Internet use and weekly Internet use respectively, while the other two led from father's and mother's education through

Table 6

Correlation Matrix for Adopted Variables with Data from School A (SD reported as the diagonal)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Age	1.340													
2	Family income	-0.145*	0.791												
3	Father's education	-0.100	0.390*	1.429											
4	Mother's education	-0.0975	0.370*	0.613*	1.244										
5	Public housing	0.032	-0.258*	-0.319*	-0.264*	0.385									
6	Peer relationship	-0.017	0.044	0.027	0.043	-0.042	3.833								
7	Relationship with teachers	-0.175*	0.191*	-0.003	0.113*	0.068	0.119*	1.566							
8	Educational stress	0.234*	-0.118*	-0.197*	-0.099	-0.002	-0.052	-0.088	9.388						
9	Freq. of social media use	0.090*	0.152*	0.028	0.034	0.003	0.078	0.035	0.104*	1.609					
10	Freq. of online gaming	0.041	0.109*	0.048	0.032	0.016	-0.102*	-0.049	0.010	0.180*	1.696				
11	Freq. of online music of video entertainment	0.106*	0.080	-0.089	-0.095	0.045	0.079	-0.0519	-0.0093	0.347*	0.216*	1.486			
12	Freq. of academic Internet use	-0.053	0.040	0.040	0.093	0.006	0.054	0.163*	-0.0436	0.053	-0.146*	0.024	1.266		
13	Weekly Internet use	0.134*	0.072	-0.006	0.029	-0.014	0.050	-0.126*	0.008	0.286*	0.173*	0.248*	-0.182*	21.207	
14	PIU	0.121*	0.086	0.059	0.006	-0.003	-0.047	-0.050	0.244*	0.342*	0.218*	0.261*	-0.147*	0.356*	12.519

Note. Freq. = Frequency. * $p < 0.05$. *SD* = standard deviation.

Table 7

Model Construction for Students from School A Starting from the Initial Full Model

Model	Description	*df*	χ^2	RMSEA	95% CI		CFI	TLI	CD	BIC
					LL	*UL*				
M0	Initial full model	0	0.000	0.000	0.000	0.000	1.000	1.000	0.253	28600.0
M1	M0 with all insignificant paths deleted except those leading from age	44	41.306	0.000	0.000	0.027	1.000	1.012	0.206	28368.1
M2	M1 plus mother's education --> frequency of online music or video entertainments	43	34.996	0.000	0.000	0.020	1.000	1.035	0.219	28368.0
M3	M2 minus father's education --> relationship with teachers	44	38.393	0.000	0.000	0.024	1.000	1.024	0.209	28365.2
M4	M3 minus mother's education --> relationship with teachers	45	40.527	0.000	0.000	0.025	1.000	1.019	0.203	28361.1
M5 *	M4 minus error covariance between frequency of social media use and frequency of academic Internet use	46	41.226	0.000	0.000	0.024	1.000	1.020	0.203	28355.6

Note. RMSEA = root mean square error of approximation; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; CFI = comparative fit index; TLI = Tucker-Lewis Index; CD = coefficient of determination; BIC = Bayesian information criterion. * denotes final model.

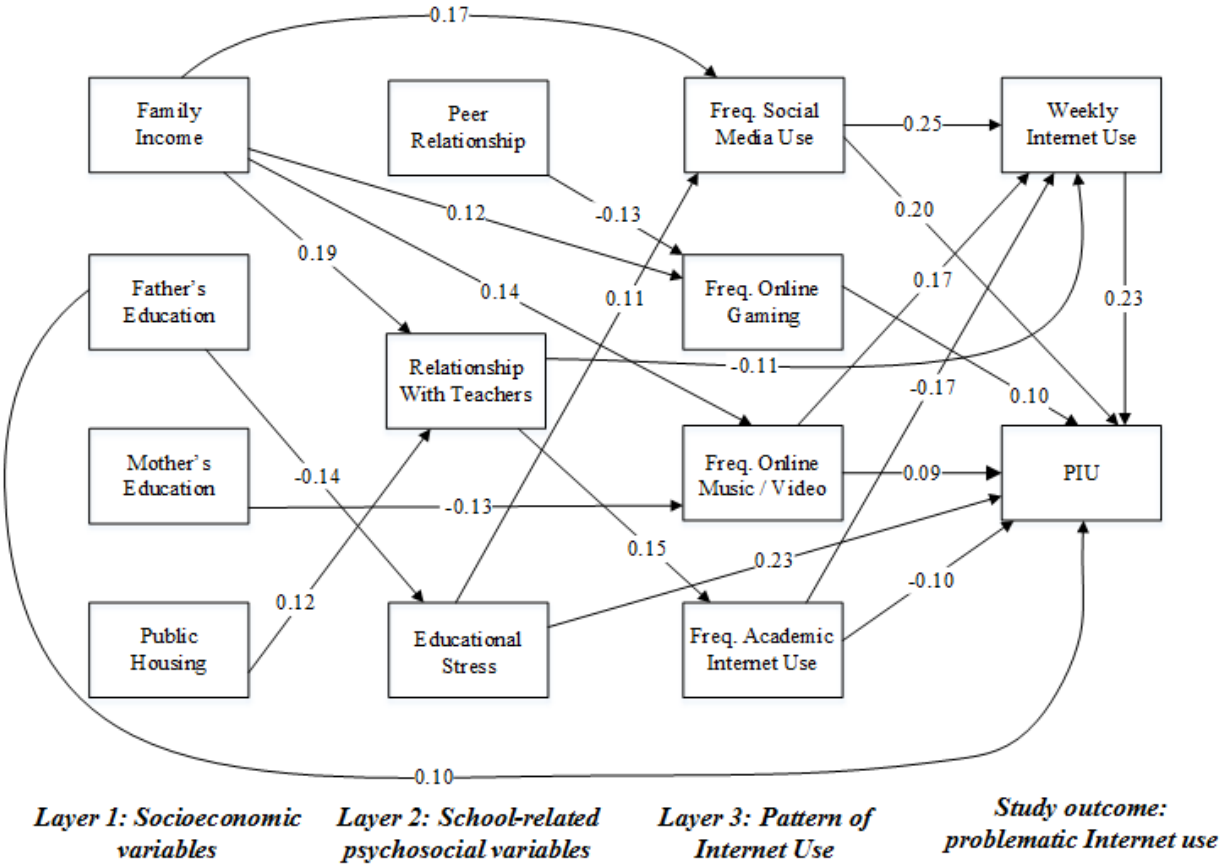

Figure 4. Final Path Model for School A with Multivariate Adjustment for Age

educational stress, online music or video entertainment and weekly Internet use respectively.

A sensitivity analysis to exclude the participants with a psychiatric diagnosis of ADHD, depression and anxiety disorder from the analyses was conducted and very similar results were obtained (data not shown).

3.2.1.2. Interpretation of findings. Findings of Study I suggested that only father's education was estimated to have a direct effect on PIU, while all other socioeconomic variables exerted influence through a series of potential intermediary determinants. By identifying specific paths of influence, a comprehensive picture of the mechanism that shapes PIU could be formulated.

3.2.1.2.1. Direct effect of father's education. Direct effect of father's education on PIU as identified in Study I is speculated to be due to the higher Internet literacy level of the

father that is inherited by the adolescent (Leung & Lee, 2012). With more skills of surfing the Internet, there should be better enjoyment of the online experience and higher gratification which, in turn, leads to more severe PIU.

Table 8

Significant Indirect Effects of Socioeconomic Indicators on PIU for School A

					95% CI	
Path	β	*SE*	*z*	*p* value	*LL*	*UL*
Income → Social media use → Weekly Internet use → PIU	0.010	0.004	2.710	0.007	0.003	0.017
Income → Social media use → PIU	0.034	0.012	2.940	0.003	0.011	0.057
Income → Relationship with teacher → Academic Internet use → Weekly Internet use → PIU	-0.001	0.001	-1.990	0.046	-0.002	0.000
Income → Online music/video → Weekly Internet use → PIU	0.005	0.003	2.070	0.038	0.000	0.011
Income → Online music/video → PIU	0.016	0.008	1.960	0.050	0.000	0.033
Father's education → Educational stress → PIU	-0.031	0.013	-2.350	0.019	-0.058	-0.005
Mother's education → Online music/video → Weekly Internet use → PIU	-0.005	0.003	-1.950	0.052	-0.010	0.000

Note. SE= standard error; CI = confidence interval; *LL*= lower limit; *UL*= upper limit

3.2.1.2.2. Indirect effects: Income → Social media use → Weekly Internet use → PIU & Income → Social media use → PIU. One of the five indirect effects of higher family income on PIU was mediated through more frequent social media use, which led to higher weekly Internet use and thus more severe PIU. Another was mediated similarly through more frequent social media use which, in turn, directly increased PIU severity. Although the relationship between social media use and PIU and that between social media use and amount of Internet use were well supported by previous studies (Kuss et al., 2013; Leung, 2014), the positive relationship between family income and social media use was less supported. For example, Lenhart, Purcell, Smith, and Zickuhr (2010) reported that American teenagers' access to social networking sites did not depend on whether they were from high or low

income families in their latest round of survey. In another American longitudinal study, Mikami, Szwedo, Allen, Evans, and Hare (2010) identified no predictive value of family income on subsequent magnitude of social media use. Hence, this association might be context-specific and subject to socio-cultural influences. Further research comparing different populations is warranted.

A plausible speculation of the reason for this identified relationship was possibly the higher gratification from social media use in adolescents with higher family income, since higher family income typically implied a larger social network with peers and thus more fun to share online (Smith-Maddox, 1999). In addition, better access to the Internet such as exclusive personal computer ownership might have induced more social media use in adolescents from higher income families (Pea et al., 2012).

3.2.1.2.3. Indirect effects: Income → Online music/video → Weekly Internet use → PIU & Income → Online music/video → PIU. An indirect effect of higher family income on more severe PIU through more frequent online music or video entertainment was identified in Study I. As discussed in earlier sections, literature on this specific purpose of Internet use is scarce. Nevertheless, the speculation for the reasons behind the indirect effect on PIU through online music or video entertainment is also similar to the indirect effect through social media use. First, more resources for a more enjoyable experience of online music or video entertainment for adolescents with higher family income served as one plausible link, such as more advanced and luxurious audio and visual technologies. Second, they could probably afford better access to the Internet for the entertainment by different means such as mobile devices.

3.2.1.2.4. *Indirect effect: Income → Relationship with teacher → Academic Internet use → Weekly Internet use → PIU.* As identified in Study I, there is an indirect negative effect of family income on PIU through the better relationship with teachers, which led to more

frequent academic Internet use and hence less overall Internet use and less severe PIU. The first stage of mediation is no surprising finding since previous studies have revealed that students from families with higher income tended to have better relationships with teachers and better interpersonal relationships in general probably due to more well-developed social and communication skills (Rudasill, Reio, Stipanovic, & Taylor, 2010). On the other hand, the association between relationship with teachers and academic Internet use probably represented the motivation induced by a good relationship with teachers for self-regulation of adolescents' own behavior (Azevedo, Dias, Salgado, GuimarÃ\poundses, & Lima, 2012; Lee, Yu, & Choi, 2012). As shown in Table 5, School A required students to use the Internet for a wide variety of academic purposes. Thus, academic Internet use was probably perceived as 'proper use' of the Internet promoted by the school. Therefore, the better the relationship with teachers, the stronger the motivation to self-regulate and meet teachers' expectations by increasing academic Internet use. This increase in the frequency of academic Internet use reduced overall gratification of Internet use and thus actual amount of Internet use as well and led to less severe PIU (Leung & Lee, 2012).

3.2.1.2.5. Indirect effect: Father's education → Educational stress → PIU. In addition to the direct effect, there is an indirect negative effect of father's education on PIU through lesser educational stress. Based on current knowledge, this indirect effect is hardly surprising. First, as reported in previous studies, lesser stress is experienced by adolescents with better educated parents with more mature parenting styles (Finkelstein, Kubzansky, Capitman, & Goodman, 2007). Second, the association between educational stress and PIU has also been well documented in the existing literature (Chong et al., 2014; Jun & Choi, 2015). Nevertheless, to the best of the investigator's knowledge, this is the first study to document a partial mediation from father's education to PIU through educational stress.

3.2.1.2.6. Indirect effect: Mother's education → Online music/video → Weekly

Internet use → PIU. Contrasting the positive indirect effect of family income on PIU through online music or video entertainment, mother's education was identified to have a negative indirect effect on PIU through online music or video entertainment in Study I. While the association between online music or video entertainment and PIU is largely anticipated, mother's education' s negative association with online music or video entertainment is believed to reflect the parenting role of mother as a manager of adolescents' behavior (Keijsers & Laird, 2014). Since higher education implies better knowledge on the potential harmful effects of excessive online video and music entertainment (Browne & Hamilton-Giachritsis, 2005; Walsh-Childers & Brown, 2009), they tend to regulate adolescents' use of the Internet for such purpose more deliberately.

3.2.1.2.7. Brief summary. In summary of the identified effects of socioeconomic indicators on PIU as antecedents in Study I, higher family income and higher father's education seemed to be a risk factor of PIU, whereas higher mother's education was revealed as a potential protective factor of PIU.

3.2.2. Study II

3.2.2.1. Results of analyses. Table 9 showed the correlation matrix of the adopted observed variables with the data from School B. The final model in Study I (M5) was applied to the data from School B, goodness-of-fit statistics suggested acceptable model fit to the data ($\chi^2(46) = 80.544$, $p = 0.0012$), with RMSEA reported as 0.056 (95% CI: 0.035-0.075), CFI as 0.835 and TLI 0.709. Figure 5 showed the path model with standardized model coefficients. Table 10 compared the estimated model coefficients for School A (from Study I) and School B, and showed the results of the Wald tests for parameter invariance between schools for each model coefficient. Specifically, the coefficient of the path leading from family income to relationship with teachers and that from online music and video entertainment to PIU were significantly different between schools. On the other hand,

Table 9.

Correlation Matrix for Adopted Variables with Data from School B (SD reported as the diagonal)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Age	1.570													
2	Family income	-0.150*	0.801												
3	Father's education	-0.0331	0.307*	1.085											
4	Mother's education	0.009	0.315*	0.671*	0.974										
5	Public housing	0.020	0.041	-0.071	-0.031	0.501									
6	Peer relationship	-0.014	-0.036	-0.095	-0.167*	-0.016	4.131								
7	Relationship with teachers	-0.003	-0.116	-0.011	0.017	-0.028	0.237*	1.742							
8	Educational stress	0.030	-0.086	-0.048	-0.038	0.048	-0.035	-0.087	10.307						
9	Freq. of social media use	0.013	0.158*	-0.030	0.125	0.029	-0.019	0.013	0.160*	1.741					
10	Freq. of online gaming	-0.181*	0.111	-0.001	0.025	0.174*	0.013	-0.082	0.103	0.219*	1.924				
11	Freq. of online music of video entertainment	-0.140*	0.191*	-0.047	-0.027	0.065	0.168*	-0.015	0.009	0.362*	0.385*	1.563			
12	Freq. of academic Internet use	0.051	0.132*	0.030	0.113	-0.023	-0.115	0.018	0.185*	0.287*	0.079	0.115	1.531		
13	Weekly Internet use	-0.097	0.096	-0.036	0.000	-0.010	0.014	-0.227*	0.097	0.234*	0.286*	0.340*	-0.087	23.768	
14	PIU	0.094	0.049	0.115	0.151	0.095	-0.129	-0.113	0.293*	0.248*	0.223*	0.036	-0.026	0.216*	13.886

Note. Freq. = Frequency. * $p < 0.05$. *SD* = standard deviation.

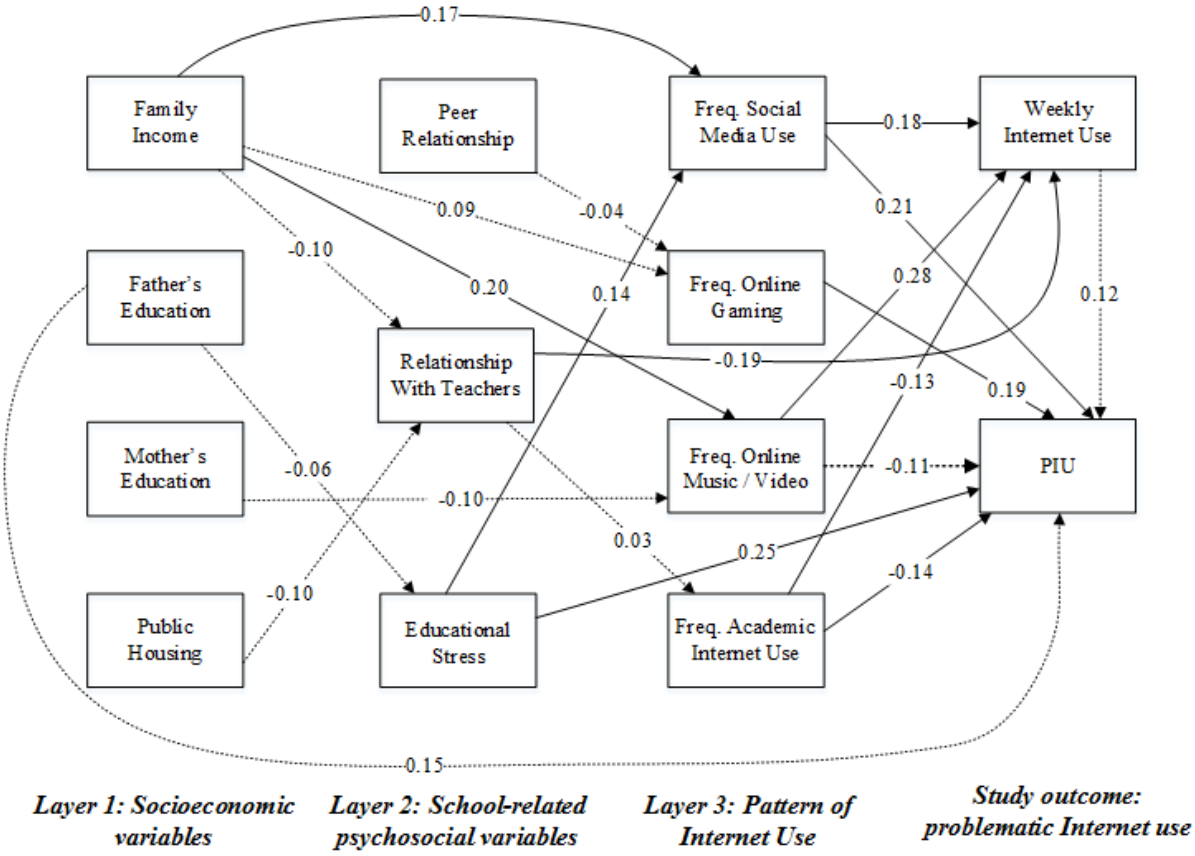

Figure 5. Model for School B. Dotted Lines Represent Insignificant Paths

Table 10

Comparison of Model Coefficients between School A and B

				Wald Test	
Dependent variable	Independent variable	β for School A	β for School B	χ^2	*p*
PIU	Online music and video entertainment	0.118**	-0.113	7.489 **	0.006
	Educational stress	0.232***	0.249***	0.064	0.801
	Social media use	0.196***	0.214***	0.091	0.763
	Online gaming	0.094*	0.191**	1.499	0.221
	Academic Internet use	-0.099*	-0.139*	0.159	0.690
	Weekly Internet use	0.233***	0.115	2.093	0.148
	Father's education	0.099*	0.149	0.869	0.351
Weekly Internet use	Online music and video entertainment	0.169***	0.278***	2.219	0.136
	Relationship with teachers	-0.106*	-0.191**	1.166	0.280
	Social media use	0.245***	0.177**	0.489	0.485
	Academic Internet use	-0.173***	-0.129*	0.467	0.494
Social media use	Educational stress	0.111**	0.143*	0.161	0.688
	Family income	0.174***	0.173**	0.015	0.901
Online gaming	Peer relationship	-0.127**	-0.036	1.318	0.251
	Family income	0.118**	0.083	0.089	0.765
Online music and	Mother's education	-0.128*	-0.098	0.000	0.984

video entertainment	Family income	0.139**	0.200**	0.648	0.421
Academic Internet use	Relationship with teachers	0.150***	0.034	1.499	0.221
Relationship with	Family income	0.188***	-0.097	10.917***	0.001
teachers	Public housing	0.122**	-0.013	3.087	0.079
Educational stress	Father's education	-0.135**	-0.064	0.127	0.721

Note. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$. 'Frequency of' omitted from frequency of social media use, frequency of online gaming, frequency of online music and video entertainment and frequency of academic Internet use

probably due to the modest sample size from School B (n = 243), among all indirect paths leading from socioeconomic indicators to PIU, only the path 'Income → Social media use → PIU' was identified as significant ($\beta = 0.037$, $z = 2.05$, $p = 0.041$).

A sensitivity analysis was conducted to add gender as a control variable into the analyses of School B data and it was found that path coefficient estimates were very similar with the model without gender (data not shown). Findings, therefore, might be robust across gender.

3.2.2.2. Interpretation of findings. Overall speaking, the mechanism of determining PIU as identified in Study I could explain the data from School B in some sense. This suggests that the dynamics as represented by School A model might be robust across schools since School A and B are very different samples to begin with.

However, only the indirect effect of 'Income → Social media use → PIU' remained significant among all potential paths of influence identified in Study I. One possible reason for that was the modest sample size of 243. In addition, the absence of a significant association between weekly Internet use and PIU have prevented the indirect influence from socioeconomic indicators as well, since 4 out of 7 identified paths of influence in Study I passed through weekly Internet use.

On the other hand, the significant difference in the path coefficient of online music and video entertainment → PIU between schools was probably due to the different interests and tastes and thus different contents of the entertainments and resulted levels of gratification.

It has been reported by previous studies that cultural preferences tend to be similar among adolescents within the same socioeconomic strata (Lewis, Kaufman, Gonzalez, Wimmer, & Christakis, 2008). Further research is needed to find out what kind of contents might be related to more severe PIU. As for the absence of a significant association between family income and relationship with teachers, it is possible that the actual family income of many of the students in School B is not within a sufficiently high range to have a positive effect on relationship with teachers. In fact, even in terms of a self-rated Likert scale rating (from 'Very high' income to 'very low' income), family income on average is far lower in School B than in School A as shown in Table 3.

In summary of the findings of Study II, it was found that socioeconomic background faded in terms of importance in the shaping of PIU among adolescents from School B. This might suggest a 'fairer' distribution of the risk of PIU by socioeconomic characteristics within School B. Also, the difference in the strength of associations among variables between the two schools suggests potential moderation effect of socioeconomic background.

3.2.3. Study III

3.2.3.1. Results of analyses. Study III was motivated by the findings in Study I and II. First, it was observed in Study I that while a better-educated father as well as higher family income act as risk factors of PIU, a better-educated mother, nevertheless, has a protective effect. Second, the association between PIU and weekly Internet use, which largely represents typical amount of Internet use, became insignificant in School B as reported in Study II. It was therefore speculated that different socioeconomic characteristics might have moderated the association between weekly Internet use and PIU.

Specifically, it was further hypothesized that a better-educated father and higher family income, which represent better resources to facilitate Internet use and enhance gratification, might strengthen the association between weekly Internet use and PIU, while a

Table 11

Correlation Matrix for Adopted Variables in Extended Analysis on the Socioeconomic Moderating Effects on the Association between Weekly Internet Use and PIU (SD reported as the diagonal)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	I	0.812															
2	P	0.083	12.924														
3	S	-0.198	-0.035	0.469													
4	G	-0.196	0.085	0.301	1.492												
5	A	-0.176	-0.037	0.77	0.193	0.412											
6	H	-0.206	0.019	0.356	0.126	0.309	0.455										
7	U	0.075	0.299	0.1	0.051	0.074	0.025	22.096									
8	F	0.394	0.055	-0.326	-0.17	-0.258	-0.347	-0.014	1.377								
9	M	0.388	0.027	-0.381	-0.191	-0.302	-0.313	0.025	0.656	1.259							
10	I × U	-0.085	0.08	-0.003	-0.051	0.046	-0.019	0.056	-0.017	0.04	18.771						
11	F × U	-0.017	0.023	-0.037	0.013	-0.033	0.013	0.073	-0.039	0.024	0.432	32.066					
12	M × U	0.039	0.04	-0.054	-0.016	-0.067	0.001	0.143	0.024	0.039	0.493	0.692	29.665				
13	S × U	-0.003	-0.034	0.071	-0.066	0.051	0.027	0.106	-0.038	-0.055	-0.191	-0.485	-0.503	10.724			
14	G × U	-0.056	-0.076	-0.072	-0.088	-0.089	0.043	-0.111	0.014	-0.017	-0.336	-0.17	-0.306	0.27	31.519		
15	A × U	0.046	-0.042	0.05	-0.08	0.097	0.018	0.077	-0.033	-0.068	-0.145	-0.408	-0.412	0.752	0.127	9.615	
16	H × U	-0.02	0.001	0.028	0.042	0.019	0.026	-0.016	0.013	0.001	-0.25	-0.474	-0.428	0.439	0.182	0.346	9.961

Note. All variables were mean centered before creating interaction terms. I = family income; P = PIU; U = weekly Internet use; S = school; G = gender; A = age; H = public housing; F = father's education; M = mother's education; *SD* = standard deviation.

better-educated mother might weaken it. Data from the 2 schools were pooled together for an extended analysis on this hypothesis. Table 11 showed the correlation matrix of the included variables for the analysis. Firstly, age, gender, school, public housing, parental education and family income were all included as moderators between weekly Internet use and PIU to preliminarily examine the moderating effects of socioeconomic background while adjusting for demographics (M6). Secondly, based on the first model, part of parental education's moderating effects was modeled as mediated by family income (M7). Lastly, the insignificant path representing direct moderating effect of father's education was eliminated to yield the final model (M8). Table 12 showed the goodness-of-fit statistics in each step of model modification. The final model was shown in Figure 6 to demonstrate the potential moderation effects, with multivariate adjustment made for age, gender, and school. It was shown in the model that after taking into account all possible moderating effects of age, gender and school, mother's education still had a significant negative direct moderation effect on the association between weekly Internet use and PIU. Besides, an indirect positive moderation effect mediated through family income was also significant. While father's education has a similar indirect positive effect through family income, no significant direct moderation effect of father's education was identified.

Table 12

Goodness-of-fit statistics for Each Step of Model Modification Examining the Moderating Effects of Socioeconomic Background between Weekly Internet Use and PIU

				95% CI				
Model	*df*	χ^2	RMSEA	*LL*	*UL*	CFI	TLI	BIC
M6	0	0.000	0.000	0.000	0.000	1.000	1.000	66663.4
M7	20	123.189	0.083	0.069	0.098	0.973	0.837	66654.4
M8 *	22	126.394	0.080	0.067	0.094	0.973	0.850	66644.3

Note. RMSEA = root mean square error of approximation; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; CFI = comparative fit index; TLI = Tucker-Lewis Index; BIC = Bayesian information criterion. * denotes final model.

3.2.3.2. Interpretation of findings. In Study III, family income, father's education and mother's education were identified as significant moderators of the association between weekly Internet use and PIU. While higher mother's education directly weakened the effect of weekly Internet use on PIU, it also had an indirect positive moderation effect mediated by higher family income. In addition, father's education positively moderated the association totally through family income. This probably reflected the different parenting role of fathers and mothers (McKinney & Renk, 2008). On one hand, parental education typically represented the socioeconomic status of the family and largely determines financial income and economic resources. As discussed earlier in the interpretation of family income's positive effect on social media use, higher socioeconomic status might imply higher gratification from Internet use since more resources could be available to the adolescents to enhance the quality of online experience. This implied that during every additional hour of Internet use, the extra enjoyment is better for adolescents from families with a higher socioeconomic status than for those from a lower status. It therefore leads to a more substantial increase in PIU severity than in adolescents from families with a poorer socioeconomic background.

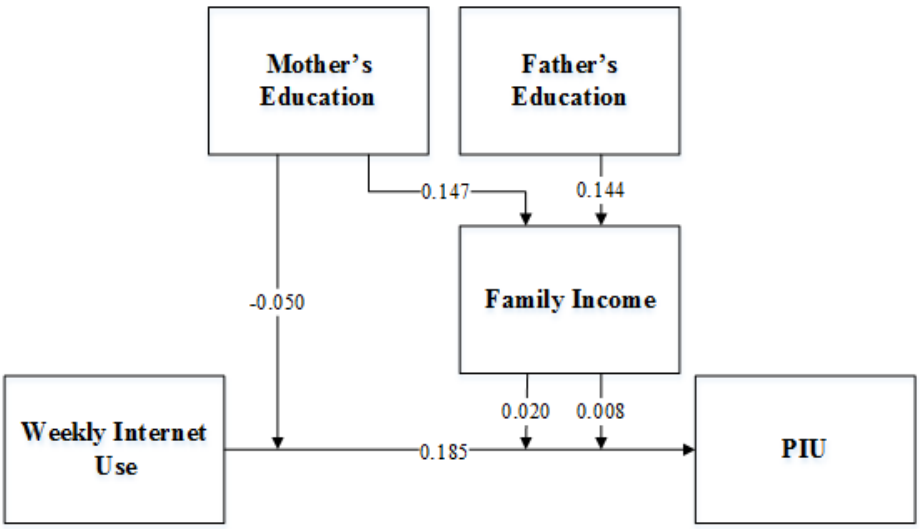

Figure 6. Significant Moderating Effects of Socioeconomic Indicators between Weekly Internet Use and PIU

On the other hand, mothers were speculated to be serving the role of the major daily guardian, who took the responsibility to manage the adolescents' behavior (Hofer et al., 2013). Higher education of the mother therefore implied a more skillful management of adolescents' Internet use and everyday behavior in general. This plausibly weakened the link through which additional daily Internet use was translated into severer PIU.

Chapter 4: Discussion and Conclusion

In summary of the findings, socioeconomic background seems to have potential impacts on PIU. Such impacts consist of two parts. On one hand, it potentially exerts influence on PIU as a causally remote antecedent through intermediary determinants such as school-related psychosocial and Internet use pattern variables. On the other hand, it potentially moderates the mechanism through which PIU is shaped in adolescents. Specifically, findings partially confirmed the research hypotheses in the sense that while family income and father's education were found to be risk factors of PIU probably due to higher Internet gratification and Internet literacy, mother's education was found to be protective of PIU.

The results well served the aim of exploring the pattern of causal influence from different aspects of adolescents' life based on Problem Behavior Theory. Possible dynamic relationship among the variables were preliminarily revealed in this study. Preliminary evidence on moderating role of socioeconomic background was identified. These findings were facilitative of further investigations on PIU in adolescents. In particular, while gratification of Internet use has been a key relevant variable in the interpretation of the results, further research adopting similar methodology should include it as a main factor of PIU.

4.1. Relationship with the Literature

In the existing literature, there is an abundance of research findings on the associations between individual aspects of adolescents' life as discussed earlier (Kuss et al., 2014; Li et al., 2014). Nonetheless, no studies have incorporated a wide variety of variables to examine potential dynamics between various aspects of life in relation to the degree and

shaping of PIU. Hence, this study adopted Problem Behavior Theory to construct explanatory models based on previous specific empirical findings and theoretical understanding of the issue to complement current knowledge by suggesting plausible paths of influence and mechanisms. It should inspire further longitudinal research to establish temporality and causality between variables.

4.2. Practical Implications

This study suggested possible ways socioeconomic background could potentially affect PIU. The practical significance of the findings is accordingly twofold. First, findings might enable easier identification of socioeconomic strata of adolescents that are at higher risks of PIU. For example, it was identified that higher father's education and family income might imply better Internet access, higher Internet literacy and better online experience which, in turn, lead to more severe PIU, while a better-educated mother might, however, be protective. This facilitates public health policy formulation by preliminarily narrowing down the target intervention group. Second, school policies and parenting strategies with regard to Internet use and PIU could be better informed and could be focused on the identified relevant intermediary determinants of PIU such as improving adolescents' relationship with teachers and reducing educational stress.

4.3. Limitations

There were several limitations to this study. First, cross-sectional data limited the findings as mere associations instead of plausible causal relationships. However, as the organization of variables was driven by a well validated theory, i.e. Problem Behavior Theory, study results should largely inspire further longitudinal investigations. Second, self-report bias was probable in the data. Nevertheless, with the pledge of strict confidentiality,

participants should be comfortable with providing honest answers. Third, convenience sampling was adopted. This limited generalizability of results to the rest of the population. Also, while differences identified between the two schools might be due to socioeconomic reasons, it could also be due to other school specific factors such as religion (School A was catholic) or gender ratio (School A was an all-girl school). Further research should significantly expand the sample of schools to confirm findings of this study. Fourth, there were missing values in sociodemographic data due to some participants' limited knowledge of their own family background. However, in the analyses, appropriate statistical methods such as MLMV and MICE were adopted to address this limitation. Fifth, measurement of family income was only based on a self-report subjective rating and it imposes reliability concerns on the variable. Also, the scale for peer relationship has not been strictly validated despite the good internal consistency in the data.

4.4. Recommendations for Future Research

4.4.1. Longitudinal Research Design

As discussed in the section on limitations, cross-sectional research design is not conducive to establishment of plausible causal relationships. To the contrary, a longitudinal design allows researchers to examine the within-subject variation over time in addition to the between-subject differences. It would be important to reveal how PIU changes over time, and how that is related to the personal and school characteristics.

4.4.2. Expand Sampling of Schools

Without a sufficiently large and representative sample of schools, it is impossible to attribute the identified differences between the schools to a certain school characteristic. For example, the sample of schools should compose of different religious backgrounds, academic rankings, geographical locations, funding modes, etc. so that formal statistical testing could

be applied to tell whether observed differences are due to chance or sampling errors. It would also be interesting to examine how school policies regarding Internet use could have an effect on PIU.

4.4.3. Diverse Selection of Variables

Although this study has included a wide variety of variables already. There are also omitted important variables that are worth investigating. For example, insightful implications could be derived by examining the interaction between socioeconomic variables and personality factors and how that could possibly translate into a higher or lower risk of PIU. Perhaps even more importantly, the level of Internet use gratification might be a powerful explanatory variable of the severity of PIU and is an important path through which socioeconomic indicators and other variables exert influence on PIU. Future research of a similar kind should include it in multivariate analyses.

4.5. Conclusion

In this study, data from a cross-sectional survey with adolescents from two Hong Kong secondary schools were utilized to construct path models for an examination of the possible mechanism of influence by which socioeconomic background affects PIU. Findings suggested that socioeconomic indicators potentially served as both antecedents of PIU and moderators of the mechanism shaping it. Educators and public health policy makers could make reference to the results and take necessary actions to lower the risk of PIU in adolescents.

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