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ARTICLE

Instruments Assessing Problematic Use of the Internet and Their Associations with Psychological Distress among Ghanaian University Students

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ABSTRACT

Background: The present study evaluated the psychometric properties of Problematic Internet Use (PIU) instruments and their correlation with psychological distress and time spent on Internet activities among university students in Ghana. **Methods:** In the present cross-sectional survey design study, 520 participants (35.96% female) were recruited with a mean age of 19.55 years (SD = 1.94) from several university departments (i.e., Behavioral Sciences, Materials Engineering, Nursing and Midwifery, and Biochemistry and Biotechnology) of Kwame Nkrumah University of Science and Technology (KNUST) between 19 July and 04 August, 2023. Participants completed a survey that included the following measures: the Gaming Disorder Test (GDT), Gaming Disorder Scale for Adolescents (GADIS-A), Internet Gaming Disorder Scale-Short Form (IGDS9-SF), Bergen Social Media Addiction Scale (BSMAS), Smartphone Application Based Addiction Scale (SABAS), Nomophobia Questionnaire (NMP-Q), and the external criterion measure: Depression Anxiety Stress Scale-21 (DASS-21). Confirmatory factor analysis (CFA) was carried out to evaluate the structure of the instruments. Cronbach's α, McDonald's ω, and composite reliability were used to evaluate internal consistency. Pearson correlation was used to examine the associations between the scores of instruments assessing PIU, time spent on Internet activities, and the level of psychological distress. **Results:** Model fits confirmed the (i) unidimensional structure of the GDT, BSMAS, SABAS, IGDS9-SF, (ii) two-factor structure of the GADIS-A, and (iii) four-factor structure of the NMP-Q. Additionally, the study found that different types of PIU were significantly associated with psychological distress and time spent on related Internet activities. **Conclusion:** The six instruments validated in the present study demonstrated very good to excellent psychometric properties when applied to university students in Ghana.

The significant associations between Internet-related disorders, time spent on Internet-related activities, and psychological distress highlight the importance of addressing issues of PIU among this population.

KEYWORDS

Factor analysis; Internet addiction disorder; psychometrics; social media; videogames

Introduction

The increase in Internet accessibility has transformed communication, education, work, and entertainment, including in Ghana (where the present study was carried out). Ghana is classified by the World Bank as a low- to middle-income country, and has experienced rapid technological advancement. Internet use has become progressively active in recent years after the Ghanaian government launched the Information and Communication Technology for Accelerated Development (ICT4AD) Policy in 2003. The ICT4AD led to the expansion of the information and communication technology (ICT) infrastructure and services, which enhanced Internet accessibility [1]. In addition, the use of ICTs in education and social connection has significantly increased in Ghana due to the closure of schools caused by COVID-19 [2]. Compared to the period before the COVID-19 pandemic in 2018, the number of Internet users has significantly increased by approximately 137.97%, rising from 12.64 million to 30.08 million at the start of 2024 [3]. Meanwhile, the number of social media users increased by approximately 23% from 6 million to 7.4 million [4]. However, the widespread prevalence of Internet use has provided some challenges. In some cases, the increased accessibility and reliance on the Internet have resulted in problematic Internet use (PIU), such as the problematic playing of videogames [5].

The definition of PIU indicates overuse, impaired control, and having the urge to use the Internet. In its most extreme form, it is also considered an addictive behavior. PIU presents in various forms. Internet gaming disorder (IGD) proposed in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) and gaming disorder (GD) included in the eleventh revision of the *International Classification of Diseases* (ICD-11) is one such form, characterized by impaired control over gaming behaviors, leading to functional impairment that impacts personal lives [6,7]. Problematic social media use is another form of PIU, characterized by individuals having an urge and being overly engaged with social media platforms such as *Facebook, Instagram*, and *Twitter* (now *X*). This often leads to reduced real-life social interactions and reduced productivity, which negatively impacts education and/or occupation [8]. Smartphones provide high accessibility to the Internet, which makes problematic smartphone use an issue when it becomes challenging to withdraw from using the smartphone, fostering continuous and excessive online engagement that leads to significant impairment in various aspects of daily life [9]. The attachment to smartphones has also led to the emergence of nomophobia (the fear of being without a mobile phone) which triggers anxiety and discomfort when individuals are unable to access their smartphone [10]. These PIU behaviors share similar features and use patterns (e.g., frequency/duration of use) but are distinct (e.g., gaming, social networking, and media streaming). The negative consequences (NCs) underscore the need for targeting distinctive Internet use behaviors when assessing PIU.

PIU has emerged as a significant public health concern, including psychological distress [11,12]. Psychological distress includes symptoms such as depression, anxiety, and stress. Numerous studies, including those conducted among Ghanaians, have established a strong association between PIU and psychological distress. People with high levels of PIU often report higher levels of depression and anxiety [5,12–14]. This makes the issue of PIU important because the Ghanaian government may not have sufficient resources to deal with the health problems (especially mental health problems) caused by PIU.

The Gaming Disorder Test (GDT), Gaming Disorder Scale for Adolescents Test (GADIS-A), and Internet Gaming Disorder Scale-Short Form (IGDS9-SF) are instruments for evaluating specific PIU related to gaming behaviors. The Bergen Social Media Addiction Scale (BSMAS) is an instrument for assessing another specific PIU (i.e., problematic social media use). The Smartphone Application Based Addiction Scale (SABAS) is an instrument that evaluates generalized PIU associated with diverse Internet activities conducted on smartphones. The Nomophobia Questionnaire (NMP-Q) is an instrument for assessing the fear of being without a mobile phone. All these instruments have been validated with good psychometric properties in Western [15–19] and Asian [20–23] countries. However, to the best of the authors' best knowledge, no previous research has thoroughly examined the psychometric properties of these instruments in Ghana. More specifically, existing studies often rely on instruments developed and validated in contexts other than African countries, which may not fully capture the unique living conditions and Internet use patterns among low- and middle-income countries. Moreover, there is a lack of validated instruments based on the state-of-art diagnostic criteria documented in the DMS-5 or ICD-11, and for examining specific forms of PIU among Ghanaians [24].

Despite the growing recognition of PIU as a significant health concern, there remains a noticeable research gap in the Ghanaian context. Most existing studies rely on instruments developed and validated outside of Africa.

Additionally, there is a lack of validated instruments based on the latest diagnostic criteria for assessing specific sub-types of PIU (e.g., GD, social media addiction, and smartphone addiction) among Ghanaians. Therefore, the present study evaluated the psychometric properties of these various PIU instruments and examined their correlation with psychological distress and time spent on related Internet activities among university students in Ghana. The primary hypotheses were that the instruments would demonstrate good psychometric properties, and be consistent with results from previous studies. Additionally, it is hypothesized that the scores of PIU-related instruments would be associated with psychological distress and related Internet activities. It was expected that the study's findings would confirm the reliability and validity of widely used PIU-related instruments that enable researchers and clinicians in Ghana to accurately assess and identify PIU behaviors and provide insights into the mental health implications of PIU.

Materials and Methods

Design

A cross-sectional survey design was used for the present study.

Participants and procedure

The participants were mainly recruited from several departments (i.e., Behavioral Sciences, Materials Engineering, Nursing and Midwifery, and Biochemistry and Biotechnology) of Kwame Nkrumah University of Science and Technology (KNUST) between 19 July and 04 August, 2023. The inclusion criteria were (i) being aged between 18 and 24 years, (ii) being a Ghanaian student at university, (iii) possessing a smartphone or having used one before, and (iv) having experience in using the Internet. The study obtained ethical approval from Kwame Nkrumah University of Science and Technology (CHRPE/AP/612/23). The research team sought permission from various lecturers to recruit their students for the study. The potential participants were then informed of the study details and provided with a 'paper-and-pencil' survey if they wanted to participate. They were first given the consent form to sign and then the surveys were distributed to all the participants who consented with the help of three research assistants. They were also informed of their rights including confidentiality, anonymity, and the right to withdraw anytime without repercussion. Ample time was given to the participants to respond to the questionnaire. All the survey questions were in the English language and included questions about participants' demographic characteristics (i.e., age and gender) and assessment on Internet use, smartphone applications, gaming, social media, smartphone use, and psychological distress. Measures on these variables were carefully selected based on their cross-cultural psychometric indices and potential fit in the Ghanaian culture. Therefore, the participants were directed to read the instructions for each measure before responding to it. Also, they were given enough time and free space (for confidentiality) to ensure that they responded truthfully without biases. They could also seek clarity if they did not understand any of the items. All the surveys were collected on the same day by the research team. After all the surveys were collected, participants were given the opportunity to ask questions about the study and then thanked for their help.

Measures

The Gaming Disorder Test (GDT)

The GDT is a self-report instrument designed to assess GD symptoms over a 12-month period based on the diagnostic criteria as defined in the ICD-11 [15]. It consists of four items, including the ability to control gaming behavior, priority given to gaming, continuation of gaming, and experience of significant problem. All four items are scored using a 5-point Likert scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = very often), with a higher score indicating more severe symptoms. A previous study reported very good internal consistency for the GDT (α = 0.84) [15].

Gaming Disorder Scale for Adolescents (GADIS-A)

The GADIS-A is a self-report instrument designed to assess the risk of GD among adolescents [20]. It comprises the cognitive behavior symptoms (CBS) subscale (Items 1, 2, 4, and 5), the negative consequences (NC) subscale (Items 3, 6, 8, and 9), and four additional questions regarding the frequency of experiencing problems due to gaming (Items 10–13), reflecting the ICD-11 criteria for GD. The first nine of the 13 items are scored on a 5-point Likert scale (1 = strongly disagree; 2 = somewhat disagree; 3 = partially agree/partially disagree; 4 = somewhat agree; 5 = strongly agree) with a higher score indicating a greater likelihood of experiencing GD. A previous study reported excellent internal consistency for the GADIS-A (α = 0.91) [20].

Bergen Social Media Addiction Scale (BSMAS)

The BSMAS is a self-report six-item instrument designed to assess the risk of social media addiction based on the experience of social media use over a 12-month period [16,17]. All six items are scored using a 5-point Likert scale (1 = very rarely; 2 = rarely; 3 = sometimes; 4 = often; 5 = very often), with a higher score indicating a greater risk of experiencing social media addiction. Previous studies have reported very good internal consistency for the BSMAS (α = 0.91) [21–23].

Smartphone Application Based Addiction Scale (SABAS)

The SABAS is a self-report six-item instrument designed to assess the risk of developing addictions to smartphone applications [17,18]. All six items are scored using a 6-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = slightly agree; 5 = agree; 6 = strongly agree), with a higher score indicating a greater risk of experiencing addiction to smartphone applications. A previous study reported very good internal consistency for the SABAS (α= 0.81) [25].

Internet Gaming Disorder Scale-Short Form (IGDS9-SF)

The IGDS9-SF is a self-report instrument designed to assess IGD over a 12-month period based on the diagnostic criteria as defined in the DSM-5 [26]. All nine items are scored using a 5-point Likert scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = very often), with a higher

score indicating greater IGD severity. A previous review of many studies using the IGDS9-SF reported very good psychometric properties [27].

Nomophobia Questionnaire (NMP-Q)

The NMP-Q is a self-report instrument designed to assess the fear of being without a mobile phone [19]. It consists of four factors: not being able to communicate (Items 1–4), losing connectedness (Items 5–9), not being able to access information (Items 10–15), and giving up convenience (Items 16–20). All 20 items are scored using a 7-point Likert scale (from 1 = strongly disagree to 7 = strongly agree), with a higher score indicating a greater nomophobia. The original validation study reported excellent internal consistency for the NMP-Q (α = 0.95) [19].

External criterion measure

Depression Anxiety Stress Scale-21 (DASS-21)

The DASS-21 is a self-report instrument designed to assess the level of psychological distress over the past week. It consists of three subscales: depression, anxiety, and stress [28]. All 21 items are scored using a 4-point Likert scale (from 0 = not applied to me at all to 3 = applied to me very much or most of the time), with a higher score indicating a greater psychological distress. Previous studies reported have reported good internal consistency for the DASS-21 [17,29,30].

Statistical analysis

Data cleaning was conducted, and descriptive statistics such as means, standard deviations, skewness, and kurtosis were used to ensure that the data distribution was appropriate for further analyses. Descriptive analyses were used to summarize the characteristics of the participants and the item properties of the instruments. Apart from the descriptive statistics, item properties of all instruments were examined through factor loadings and item-total correlation. Cronbach's α, McDonald's ω, and composite reliability were used to evaluate internal consistency, with a threshold of >0.70 indicating acceptable internal consistency.

Confirmatory factor analysis (CFA) was carried out to evaluate the structure of the instruments. More specifically, (i) the unidimensional structure of the GDT, BSMAS, SABAS, IGDS9-SF, (ii) two-factor structure of the GADIS-A, and (iii) four-factor structure of the NMP-Q. All CFAs were conducted using the diagonally weighted least square (DWLS) estimator. Various fit indices were used to indicate the goodness of model fits, including a nonsignificant χ^2 test, comparative fit index (CFI) and Tucker-Lewis's index (TLI) >0.9, standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA) <0.08, all of which supported the factor structure [31,32].

Pearson correlations were used to test the associations between the scores of Internet-related instruments (i.e., GDT, GADIS-A, BSMAS, SABAS, IGDS9-SF, and NMP-Q), time spent on Internet activities (i.e., online gaming, social media use, and online learning), and the level of psychological distress (i.e., the score of depression, anxiety, and stress subscales in the DASS-21). The level of statistical significance was set at $p < 0.05$. The strength of the correlations was interpreted using standard benchmarks: r = 0.10 to 0.29 for small, r = 0.30 to 0.49 for medium, and $r \geq$ 0.50 for large effects. CFA and Pearson correlation were conducted using JASP 0.18.3. IBM SPSS Statistics 22.0 was used for all other statistical analyses.

Results

In the present study, there were 520 participants (35.96% female) with a mean age of 19.55 years (SD = 1.94). Participants reported an average of 1.56 h spent on gaming daily (SD = 1.83), 4.96 h on social media daily (SD = 3.52), and 3.47 h on online learning daily (SD = 2.45). The scores on the PIU scales were as follows: GDT (mean score = 7.17 out of 20; SD = 3.33), GADIS-A (mean score = 15.92 out of 36; SD = 7.14), BSMAS (mean score = 15.74 out of 30; SD = 6.04), SABAS (mean score = 14.85 out of 36; SD = 6.49), IGDS9-SF (mean score = 15.95 out of 45; SD = 6.88), and NMP-Q (mean score = 73.10 out of 140; SD = 35.62), and DASS-21 (mean score = 15.37 out of 63; SD = 11.87) (Table 1).

TABLE 1

Characteristics of the participants (N = 520)

Variable	Mean (SD)	N (%)
Age (years)	19.55 (1.94)	
Gender (female)		187 (35.96)[a]
Internet use (hours per day)		
Time spent on gaming	1.56 (1.83)	
Time spent on using social media	4.96 (3.52)	
Time spent on online learning	3.47 (2.45)	
Gaming ≧2 h per day		181 (34.8)
Scales for PIU		
GDT	7.17 (3.33)	
GADIS-A (T)	15.92 (7.14)	209 (40.2)
GADIS-A (CBS)	7.30 (3.37)	
GADIS-A (NC)	8.61 (4.18)	
Temporal issue ≧ score 2		
BSMAS	15.74 (6.04)	
SABAS	14.85 (6.49)	
IGDS9-SF	15.95 (6.88)	
NMP-Q	73.10 (35.62)	
Scale for psychological distress		
DASS-21 (Total score)	15.37 (11.87)	
Depression	3.98 (4.32)	
Anxiety	5.23 (4.16)	
Stress	5.21 (4.11)	

Note: GDT, Gaming Disorder Test; GADIS-A (T), Gaming Disorder Scale for Adolescents (total score); GADIS-A (CBS), Gaming Disorder Scale for Adolescents (cognitive behavioral symptoms subscale score); GADIS-A (NC), Gaming Disorder Scale for Adolescents (negative consequences subscale score); BSMAS, Bergen Social Media Addiction Scale; SABAS, Smartphone Application Based Addiction Scale; IGDS9-SF, Internet Gaming Disorder Scale-Short Form; NMP-Q, Nomophobia Questionnaire; DASS-21, Depression Anxiety Stress Scale–21. [a]Five participants did not report their gender information.

TABLE 2

Item properties of the problematic Internet use-related instruments

	Mean (SD)	Factor loadings	Item-total correlation	Skewness	Kurtosis
GDT					
Item 1	1.80 (1.00)	0.69	0.60	1.02	0.30
Item 2	1.76 (0.98)	0.81	0.69	1.18	0.66
Item 3	1.83 (1.09)	0.79	0.69	1.17	0.47
Item 4	1.81 (1.12)	0.60	0.54	1.17	0.37
GADIS-A					
Item 1	2.01 (1.12)	0.66	0.66	0.88	−0.27
Item 2	1.81 (0.98)	0.72	0.71	1.15	0.70
Item 3	1.86 (1.07)	0.77	0.73	1.14	0.44
Item 4	1.78 (1.00)	0.80	0.74	1.24	0.76
Item 5	1.76 (0.98)	0.82	0.76	1.46	1.92
Item 6	1.75 (1.01)	0.81	0.78	1.38	1.34
Item 7	1.62 (0.95)	0.73	0.74	1.68	2.34
Item 8	1.70 (0.99)	0.69	0.71	1.57	2.01
Item 9	1.74 (1.04)	0.72	0.74	1.42	1.30
BSMAS					
Item 1	2.52 (1.16)	0.66	0.67	0.39	−0.56
Item 2	2.81 (1.19)	0.82	0.81	0.17	−0.76
Item 3	2.81 (1.30)	0.74	0.71	0.18	−0.98
Item 4	2.65 (1.21)	0.82	0.76	0.34	−0.76
Item 5	2.50 (1.246)	0.84	0.75	0.55	−0.63
Item 6	2.51 (1.286)	0.79	0.73	0.50	−0.70
SABAS					
Item 1	2.53 (1.52)	0.61	0.63	0.71	−0.65
Item 2	2.56 (1.55)	0.63	0.64	0.67	−0.76
Item 3	3.38 (1.65)	0.82	0.75	0.06	−1.26
Item 4	3.39 (1.63)	0.91	0.80	0.02	−1.23
Item 5	3.06 (1.58)	0.72	0.71	0.36	−1.00
Item 6	3.39 (1.70)	0.79	0.73	0.11	−1.28
IGDS9-SF					
Item 1	1.84 (0.99)	0.68	0.66	1.01	0.57
Item 2	1.70 (0.95)	0.68	0.66	1.24	0.81
Item 3	1.78 (0.99)	0.70	0.66	1.14	0.71
Item 4	1.72 (0.98)	0.78	0.75	1.19	0.61
Item 5	1.66 (1.00)	0.80	0.76	1.49	1.50
Item 6	1.77 (1.04)	0.82	0.77	1.23	0.67
Item 7	1.67 (1.01)	0.79	0.73	1.42	1.64
Item 8	2.34 (1.28)	0.57	0.56	0.52	−0.80
Item 9	1.55 (0.96)	0.66	0.62	1.81	2.61
NMP-Q					
Item 1	3.80 (2.29)	0.82	0.76	0.24	−1.46
Item 2	3.77 (2.29)	0.82	0.72	0.27	−1.49
Item 3	3.20 (2.11)	0.72	0.68	0.65	−0.99

(Continued)

Table 2 (continued)

	Mean (SD)	Factor loadings	Item-total correlation	Skewness	Kurtosis
Item 4	3.89 (2.24)	0.84	0.80	0.20	−1.46
Item 5	3.18 (2.16)	0.69	0.71	0.65	−1.04
Item 6	3.20 (2.19)	0.71	0.73	0.62	−1.11
Item 7	4.08 (2.40)	0.84	0.79	0.02	−1.64
Item 8	3.68 (2.27)	0.78	0.74	0.27	−1.45
Item 9	3.90 (2.32)	0.84	0.80	0.14	−1.54
Item 10	3.96 (2.27)	0.87	0.85	0.09	−1.51
Item 11	4.15 (2.28)	0.90	0.82	−0.04	−1.51
Item 12	4.10 (2.24)	0.91	0.86	0.00	−1.51
Item 13	4.15 (2.28)	0.91	0.82	−0.04	−1.55
Item 14	4.01 (2.23)	0.91	0.85	0.03	−1.50
Item 15	3.89 (2.29)	0.86	0.81	0.11	−1.53
Item 16	3.37 (2.20)	0.84	0.79	0.49	−1.22
Item 17	3.40 (2.17)	0.89	0.78	0.48	−1.20
Item 18	3.37 (2.17)	0.91	0.80	0.52	−1.20
Item 19	3.23 (2.13)	0.86	0.73	0.62	−1.02
Item 20	3.52 (2.27)	0.82	0.77	0.38	−1.39

Note: GDT, Gaming Disorder Test; GADIS-A, Gaming Disorder Scale for Adolescents (total score); GADIS-A (CBS), Gaming Disorder Scale for Adolescents (cognitive behavioral symptoms subscale score); GADIS-A (NC), Gaming Disorder Scale for Adolescents (negative consequences subscale score); BSMAS, Bergen Social Media Addiction Scale; SABAS, Smartphone Application Based Addiction Scale; IGDS9-SF, Internet Gaming Disorder Scale-Short Form; NMP-Q, Nomophobia Questionnaire.

The descriptive statistics demonstrated near-normal distributions with acceptable values of skewness (ranging from: 0.60 to 0.69 for GDT, 0.66 to 0.8 for GADIS-A, 0.67 to 0.76 for BSMAS, 0.63 to 0.80 for SABAS, 0.52 to 1.81 for IGDS9-SF, −0.04 to 0.65 for NMP-Q) and kurtosis (ranging from: 0.30 to 0.66 for GDT, −0.27 to 2.34 for GADIS-A, −0.56 to −0.63 for BSMAS, −0.65 to −1.28 for SABAS, −0.80 to 2.61 for IGDS9-SF, −0.99 to −1.55 for NMP-Q). All values of factor loadings and item-total correlation were above 0.4 (Table 2).

The internal consistency values ranged from 0.81 to 0.97 indicating very good to excellent reliability for all instruments. More specifically, Cronbach's α = 0.81, McDonald's ω = 0.81, and composite reliability = 0.81 for GDT; Cronbach's α = 0.93, McDonald's ω = 0.93, and composite reliability = 0.93 for GADIS-A; Cronbach's α = 0.91, McDonald's ω = 0.91, and composite reliability = 0.90 for BSMAS; Cronbach's α = 0.89, McDonald's ω = 0.89, and composite reliability = 0.89 for IGDSF-S9; and Cronbach's α = 0.97, McDonald's ω = 0.97, and composite reliability = 0.97 for NMP-Q. In the CFA fit indices supported the unidimensional structure of the GDT (CFI = 1.000, TLI = 0.999, SRMR = 0.016, RMSEA = 0.026), BSMAS (CFI = 1.000, TLI = 0.999, SRMR = 0.019, RMSEA = 0.030), SABAS (CFI = 0.998, TLI = 0.997, SRMR = 0.029, RMSEA = 0.068), and IGDS9-SF (CFI = 0.999, TLI = 0.998, SRMR = 0.035, RMSEA = 0.044). The CFA fit indices also supported the two-factor structure for GADIS-A (CFI = 0.998, TLI = 0.997, SRMR = 0.037, RMSEA = 0.067) and the four-factor structure for NMPQ (CFI = 0.998, TLI = 0.998, SRMR = 0.038, RMSEA = 0.069) (Table 3).

The scores on the problematic gaming-related instruments (i.e., GDT, GADIS-A, IGDS9-SF) showed a significant positive correlation with GD (r = 0.29–0.35; all p-values < 0.001). Time spent on social media was found to be positively related to the score on the social media addiction scale (BSMAS; r = 0.17; p < 0.001) and smartphone addiction scale (SABAS; r = 0.13; p < 0.001). Higher scores on the DASS-21 were associated with higher scores on the problematic Internet use-related instruments (r = 0.21–0.39; all p-values < 0.001), especially with gaming disorder (r = 0.32–0.35; all p-values < 0.001), indicating an association between problematic Internet use and psychological distress. With regards to the results of the correlations across gender, the scores of the problematic gaming-related instruments showed a significant positive correlation with gaming time among both males (r = 0.19–0.29; all p-values < 0.001) and females (r = 0.29–0.45; all p-values < 0.001). An additional negative correlation between score on the BSMAS and gaming time was found among males (r = −0.15; p < 0.005). Time spent on social media was found to be (i) positively related to score on the SABAS among males, and (ii) negative related to the GADIS-A NC subscale score (r = −0.11; p < 0.005) and positive related to BSMAS score (r = 0.19; p < 0.001) among females. Higher scores on the DASS-21 were associated with higher scores on the problematic Internet use-related instruments among both males (r = 0.19–0.56; all p-values < 0.001) and females (r = 0.18–0.32; all p-values < 0.001), with a more pronounced relationship to gaming disorder among males (r = 0.46–0.56; all p-values < 0.001) (Table 4).

TABLE 3

Confirmatory factor analysis and internal consistency of the problematic Internet use-related instruments

	GDT	GADIS-A	BSMAS	SABAS	IGDS9-SF	NMP-Q
Cronbach's α	0.81	0.93	0.90	0.89	0.91	0.97
McDonald's ω	0.82	0.93	0.91	0.89	0.91	0.97
Composite reliability	0.82	0.93	0.90	0.89	0.91	0.97
χ^2(df)	4.43 (2)	68.5 (22)	20.9 (8)	24.2 (6)	106 (26)	666 (163)
CFI	0.996	0.984	0.993	0.989	0.966	0.950
TLI	0.989	0.974	0.986	0.973	0.953	0.942
SRMR	0.012	0.023	0.017	0.019	0.033	0.039
RMSEA	0.060	0.064	0.056	0.078	0.077	0.077
(90% CI)	(0.000, 0.111)	(0.047, 0.081)	(0.027, 0.087)	(0.047,0,111)	(0.062, 0.093)	(0.072, 0.084)

Note: GDT, Gaming Disorder Test; GADIS-A, Gaming Disorder Scale for Adolescents (total score); BSMAS, Bergen Social Media Addiction Scale; SABAS, Smartphone Application Based Addiction Scale; IGDS9-SF, Internet Gaming Disorder Scale-Short Form; NMP-Q, Nomophobia Questionnaire; CFI, Comparative fit index; TLI, Tucker-Lewis index; SRMR, Standardized root mean square residual; RMSEA, Root mean square error of approximation; CI, Confidence interval. Unidimentional structure for GDT, BSMAS, SABAS, IGDS9-SF; two-factor structure for GADIS-A; and four-factor structure for NMP-Q.

TABLE 4

Correlations between time spent on Internet activities and DASS-21 subscale scores and problematic Internet use-related instruments

	r (*p*-value)					
	Gaming	Social media	Online learning	Depression	Anxiety	Stress
Total						
GDT	0.34 (<0.001)	0.03 (0.485)	−0.06 (0.187)	0.32 (<0.001)	0.34 (<0.001)	0.32 (<0.001)
GADIS-A (T)	0.32 (<0.001)	−0.03 (0.487)	−0.12 (0.007)	0.38 (<0.001)	0.38 (<0.001)	0.35 (<0.001)
GADIS-A (NC)	0.29 (<0.001)	−0.03 (0.469)	−0.13 (0.004)	0.39 (<0.001)	0.39 (<0.001)	0.35 (<0.001)
GADIS-A (CBS)	0.33 (<0.001)	−0.02 (0.694)	−0.12 (0.009)	0.32 (<0.001)	0.33 (<0.001)	0.32 (<0.001)
BSMAS	−0.07 (0.115)	0.17 (<0.001)	−0.14 (0.001)	0.23 (<0.001)	0.26 (<0.001)	0.24 (<0.001)
SABAS	−0.01 (0.747)	0.13 (0.005)	−0.14 (0.002)	0.24 (<0.001)	0.23 (<0.001)	0.23 (<0.001)
IGDS9-SF	0.35 (<0.001)	−0.02 (0.677)	−0.07 (0.143)	0.34 (<0.001)	0.35 (<0.001)	0.33 (<0.001)
NMP-Q	−0.04 (0.376)	0.05 (0.257)	−0.06 (0.169)	0.21 (<0.001)	0.22 (<0.001)	0.23 (<0.001)
Male						
GDT	0.19 (<0.001)	0.13 (0.069)	−0.10 (0.151)	0.55 (<0.001)	0.53 (<0.001)	0.52 (<0.001)
GADIS-A (T)	0.25 (<0.001)	0.11 (0.115)	−0.17 (0.015)	0.56 (<0.001)	0.55 (<0.001)	0.49 (<0.001)
GADIS-A (NC)	0.22 (<0.001)	0.11 (0.127)	−0.20 (<0.001)	0.53 (<0.001)	0.52 (<0.001)	0.46 (<0.001)
GADIS-A (CBS)	0.25 (<0.001)	0.10 (0.152)	−0.13 (0.083)	0.52 (<0.001)	0.51 (<0.001)	0.47 (<0.001)
BSMAS	−0.15 (0.039)	0.12 (0.091)	−0.09 (0.205)	0.25 (<0.001)	0.29 (<0.001)	0.22 (<0.001)
SABAS	−0.06 (0.404)	0.20 (<0.001)	−0.20(<0.001)	0.28 (<0.001)	0.27 (<0.001)	0.25 (<0.001)
IGDS9-SF	0.29 (<0.001)	0.10 (0.152)	−0.07 (0.337)	0.50 (<0.001)	0.48 (<0.001)	0.46 (<0.001)
NMP-Q	−0.07 (0.344)	0.04 (0.578)	−0.07 (0.319)	0.20 (<0.001)	0.19 (<0.001)	0.20 (<0.001)
Female						
GDT	0.45 (<0.001)	−0.02 (0.717)	−0.04 (0.502)	0.18 (<0.001)	0.24 (<0.001)	0.22 (<0.001)
GADIS-A (T)	0.33 (<0.001)	−0.11 (0.059)	−0.10 (0.077)	0.27 (<0.001)	0.30 (<0.001)	0.28 (<.001)
GADIS-A (NC)	0.29 (<0.001)	−011 (0.045)	−0.08 (0.177)	0.30 (<0.001)	0.32 (<0.001)	0.30 (<0.001)
GADIS-A (CBS)	0.34 (<0.001)	−0.09 (0.131)	−0.12 (0.037)	0.20 (<0.001)	0.24 (<0.001)	0.23 (<0.001)
BSMAS	0.03 (0.566)	0.19 (<0.001)	−0.17 (<0.001)	0.22 (<.0001)	0.24 (<0.001)	0.23 (<0.001)

(Continued)

Table 4 (continued)

	r (*p*-value)					
	Gaming	**Social media**	**Online learning**	**Depression**	**Anxiety**	**Stress**
SABAS	0.08 (0.168)	0.06 (0.338)	−0.07 (0.203)	0.21 (<0.001)	0.21 (<0.001)	0.21 (<0.001)
IGDS9-SF	0.34 (<.001)	−0.08 0 (0.146)	−0.08 (0.153)	0.26 (<0.001)	0.31 (<0.001)	0.29 (<0.001)
NMP-Q	0043 (0.450)	0.03 (0.575)	−0.04 (0.489)	0.21 (<0.001)	0.24 (<0.001)	0.25 (<0.001)

Note: GDT, Gaming Disorder Test; GADIS-A (T), Gaming Disorder Scale for Adolescents (total score); GADIS-A (CBS), Gaming Disorder Scale for Adolescents (cognitive behavioral symptoms subscale score); GADIS-A (NC), Gaming Disorder Scale for Adolescents (negative consequences subscale score); BSMAS, Bergen Social Media Addiction Scale; SABAS, Smartphone Application Based Addiction Scale; IGDS9-SF, Internet Gaming Disorder Scale-Short Form; NMP-Q, Nomophobia Questionnaire; DASS-21, Depression Anxiety Stress Scale–21. Five participants did not report their gender information.

Discussion

The present study validated five instruments in English (i.e., GDT, GADIS-A, IGDS9-SF, BSMAS, and SABAS) among university students from Ghana assessing PIU (including specific forms of PIU and generalized PIU); one instrument (i.e., NMP-Q) assessed the consequences of PIU, and their associations with general psychological distress (assessed using DASS-21) among university students in Ghana. All instruments demonstrated very good reliability. Model fits confirmed the (i) unidimensional structure of the GDT, BSMAS, SABAS, IGDS9-SF; (ii) two-factor structure of the GADIS-A; and (iii) four-factor structure of the NMP-Q. Additionally, the study found that all forms of PIU, irrespective of being specific or generalized, were significantly associated with psychological distress.

The GDT demonstrated a unidimensional structure with very good internal consistency (α = 0.81). This is in line with previous validations in other languages and populations [15,30,33,34], suggesting that the GDT is a reliable instrument for assessing GD among Ghanaian university students. The GDT was designed based on the diagnostic criteria outlined in the ICD-11. Although there are only four items in the GDT, all items capture distinctive features of GD. Higher GDT scores were significantly associated with higher levels of depression, anxiety, and stress, supporting the association between GD and psychological distress reported in previous studies [5,12]. GD may directly lead to psychological distress or through sleeping problems (as mediators) [35]. Additionally, individuals may reduce participation in social activities because of gaming which can contribute to feelings of loneliness and depression [36]. Individuals may adopt gaming as a method to escape from negative situations in the real world, especially those with emotional regulation deficits [37]. However, problematic gaming behaviors may trigger more emotional difficulties (for example, conflicts with families or friends), further creating a vicious circle of GD and psychological distress [36].

The GADIS-A CFA supported the two-factor structure and it had excellent internal consistency (α = 0.93). These results are consistent with previous findings in both Western and Asian adolescent populations [20,30,34,38]. These results suggest that the GADIS-A is a valid and reliable instrument for assessing GD among university students in Ghana. The GADIS-A was designed based on the ICD-11 diagnostic criteria defined. Paschke et al. developed the GADIS-A with a two-factor structure to describe GD symptoms and consequences of problematic gaming [20], which better distinguish individuals based on the level of symptoms and impairment experienced. Similar to the GDT, the GADIS-A had significant associations with time spent gaming and psychological distress. This indicates that the GADIS-A, like the GDT, is another robust instrument for assessing GD.

The IGDS9-SF exhibited a robust unidimensional structure and excellent internal consistency (α = 0.91). These psychometric properties align with those found in other international validations synthesized in a recent systematic review [27] suggesting that the IGDS9-SF is a reliable and valid instrument for assessing GD. The IGDS9-SF was developed based on the DSM-5 diagnostic criteria with a broader range of symptoms and a greater emphasis on biological symptoms compared to the ICD-11 diagnostic criteria for GD [27]. Despite the heterogeneity in the definitions of GD and IGD, both the DSM-5 and ICD-11 recognize problematic gaming as a condition characterized by impaired control over gaming, prioritizing gaming over other activities, and persisting in gaming despite negative consequences. Both frameworks require significant functional impairment and specific duration of symptoms for diagnosis, demonstrating a shared understanding of the problematic gaming. The positive associations between IGDS9-SF scores and levels of depression, anxiety, and stress confirmed the external criteria with GDT and GADIS-A in terms of reflecting mental health deficits.

The BSMAS was designed based on the addiction component model [39] with further evidence supporting both one-factor and two-factor structures [40,41]. The present study's findings supported the unidimensional structure of BSMAS. This finding is consistent with prior studies validating the BSMAS in different cultural contexts [21–23]. The results indicated that the BSMAS is a robust instrument for assessing the potential development of social media addiction among university students in Ghana. The positive correlations between BSMAS scores and psychological distress indicators highlight the detrimental effects of social media addiction being associated with poor mental health as reported in previous studies [14,42]. Similar to problematic gaming, social media addiction has been found to be associated with sleeping problems which can intensify the development of psychological distress [35]. Excessively engaging in social media use can lead to social isolation, because individuals may reduce real-life social participation, and negative social comparison generated

from social media platforms may contribute to poor self-esteem [36]. These social challenges can contribute to feelings of depression and anxiety. Moreover, individuals may see social media platforms as places to escape from the real world and seek validation [36]. Those who depend more on social media validation experience higher levels of psychological distress when their validation needs are unmet [43].

The SABAS was also developed using the components model of addiction [39]. Although the literature has debated the factor structure of the model when conducting validations with BSMAS, there is no research testing a two-factor structure of the SABAS. Previous studies have all provided validation of the single-factor structure. The present study's results demonstrated good internal consistency (α = 0.89) and supported the unidimensional structure. These psychometric properties align with previous studies conducted in various countries [24,44,45]. The results suggest that the SABAS is a robust instrument for assessing the risk of smartphone addiction among Ghanaian university students. Associations were found between SABAS scores and levels of depression, anxiety, and stress. Smartphone addiction is associated with psychological distress due to its impacts on individuals' behavior, emotions, and social interactions. Excessive use of smartphones often leads to sleeping problems and disruption of daily routines which can increase stress and anxiety [46]. Similar to social media addiction, smartphone addiction can contribute to social isolation because interactions on social media through smartphones can replace face-to-face relationships, leading to loneliness and depression [47].

The NMP-Q showed a four-factor structure with excellent internal consistency (α = 0.97). These results are consistent with prior research validating the NMP-Q in different cultural settings [10,19]. Higher NMP-Q scores were significantly associated with increased psychological distress, supporting the association between nomophobia and poor mental health. Nomophobia is associated with psychological distress due to the high dependence on mobile phones. The fear of not having a smartphone, often derived from the fear of missing out on updates on social media, can cause significant psychological distress [48]. Additionally, the fear of missing out can make it difficult to concentrate on daily tasks and can exacerbate psychological distress by causing disturbances in individuals' personal lives [12].

The present study further investigated the correlations between time spent on Internet activities and DASS-21 subscale scores as well as PIU-related instruments. The overall results align with previous studies showing that PIU is positively correlated with psychological distress among both males and females [49–51]. Moreover, the results indicated a stronger relationship with GD, which was found to be more pronounced among males, suggesting a stronger link between gaming disorder and psychological distress in males. These findings highlight that the psychological impact of PIU may differ between genders.

There are some limitations to the present study. First, the sample for the present study was predominantly composed of older adolescents from a single university in Ghana, which may limit the generalizability of the findings to other populations or age groups. Second, the study relied on self-report data, which is subject to social desirability and recall biases. Participants may have underreported or overreported their Internet use and psychological distress, potentially affecting the accuracy of the findings. Third, the study did not assess the test-retest reliability of the instruments, which is essential for determining the stability of the instruments over time. To address these aforementioned limitations, future research should include more diverse and representative samples to enhance the external validity of the results. Incorporating objective measures of Internet use could help reduce the bias od using self-report data. Future research should include longitudinal designs to evaluate the consistency of these instruments across different time points.

In conclusion, the six instruments validated among university students from Ghana in the present study demonstrated very good to excellent psychometric properties when applied to university students in Ghana. The significant associations between Internet-related disorders, time spent on Internet-related activities, and psychological distress highlight the importance of addressing issues of PIU among this population. Despite the limitations, the present study provides a valuable contribution to the understanding of Internet-related disorders in a Ghanaian context and underscores the need for continuous research and intervention efforts in this area.

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