Introduction:
The past decades have witnessed exponential technological growth. The increasing pervasive presence of digital technologies has led to its incursion into nearly every aspect of daily life. Within this context is the widespread usage of the Internet. Nowadays, one need not be physically sitting in front of the computer to access the internet in order to obtain information, interact with friends, watch videos or play games. An avalanche of internet-enabled connections allows an individual to access anything from anywhere with just phones, tablets or other electronic devices. Although there is little doubt as to the expediency of this technology, the risks associated with overuse of the internet, social media and online forms of entertainment are gradually becoming evident. Young people seem especially vulnerable; with case studies highlighting students whose academic performance plummets as they spend more time online.[1] Some also suffer health consequences from loss of sleep, as they stay up late to chat online, check for social network status updates or to reach the next game levels.[1]

The realization that certain attributes of internet may be fostering some addictive-seeming behaviors has raised concerns worldwide with regard to what has been labeled Internet addiction.

Besides ‘Internet addiction’, terms such as ‘problematic Internet use’, ‘computer addiction’, ‘Internet dependency’, ‘pathological Internet use’, ‘compulsive Internet use’ and many other labels have been proposed as ways to describe these behaviors.[2] Internet addiction (IA) commonly refers to an individual’s inability to control Internet use, which in turn leads to feelings of marked distress and functional impairment in daily life.[3] Several studies have indicated that IA eventually may cause psychological and social problems, or even physical and mental disorders [4-9], thereby affecting the individual’s occupational and academic achievement. Some experts have even suggested that IA appears to be a common disorder that merits inclusion in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V).[10]
Although IA was not classified as a clinical disorder, the American Psychiatric Association (APA) finally included Internet Addiction Disorder (IA) as a DSM-V (section 3) as a condition deserving further studies.[11] Increasing interest on IA and its associated negative influences has led to the development of several instruments for its assessment in clinical and research settings. The most widely used diagnostic criterion is Young’s Diagnostic Questionnaire,[8,12,13] which was conceptualized based on the DSM-IV as a concise 8-item instrument to assess IA.[8] Subsequently, a 20-item longer version called the Internet Addiction Test (IAT)[13] was developed to encompass a variety of Internet use behaviors and common addiction symptoms. Items of the IAT included compulsive behavior related to use of the internet, occupational or academic difficulties, lack of competence at home, problems in interpersonal relations, and emotional problems.[13] Initial investigations proved that the IAT was a valid and reliable instrument for classifying IA.[14] However, successive psychometric analyses have portrayed equivocal factor structures. The IAT was primarily designed as a unidimensional instrument, yet different validations have presented factor structures with two [15-18], three [19-22], four [23-25], five [26,27] or six dimensions [28,29]. Due to the heterogeneity of these outcomes, the present study was conducted to assess the construct validity of IAT by specifically using an undergraduate student sample as the target population. This is mainly because young people nowadays are spending more and more time online - studying, learning, communicating, creating, and entertaining themselves, largely owing to widespread connectivity and constant emergence of tantalizing online activities.[1] As with other countries, this trend has been noted in Malaysia as well. In a recent conference held here, researchers expressed their worry about the increasingly excessive use of Internet by Malaysian youth, with local studies revealing that 37% of parents felt their children’s online life was interfering with home and school obligations while 18% conveyed that their children were sacrificing basic social activities.[30] In tandem, several studies have reported that Malaysian university students spend major part of their time in accessing the Internet for both academic and extracurricular purposes,[31-33], with one study even indicating that prevalence of IA was a whopping 43%.[27] Given that students are particularly vulnerable to addictive use of the Internet and prone to its negative associations, evaluation of the behavioral components underlying IA was undoubtedly needed within this at-risk population in a Malaysian context.

Methodology

Participants and Procedure

The cross-sectional study was conducted among a sample comprising 307 undergraduate students of University Malaysia Sarawak. A convenience sampling technique was executed whilst selecting participants who were enrolled full-time at the Faculty of Cognitive Science and Human Development. Prior to assessment, students were briefed about the purpose of the study and assured about the anonymity of their responses. The self-administered questionnaire was distributed during the last 10 minutes of a regularly-scheduled 2-hour class session. Participation was voluntary and applicable only to students who were present on the day of assessment. Signed consent was also obtained from participating students. The project was self-funded with no formal obligations or conflict of interest.

Materials

The self-report questionnaire consisted of two parts. The first section included the sociodemographic details of participants. The second section comprised of the Internet Addiction Test (IAT)[34]. Participants were required to answer the 20 IAT items on a 6-point Likert scale ranging from 0 (not applicable) to 5 (always), which presented an overall maximum score of 100. According to IAT recommendations, participants who recorded scores less than 30 were representative of normal level of internet usage, scores of 31 to 49 indicated mild level of internet addiction, 50 to 79 reflected moderate internet addiction, and scores of 80 to 100 pointed towards severe dependence. Since moderate users are often unable to control their internet use [34], both excessive and moderate use of internet was considered as problematic in this study.

Before commencing the survey, the IAT questionnaire was translated from English into Malay language independently by two bilingual language experts. Subsequent reviews for appropriateness of language and back-translation to English for verification ensured that it was conceptually and semantically equivalent to the original. The ensuing pilot test which was conducted amongst a group of 22 students indicated that the Malay version was comprehensible. Given that most of the participating students were proficient in English and/or Malay language, both versions were provided during the survey. Analysis of data was performed by Statistical Program Social Sciences (SPSS) version 23. Prior to conducting primary analyses, the data was examined for univariate outliers and all were found to be within range values. Data was normally distributed, hence no variable transformation was deemed necessary. Exploratory Factor Analysis (EFA) was conducted by using the extraction method of principal component analysis with varimax rotation of axes, in order to examine the structure of IAT scale. The number of factors to be extracted was determined through a scree plot test, in combination with the conventional cut-off criteria of eigenvalues greater than one.

Factorability of the data was evaluated using Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett’s Test of Sphericity (BTS). A KMO value greater than 0.80 is considered meritorious, and if the BTS value is large with a significant p value (p < 0.05) then the data is probably factorable.[35] Interpretation of factors was based on observation of factor loadings. Items with a loading of over 0.40 in one factor, and less than 0.30 in each of the remaining factors, were interpreted to be indicative of that factor. The average variance extracted is the amount of common variance among latent construct indicators.[36] An acceptable factor loading value of 0.7 and above is considered a good indicator.[37]

The IAT factor structure that emerged from EFA was further verified by Confirmatory Factor Analysis (CFA), using structural equation modelling in AMOS v. 23. In each analysis, the maximum likelihood estimation method was used, and the covariance matrices were assessed. For the model tested, adequacy of fit was examined by considering several indices. Since the χ² statistic is extremely sensitive to sample size, two absolute fit indices were also considered: the Goodness of fit index (GFI) and Adjusted goodness of fit index (AGFI). In addition, the relative fit index which included the Tucker Lewis index (TLI) was similarly utilized. Absolute fit indices do not use an alternative model as a base for comparison, while the relative fit indices use a baseline model with chi-square for comparison. Besides this, results were also assessed on non-centrality-based indices, which included the comparative fit index (CFI) and the root mean square error of approximation (RMSEA) parameters. Finally, construct reliability of the measurement model was explored using the Composite Reliability (CR) index. The index is based on proportions of variance (lambda parameters) and takes account of each item’s error, providing a less biased estimate of reliability than Cronbach’s alpha.[38] Generally, acceptable models do not have definite cut-off points. Nonetheless, the following criteria were used to detect
the goodness-of-fit for a specific model, GFI value of 1 could be considered perfect fit, GFI greater than 0.90 may indicate good fit, and values close to 0 points towards very poor fit. The AGFI differs from GFI, only in the fact that it adjusts for the number of degrees of freedom in the specified model, thereby addressing the issue of parsimony. AGFI values range from 0 to 1, with values close to 1 being indicative of a good fit. The TLI has a predictable cut-off value, in which values larger than 0.90 are considered good fitting models. The CFI is an incremental fit index that is normed so that values range between 0 and 1, where higher values indicate a better fit. In general, values greater than 0.95 and 0.97 are associated with acceptable and good fit, respectively. RMSEA values less than 0.05 could be considered as a good fit, between 0.05 and 0.08 an adequate fit, between 0.08 and 0.10 a mediocre fit, and those greater than 0.10 could suggest poor fit. The Standardized Root Mean Square Residual (SRMR) with a value of 0.08 or less is indicative of an acceptable model.

To assess factor invariance, multi-group CFA was performed in AMOS v. 23, using maximum likelihood estimations. Model fit of the best-factor solution was evaluated across gender, using the same aforementioned criteria of approximate fit indices. The degree of invariance was assessed by the likelihood ratio test, also known as chi-square difference test.[39]

**Results**

Majority of the participating students were females (60%) while 40% were male. A considerable proportion (81%) of participants was in the age group 20 to 22 years, 17% were aged between 23 and 25 years, and only 2% were over 26 years. Malay students made up 39% of the sample, 28% were Chinese, 22% were represented by the various indigenous ethnic groups of Sarawak, and the remaining 11% were of Indian ethnicity. The IAT scores which were based on the proposed cut-off criteria [40] portrayed that 13% students could be categorized as normal internet users, 52% as mildly addicted, 32% as moderately addicted, while 3% could be considered as severely addicted. Given that the estimated percentage of participants belonging to the problematic internet users group was fairly large (35%), the number of students at-risk of internet addiction appears to be alarmingly high.

**Exploratory Factor Analysis**

The KMO Test of Sampling Adequacy was .87 and Bartlett’s Test of Sphericity was significant ($\chi^2 (190) = 2251$, $p < .05$), indicating that the IAT items were suitable for factor analysis. Moreover, all the communalities were above .4, suggesting that each item shared some common variance with other items. Based on the scree-test and Kaiser criterion of eigenvalue greater than 1, a three-factor structure was extracted from EFA.

The first factor (Lack of control) which included items 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20 explained 21.92% of variance. The second factor (Excessive use) which encompassed items 7, 8, 9 and 10 explained 13.14% of variance, though Item 8 showed poor loading. The third factor (Compulsion) containing items 1, 2, 3, 4, 5 and 6 explained 13.01% variance, although Items 3 and 5 were found to cross-load with the second factor. However, the loading was not particularly high on the second factor. The three-factor solution accounted for approximately 48% of total variance.

**Confirmatory Factor Analysis**

In order to verify the three-factor structure, CFA was performed on the model extracted from EFA. Modification indices were utilized to examine if any model improvement was obtainable. Error covariance was added where required. Taking into account that item 8 presented poor loading with an unsatisfactory fit, it was subsequently excluded from the model. Thus, the CFA which was performed on the shortened 19-item scale yielded a much better fitting model, as illustrated in Figure 1.

Table 1 depicts the values of goodness-of-fit indices for the three-factor CFA model of the IAT in the whole sample. As indicated, values of CFI and GFI were greater than 0.90, while those of RMSEA and SRMR were less than 0.08 which supported the criteria for an acceptable three-factor CFA model. The AGFI and TLI values, although lower than proposed thresholds, were discernibly closer to the adequate range. These results confirmed the construct validity of the instrument.

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<th>Table 1: Values of goodness-of-fit indices for the three-factor CFA model of the IAT in the whole sample</th>
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*Note: GFI: Goodness of fit index; AGFI: Adjusted goodness of fit index; TLI: Tucker-Lewis index; CFI: Comparative fit index; SRMR: Standardized Root Mean Square Residual; RMSEA: Root mean square error of approximation.*

Subsequently, confirmatory factor analyses using the three-factor model, in which factor loadings and/or thresholds were free and then constrained, were also performed across gender to assess factorial invariance. Thus, evidence for configural invariance was provided by keeping the first model as the unconstrained model, in which the factor loadings and thresholds were allowed to differ across groups. A good model fit was achieved in this case, which indicated equivalence in both groups with regards to the factor structure. In other words, configural invariance was established. Afterwards, the second (constrained) model was tested further by means of chi-square test. Accordingly, the factor loadings and thresholds were constrained to be equal with the scale factor in this model. Difference in chi-square was verified in EXCEL by the chi-square tester which gave value of, $\chi^2(25, N = 307) = 33.3, p = .124$. A non-significant $p$-value implied that metric invariance was established. Presented with these findings, it was indicated that the two groups showed invariance with respect to the factor structure.

**Reliability**

Composite Reliability (CR) index is a less biased estimate than Cronbach’s Alpha, wherein a value of 0.70 and above, provides strong support to the reliability of the scales. CR indexes for the first, second and third factor in the present study, were 0.77, 0.71 and 0.83, respectively.

Discussion

Internet is no longer a simple means of communication, as it represents a necessary way of living in the professional, academic, and sentimental life.[41] Nonetheless, pervasion of the Internet into daily life has become problematic for an increasing number of people, particularly for individuals afflicted with this disorder which is often referred as Internet addiction (IA). A growing body of global research has demonstrated the perceptible adverse consequences of IA, especially among students. These studies have shown that students with IA may exhibit symptoms of psychological distress (e.g., depression, social anxiety, attention deficit-hyperactivity disorder)[42-45] impaired physical health (e.g., obesity, sleep disorders)[46,47], and behavioral problems (e.g., substance abuse and behavioral addictions, aggression, self-injurious behaviors).[48-50] Also, students with problematic Internet use often experience more interpersonal problems [51], and worse school and work performance compared to their problematic Internet use-free peers.[52] Though there is little doubt as to the usefulness and acceptability of the Internet in academia, concerns about the looming possibility of IA among students seems warranted. It is paradoxical, and somewhat ironic, that even though a student may be suffering due to overuse of online activities, he/she might also need to use the Internet as an academic resource. Timely intervention is certainly needed for students who could be exhibiting symptoms of IA, especially in an educational setting. That being the case, further research is undeniably essential to recognize and determine the addictive components of IA among university students. The present study was therefore conducted with the intent of augmenting existing literature and to shed additional light on previous findings about this subject. To this end, the IAT was utilized as a screening tool in order to measure different aspects of Internet use, and more particularly IA among students. Specifically, the factor structure of IAT was assessed to understand the dimensional conceptualization of IA. Extant research on the factor structure of IAT has done much to highlight key issues in the dimensionality of the construct, yet several concerns warrant further empirical attentions.[16] Results from previous factor analytic studies have revealed a large degree of inconsistency, with different authors proposing between one- and six-factor models for the IAT.[53] Due to these ambiguities, a combination of exploratory and confirmatory approaches was executed in the present study to re-establish as well as verify the most parsimonious and apposite representation of the latent structure of IA as evaluated by the IAT. Consequently, the preliminary Exploratory Factor Analysis yielded a 3-factor solution composed of ‘Lack of control’, ‘Excessive use’ and
‘Compulsion’, which altogether accounted for 48% of the total variance. The adequacy of explained variance, in conjunction with moderately strong inter-item correlation indicated that the IAT may well be a valid instrument for assessing IA among university students. Moreover, finding from this study has extended sufficient support for the 3-factor model of IAT. This outcome was in keeping with a number of prior studies which had likewise extracted 3-factor solutions. Correspondingly, the retrieved factors in these studies have been labeled: ‘Withdrawal and social problem’, ‘Time management and performance’ and ‘Reality substitution’[19], ‘Withdrawal and social problems’, ‘Time management and performance’ and ‘Reality substitute’ [54], ‘Social interactive problems’, ‘Virtual reality’ and ‘Obsession and impulse’ [55], ‘Outcomes’, ‘Emotional and cognitive factors’ and ‘Time management’ [21], and ‘Emotional/psychological conflict’, ‘Time management issues’ and ‘Mood modification’ [22]. However, the allocations of items into the individual factor domains were found to be dissimilar in most of the studies, which was observed in the current study as well.

Another perspective worth mentioning is that a 3-factor model was constantly identified for the bilingual (Chinese and English) versions of IAT.[19,54] Particularly notable was the fact that the bilingual questionnaire which was administered to the respondents in this study, in turn, also led to the replication of a 3-factor solution. However, this viewpoint was subsequently refuted by a recent study which examined the psychometric properties of a bilingual version (Malay and English) in a sample of undergraduate students and extracted a 6-factor model.[56] Despite this ambiguity, an open issue open for discussion is whether utilization of a bilingual version could repeatedly yield 3-factor models for the IAT, as was noted unfailingly in all three studies. The Confirmatory Factor Analysis which was successively executed further verified the 3-factor model, albeit with items reduced. The omission of Item 8 was similarly explicated in a number of other studies, which coincidentally comprised of either adolescent or student samples.[16,18,57,58] Elimination of this item in the alluded studies revealed that Item 8 which principally dealt with the impact of Internet on job performance or productivity, may not be contextually relevant to that particular demographic. Participants in these studies were students, and perhaps were unable to respond to the query pertinent. Thus, low factor loadings acquired for this item indicated that the question may not be relatable to undergraduates in this study, and hence its exclusion was plausible. Besides this, it was also noted that individual concerns regarding some specific item-related aspects had led more than a few authors to modify or discard items [19,25,27,54,59,60] eventually prompting them to recommend shorter versions of the IAT.

A further purpose of the present study was to assess measurement invariance of the IAT across gender. The Multi-Group Confirmatory Factor Analysis which was implemented for this sample, demonstrated equal form for the 3-factor solution revealing that scores for this model was invariant in terms of gender. Regarding psychometric properties, the Composite Reliability values for each factor were higher than the standard criteria of .70, thus suggesting adequate reliability for the bilingual IAT. This result was substantiated by a recent meta-analysis drawn from a large sample of studies conducted with IAT, which portrayed an overall Cronbach's coefficient of 0.889 (95% confidence interval [CI] 0.884-0.895) with a low standard deviation of 0.049.[61] Therefore, it indicates that the IAT is an internally reliable measure of IA of individuals across different demographic backgrounds and cultural settings. Nonetheless, results of the present study should be viewed in light of a few limitations. Firstly, cross-sectional nature of the study restricted the analysis of causality. Secondly, a relatively small sample size which comprised of undergraduates from only one university hinders moderate generalizability of the findings.

**Conclusion**

Overall, the present study was able to supplement previous findings on the latent structure of the IAT scale. The 19-item three-factor model of IAT appears to be a valid and reliable instrument for measuring IA among Malaysian students as demonstrated by its satisfactory psychometric properties. Though initial indications of construct validity were promising, additional research may still be required to elucidate the stability of factor solutions in a variety of settings and demographic backgrounds in Malaysia.

**References**


