The Effect of Problematic Internet Use Behaviors and Psychological Need Thwarting of Online Teaching on Primary and Middle School Teachers' Psychological Distress during COVID-19: Cross-sectional Questionnaire Study

Jian Yi, I-Hua Chen, Chung-Ying Lin, Cheng-Chieh Li, Xiao-Ling Liao, Zhi-Hui Wei, Jeffrey Hugh Gamble

Submitted to: Journal of Medical Internet Research
on: March 09, 2021

Table of Contents

The Effect of Problematic Internet Use Behaviors and Psychological Need Thwarting of Online Teaching on Primary and Middle School Teachers' Psychological Distress during COVID-19: Cross-sectional Questionnaire Study

Jian Yi[1*]; I-Hua Chen[2, 3, 4*] PhD; Chung-Ying Lin[5, 6, 7*] PhD; Cheng-Chieh Li[8*]; Xiao-Ling Liao[3*]; Zhi-Hui Wei[9*]; Jeffrey Hugh Gamble[10*] PhD

[1]College of Education Capital Normal University Beijing CN
[2]Fujian Province University Key Laboratory of Applied Cognition & Personality Zhangzhou CN
[3]International College Krirk University Bangkok TH
[4]School of Education Science Minnan Normal University Zhangzhou CN
[5]Institute of Allied Health Sciences National Cheng Kung University Hospital College of Medicine Tainan TW
[6]Department of Occupational Therapy College of Medicine National Cheng Kung University Tainan TW
[7]Department of Public Health National Cheng Kung University Hospital College of Medicine Tainan TW
[8]School of Education Zhaoqing University Zhaoqing CN
[9]Development and Research Department Shanghai Open University Shanghai CN
[10]Department of Foreign Languages National Chiayi University Chiayi TW
[*]these authors contributed equally

Corresponding Author:
Jeffrey Hugh Gamble PhD
Department of Foreign Languages
National Chiayi University
85 Wenlong Village
Minhsiung County
Chiayi
TW

Abstract

Background: Recently, the negative effects of the COVID-19 pandemic on mental health have been addressed from the perspective of general public health. The role of problematic Internet use as a risk factor for psychological distress during the epidemic is another area of increased concern. Preliminary evidence suggests an increased psychological vulnerability for elementary and middle school teachers.

Objective: The current study analyzed the role of problematic Internet use, including problematic smartphone (PSU) and problematic social media use (PSMU), as explanatory variables in terms of primary and middle school teachers' fear of COVID-19. The effects of PNT of online teaching and fear of COVID-19 were also evaluated in terms of teachers' psychological distress. The purpose was to empirically evaluate the relationships among these research variables using a proposed model of factors contributing to teachers' psychological distress during COVID-19.

Methods: Online survey data was collected from 9030 primary and middle school teachers. A conventional model based on recent publications in the field of problematic Internet use and psychological distress during COVID-19 was compared with a proposed model, based on prior findings indicating problematic Internet use variables serve as explanatory, rather than outcome, variables.

Results: Structural Equation Modelling confirmed the superior goodness of fit of the proposed model (?2 (348) = 6220.27, RMSEA = 0.04, NNFI = 0.07, CFI = 0.99, SRMR = 0.07), as evidenced by a?AIC of 578.505 (significant when greater than 10) between the conventional model and proposed model. The data also demonstrated that the proportion of participants with psychological distress was relatively high: depression (20.4%), anxiety (26.4%), and stress (10.2%). The problematic Internet use behaviors were significantly associated with fear of COVID-19 (PSU: t = 17.19, P < 0.001; PSMU: t = 7.91, P < 0.001). Fear of COVID-19 and PNT of online teaching were both positively related with psychological distress (Fear of COVID-19: t = 9.65, P

< 0.001; PNT of online teaching: t = 10.83, P < 0.001). A significant moderating effect was found for PNT of online teaching on psychological distress (t = 5.68, P < 0.001), in that PNT of online teaching enhances the harmful effect of fear of COVID-19 on psychological distress.

Conclusions: The findings suggest that problematic Internet use behaviors contribute to fear of COVID-19 which, in turn, results in psychological distress. PNT of online teaching was both directly associated with increased psychological distress as well as serving as a moderator enhancing the impact of fear of COVID-19 on psychological distress. We suggest that school administrators pay attention to teachers' psychological needs and make efforts to assist teachers in experiencing greater autonomy and relatedness from interpersonal relationships to alleviate the psychological need thwarting that may arise from online teaching tasks.

(JMIR Preprints 09/03/2021:28373)
DOI: https://doi.org/10.2196/preprints.28373

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Original Paper

The Effect of Problematic Internet Use Behaviors and Psychological Need Thwarting of Online Teaching on Primary and Middle School Teachers' Psychological Distress during COVID-19: Cross-sectional Questionnaire Study

Abstract

Background: Recently, the negative effects of the COVID-19 pandemic on mental health have been addressed from the perspective of general public health. The role of problematic Internet use as a risk factor for psychological distress during the epidemic is another area of increased concern. Preliminary evidence suggests an increased psychological vulnerability for elementary and middle school teachers.
Objective: The current study analyzed the role of problematic Internet use, including problematic smartphone (PSU) and problematic social media use (PSMU), as explanatory variables in terms of primary and middle school teachers' fear of COVID-19. The effects of PNT of online teaching and fear of COVID-19 were also evaluated in terms of teachers' psychological distress. The purpose was to empirically evaluate the relationships among these research variables using a proposed model of factors contributing to teachers' psychological distress during COVID-19.
Methods: Online survey data was collected from 9030 primary and middle school teachers. A conventional model based on recent publications in the field of problematic Internet use and psychological distress during COVID-19 was compared with a proposed model, based on prior findings indicating problematic Internet use variables serve as explanatory, rather than outcome, variables.
Results: Structural Equation Modelling confirmed the superior goodness of fit of the proposed model (X^2 (348) = 6220.27, RMSEA = .04, NNFI = .07, CFI = .99, SRMR = .07), as evidenced by aΔAIC of 578.505 (significant when greater than 10) between the conventional model and proposed model. The data also demonstrated that the proportion of participants with psychological distress was relatively high: depression (20.4%), anxiety (26.4%), and stress (10.2%). The problematic Internet use behaviors were significantly associated with fear of COVID-19 (PSU: t = 17.19, P < .001; PSMU: t = 7.91, P < .001). Fear of COVID-19 and PNT of online teaching were both positively related with psychological distress (Fear of COVID-19: t = 9.65, P < .001; PNT of online teaching: t = 10.83, P < .001). A significant moderating effect was found for PNT of online teaching on psychological distress (t = 5.68, P < .001), in that PNT of online teaching enhances the harmful effect of fear of COVID-19 on psychological distress.
Conclusions: The findings suggest that problematic Internet use behaviors contribute to fear of COVID-19 which, in turn, results in psychological distress. PNT of online teaching was both directly associated with increased psychological distress as well as serving as a moderator enhancing the impact of fear of COVID-19 on psychological distress. We suggest that school administrators pay attention to teachers' psychological needs and make efforts to assist teachers in experiencing greater autonomy and relatedness from interpersonal relationships to alleviate the psychological need thwarting that may arise from online teaching tasks.

Keywords: problematic Internet use; psychological need thwarting; psychological distress; online teaching; COVID-19; online survey; structural equation modelling; primary and middle school teachers

Introduction

The pandemic caused by the novel coronavirus disease 2019 (COVID-19) has resulted in quarantines and isolation at home in many countries. In addition to the physical effects of the pandemic, scholars are paying increasing attention to the effects on individuals' mental health, including the stress caused by restrictions on movement, anxiety about the influence of COVID-

19 on their lives, and fear of infection [1-4]. Scholars and medical professionals have even referred to these potentially long-lasting psychological impacts as a "second wave" resulting from the pandemic [5].

Primary and Middle School Teachers as a Vulnerable Population

However, while several studies, such as those cited above, have focused on the general population, the impact on specific populations whose work has required substantial changes due to COVID-19 has not been sufficiently evaluated. Specifically, given the closure of school campuses and the required implementation of online teaching in many countries [6-8], primary and middle school teachers should be considered a vulnerable population in terms of mental health risk factors. In fact, some preliminary analysis of demographic factors related to the prevalence of anxiety among teachers in China during the pandemic indicates that elementary school teachers are at greater risk as compared to high school teachers [9]. There are several factors which make teachers vulnerable to the impact of COVID-19, including strains upon the teacher-learner relationship during interrupted learning, uncertainty regarding teachers' current and future responsibilities, and the technical and logistic challenges related to the transition from a classroom to home-based teaching environment [10].

Thus, although some researchers have evaluated the impact of COVID-19 on psychological well-being in educational contexts, these studies have tended to focus on university contexts (e.g. Al-Sabbah et al. [11] who found negative biopsychosocial effects on both teachers and students at the tertiary level) or the impact of the pandemic on students (e.g. Zhang et al. [12-13] who noted an increase in mental health issues for children and adolescents following school closures). While these studies provide evidence of the negative impacts of COVID-19, further research focusing on primary and middle school teachers as a vulnerable population is warranted.

Online Teaching and Primary and Middle School Teachers' Psychological Well-being

Studies on the time spent in online teaching has demonstrated that elementary and secondary school students spend significantly more time learning online as compared to university students [14]. As a result, the numbers of hours of online teaching activities is associated with the prevalence of symptoms of emotional problems among teachers [10]. One reason online teaching negative influences teachers' mental health is the fact that primary and secondary teachers were not well-prepared with the required technological skills online teaching [6-8, 10], since school closures and online teaching requirements were announced without sufficient time to prepare. Online teaching requires sufficient information and communication technology (ICT) literacy and experience in online teaching design [15] since, without ICT skills and experience, it is difficult to achieve successful online teaching results. According to Zheng and Song's survey of online teaching by Chinese primary and secondary school teachers during the epidemic, less than half of the teachers reported having sufficient ICT skills to share digital teaching resources with others, carry out collaborative teaching, and use learning management systems to evaluate student learning outcomes [6]. As a result, 31.3% of teachers indicated that they were not willing to continue online teaching after the epidemic [6]. Similar results were also found for Indonesian elementary school teachers, where 80% of surveyed teachers felt dissatisfied with the efficiency of online teaching [8]. Given these levels of dissatisfaction with online teaching, it is critical to evaluate the role of online teaching in terms of teachers' psychological well-being.

While some research has discussed how online teaching activities generally result in additional work-related burdens, pressure, and excessive time expenditures for teachers [10, 16-17], there is a lack of large scale empirical studies reporting on the resulting impact on the psychological well-being of teachers. In fact, few studies have evaluated the impact of online teaching on primary and secondary school teachers' mental health. Existing research has tended to emphasize general demographic factors without considering the influence of online teaching (e.g. Li et al. [9] who reported higher levels of anxiety among female teachers and urban school teachers). As such, risk factors related to elementary and middle school teachers' psychological distress during the COVID-19 pandemic, in the context of online teaching, have yet to be empirically examined.

The Role of Problematic Internet Use

Given the demands of designing, conducting, and evaluating learning through online courses, most teachers require use of the Internet (or mobile devices) over an extended period of time [6,8,10]. Additionally, since most primary and middle school teachers also serve as home room teachers, which is particularly common in Asian countries [18], mobile devices, such as smartphones, are frequently required to communicate with parents. However, given the Internet access provided by smartphones, problematic Internet use related to smartphones (problematic smartphone use; PSU) has become a common phenomenon which negatively impacts mental health, including increased Internet addiction [19-20], and the prevalence of attention-related disorders [21] .

Related to excessive use of smartphones is the phenomenon of problematic social media use (PSMU). Teachers working in environments with immediate access to the Internet may receive frequently updated information on COVID-19, partly due to the fact that some social media applications automatically list breaking news (such as announcements related to pandemics) on their homepage. For example, Weibo, the dominant microblogging website in China with more than 500 million users, automatically lists major social news events immediately after logging in, so that users are forced to view headlines related to breaking news stories, particularly concerning COVID-19. Moreover, it is also likely that teachers will take the initiative to check for updated information on COVID-19 using social media, a phenomenon demonstrated by previous studies on the general population [2,22].

Unfortunately, whether teachers are passively (via automatic updates on COVID-19 news) or actively (through intentional searching) exposed to social media regarding COVID-19, negative emotions may be induced for two main reasons: a) disturbing information on the epidemic may deepen one's anxiety [4,22-23]; and b) when updated information is not immediately available, individuals will tend to continue searching for relevant information, forming a negative emotion feedback loop [3]. This type of negative emotion related to COVID-19 can be characterized as fearfulness, with fear of COVID-19 clearly related to mental health issues, including anxiety and depression [24]. In fact, the impact of fear of COVID-19 on anxiety and depression has been supported by a recent cohort study of adults, which found an overall increase of between 6.6 and 7.4 fold in depression and anxiety among the surveyed adults [25]. Given existing empirical findings, it is likely that PSU and PSMU serve as two critical factors related to primary and middle school teachers' fear of COVID-19 [26] and overall psychological distress during the outbreak of COVID-19 [3,22,27-30]. Thus, the role of PSU and PSMU in terms of fear of COVID-19 and psychological distress require further empirical evaluation and modelling to understand the relationships among these important variables.

Psychological Need Thwarting of Online Teaching

From previous studies, it is obvious that online teaching during the epidemic has left a negative impression on teachers, including very low satisfaction and lack of intention to engage in online teaching [6,8]. Although most teachers consider online teaching to be necessary, given the preventative effect of distance learning on the spread of the virus and the potential benefits to student learning [10], teachers' motivation has suffered due to a lack of direct interaction with students while teaching online [7]. Given unfamiliarity with online teaching, low teaching motivation may be reflected in teachers' lack of autonomy and competence in online teaching. Moreover, during the epidemic teachers were isolated at home, restricting teachers' sense of satisfaction in terms of their need for relatedness [10]. According to Self Determination Theory (SDT), autonomy, competence, and relatedness are three basic psychological needs impacting motivation [31-32]. When these three psychological basic needs are not satisfied, frustration occurs, resulting in a phenomenon called psychological need thwarting (PNT) [33-34]. This study proposes a novel construct based on PNT within the context of online teaching: PNT of online teaching.

We believe that PNT of online teaching can provide a new perspective to assist in interpreting the mechanisms contributing to mental health issues among teachers during the epidemic. We hypothesize that PNT of online teaching may contribute to teacher's psychological distress since studies indicate that higher levels of teachers' PNT are associated with professional burnout [35-36], and burnout is a construct closely related with psychological distress (e.g. depression and anxiety) [37]. However, the effects of PNT of online teaching requires further examination. For example, the nature of the influence of PNT of online teaching on mental health (as a direct effect or moderating variable for the impact of other variables on psychological distress) requires clarification.

Aims of the Present Study

Although COVID-19 research has addressed the association between digital technology use and psychological distress [2,3,22,29,38], there is a lack of research on a) the vulnerable population of primary and middle school teachers and b) the novel construct of PNT of online teaching. As such, in the present study, we conducted a cross-sectional survey to investigate the prevalence of psychological distress among primary and middle school teachers in Mainland China. Most importantly, in order to further understand the relationships among problematic Internet use behaviors (i.e., PSU and PSMU), PNT of online teaching, fear of COVID-19, and psychological distress, we propose and examine two competing models which both offer plausible interpretations and implications. This study intends to contribute to both theory and practice by evaluating the influence of problematic Internet use behaviors and PNT of online teaching on the psychological distress experienced by primary and middle school teachers during the COVID-19 pandemic.

Existing Model based on the I-PACE Framework

The theoretic models evaluated in this study are based on two opposite perspectives for explaining the mechanisms involved in the development of psychological distress and problematic Internet use behaviors. The first model is based on Brand et al.'s Interaction of Person-Affect-Cognition-Execution (I-PACE) model which has been used to explain how the problematic use of Internet use activities develops [39]. According to the I-PACE model, under stressful environmental conditions (e.g., the COVID-19 outbreak and the burdens and challenges of online teaching), individuals will experience an emotional response, such as psychological distress. In turn, these emotional responses can induce addictive behaviors, such

as PSU, and PSMU (explained as behaviors caused by a reduction of executive functioning and loss of self-control in the I-PACE Model). Consequently, in the I-PACE model, increased psychological distress reduces an individual's ability to inhibit their cravings for and addition to smartphone use and social media use. Finally, given diminished inhibitory control, an individual tends to increase their time spent on smartphone and social media use, which becomes problematic in nature. Empirical support for the fit of the I-PACE model with Chinese adults has been recently reported [28], with depression and anxiety having a positive effect on PSU, mediated by the anxiety caused by COVID-19.

The I-PACE model has been widely used in recent empirical studies, such as the research of Peng et al. who examined the relationships among self-esteem, life satisfaction, teacher autonomy support, and PSU among adolescents based on the I-PACE model [40]. Recent research by Wolniewicz et al. also adopted the I-PACE model as a framework to assess the relationships among depression and anxiety and PSU, in which proneness to boredom and fear of missing out served as mediators [41]. Likewise, Dang et al. conducted a one-year longitudinal study to test hypotheses based on the I-PACE model that emotional intelligence would have an indirect effect on Internet Gaming Disorder (IGD) and that depression would have a direct effect on IGD [42].

Based on the original I-PACE model [39], we have developed a testing model (Figure 1). All hypothesized relationships in Model 2 are positive. In the model, psychological distress is an explanatory variable, while problematic Internet use behaviors serve as dependent variables (i.e., PSU and PSMU). Fear of COVID-19, following prior I-PACE model testing research in the context of COVID-19 [28], was included as a mediator. More specifically, in the I-PACE model, the anxiety or fear caused by COVID-19 is a mediator for the influence of psychological distress (i.e., general depression and anxiety) on problematic Internet use [28]. Regarding PNT from online teaching, the rationale of the I-PACE model suggests that this variable will have a direct positive effect on PSU and PSMU, since the I-PACE model predicts that an individual in a stressful environment will experience an emotional response (e.g., PNT) which, in turn, will increase the probability of addictive behaviors. The expectation that stress and anxiety can lead to the development of addictive behaviors, including problematic Internet use, has recently been reiterated in the context of COVID-19 guidance published by authors including several involved in the development of the original I-PACE model [43].

Insert Figure 1 here

Proposed Model

Despite the fact that the I-PACE model has been supported by the aforementioned studies [28,40-42], other recent research provides an alternative explanation for the established relationships among psychological distress (including anxiety and depression) and problematic Internet use behaviors. In fact, scholars have proposed a perspective which is opposite to that of the I-PACE framework. Namely, excessive Internet use behaviors are considered to be risk factors predictive of psychological distress [20,44-45], rather than behaviors resulting from such distress. In Chen et al.'s longitudinal study, increases in PSU were associated with increases in psychological distress among Hong Kong university students, although no influence of PSMU was found [20]. It is probable that the association

between problematic Internet use behaviors and psychological distress may be even stronger during the COVID-19 pandemic, given the results of Chen et al.'s study comparing the magnitude of the association of Internet us behaviors with psychological distress between measures taken pre-COVID-19 and during the COVID-19 outbreak [38], which found that PSU and PSMU were only positively associated with psychological distress during the COVID-19 outbreak but not prior to the outbreak. One explanation for this finding is that individuals restricted to their homes may rely more on social media to receive updated information of COVID-19, with social media providing false or exaggerated reports about COVID-19 [4]. In addition, the negative emotions expressed by Netizens may cause harm to individuals' mental health through "(mis)information overload" [4].

Based on relevant literature, we propose an alternative model (Figure 2). All hypothesized relationships in Model 2 are positive. The proposed model is based on previous studies of excessive problematic Internet use behaviors leading to psychological distress [4,20,38,44-46]. As such, PSU and PSMU serve as explanatory variables (rather than as dependent variables), and are expected to significantly influence teachers' psychological distress (as the dependent variable). In order to address the context of COVID-19, we hypothesize that fear of COVID-19 will serve as a mediator between problematic Internet use behaviors and psychological distress (a mental health problem), which is also in line with the findings of Hashemi et al. [47]. Specifically, since teachers use smartphones and social media more frequently during the outbreak, exposure to a greater amount of negative and frightening information can result in higher levels of fear of COVID, a specific fear that is likely to result in general psychological distress. This mechanism has also supported by Lin et al.'s study wherein fear of COVID-19 was a mediator between PSMU and psychological distress [2]. Since PNT is positively associated with teacher burnout (which is strongly related to anxiety and depression) [35-36], the proposed model hypothesizes that PNT of online teaching will be positively related with mental health problems, since PNT has been demonstrated to serve as a proxy for psychological distress [37,48]. In addition to a direct effect, the proposed model also hypothesizes that PNT will strengthen the impact of fear of COVID-19's on teachers' psychological distress (i.e. PNT will also serve as a moderator). Specifically, according to Neufeld et al., an individual's stress-protective system diminishes as basic psychological needs are frustrated [49]. That is, PNT of online teaching may weaken teachers' stress-protective system and thereby enhance the harm from the fear of COVID-19 on mental health. As such, in the proposed model, for teachers frustrated by online teaching (and associated lower levels of self-autonomy, competence, relatedness with others) fear of COVID-19 may result in more serious harm to mental health as compared to teachers with higher levels of autonomy, competence, and relatedness in terms of online teaching.

Insert Figure 2 here

Method

Participants and Procedure

This study conducted a cross-sectional online survey of primary and middle school teachers between May 25 and June 30, 2020. Ethics approval for the study was provided by the

Institutional Review Board (IRB) of the Jianxi Psychological Consultant Association (IRB ref: JXSXL-2020-J013). A non-probability sampling strategy was adopted to implement an online survey using Sojump, a platform for online questionnaire collection. We first sought help from principals of primary and middle schools in Jiangxi, Sichuan, and Shandong, China. Subsequently, the principals who accepted our invitation provided the online survey's hyperlink to their respective school's teachers. Implementation of the online survey was voluntary and anonymous. Informed consent was obtained at the beginning of the survey. In total, 11014 primary and middle school teachers complete the online survey.

As the Sojump platform required participants to complete all items, there were no missing data. However, not all participant data was utilized for subsequent analysis, as we only selected participants who had experience in online teaching during the COVID-19 outbreak. Filtering of responses was achieved through the use of one survey item which asked "During the epidemic, did you conduct online teaching? (including online teaching, assigning and grading homework in the Internet environment, etc.)". Based on responses to this item, respondents were screened, and only teachers with online teaching experience were included as eligible participants for data collection. As a result, the effective sample included 9030 participants. 5838 responses from primary school teachers (65%) and 3192 responses from junior high school teachers (35%) were collected. Given that there were generally no significant differences in the observed scores between primary and junior high school teachers for the target variables, with the exception of PSMU, for which there was a significant difference between primary and junior high school teachers (t = 3.79, P = .001), with a small effect size (Cohen d = .08), we integrated the data from the two samples (primary and middle school teachers) during this stage of model evaluation.

Measures

Five validated psychometric instruments were used to evaluate teachers' psychological distress, fear of COVID-19, problematic smartphone use, problematic social media use, and psychological need thwarting of online teaching. These instruments were administered as online questionnaires wherein participants were asked to self-evaluate themselves in terms of these constructs during a specific timeframe in which the COVID-19 outbreak was considered to be the most serious in terms of its impact on teachers and online teaching; namely, the school semester beginning in February 2020 and ending in June 2020.

Psychological Distress

We used scores from the Depression, Anxiety and Stress Scale-21 (DASS-21) as indicators for psychological distress. The DASS-21 contains 21 items evenly divided into three subscales: depression, anxiety, and stress (each subscale consisting of seven items) [50]. All items were rated using a four-point Likert scale (zero to three), with higher scores indicating higher level of depression, anxiety, or stress. We summed all item scores for each subscale and multiplied the summed scores by two to facilitate a comparison with the scale's cutoff values. According to the DASS-21 manual, multiplied scores higher than 10 (depression), 8 (anxiety) and 15 (stress) indicate a mental health problem [50]. Prior studies have demonstrated the sound psychometric properties of the Chinese version of DASS-21 [51-52] among mainland Chinese respondents. The internal consistency of the Chinese DASS-21 instrument utilized in our study was high (0.92, 0.91 and 0.91 for depression, anxiety and stress, respectively). Sample items for each subscale include: "I couldn't seem to experience any positive feelings at all" (depression); "I was aware of dryness of my mouth" (anxiety); and "I tended to over-react to situations" (stress).

Fear of COVID-19

The Fear of COVID-19 Scale (FCV-19S) was used to measure the level of the fear of COVID-19. FCV-19S contains seven items scored on a five-point Likert-type scale (from 1 to 5). Higher scores on the FCV-19S indicate higher levels of fear of COVID-19. FCV-19S was developed by Ahorsu et al. [53] and has demonstrated sound psychometric properties. The internal consistency of the FCV-19S in this study was 0.89, indicating good reliability. Sample items include: "I am most afraid of COVID-19" and "I am afraid of losing my life due to COVID-19".

Problematic Smartphone Use

The Smartphone Application-Based Addiction Scale (SABAS) was used to measure respondents' level of PSU. Csibi et al. developed SABAS [54], which includes six items. SABAS measures a single construct: risk of addiction to smartphone applications. SABAS was used to assess general problematic smartphone/Internet use. SABAS items were scored on a six-point Likert-type scale (from 1 to 6), with higher scores indicating more problematic smartphone use. The psychometric properties of the Chinese version of SABAS have been established with a Chinese sample [55-56]. The internal consistency of SABAS in the present study was 0.87, which was deemed acceptable. Sample items include: "My smartphone is the most important thing in my life" and "I tend to increasingly use my smartphone".

Problematic Social Media Use

The Bergen Social Media Addiction Scale (BSMAS) was adopted by this study to measure PSMU. BSMAS was developed by Andreassen et al. [57] and includes six items score on a five-point Likert-type scale (from 1 to 5), with higher scores indicating greater risk of social media addiction. The Chinese version of BSMAS has sound psychometric properties [55-56]. The internal consistency of BSMAS in the present study was satisfactory (α = 0.88). Sample items include: "I spend a lot of time thinking about or planning on using social media" and "I use social media to forget about personal problems".

Psychological Need Thwarting of Online Teaching

According to our review of the literature, there is no published instrument available to measure the psychological need thwarting of online teaching. Therefore, we made slight modifications to the original content of the Chinese Psychological Need Thwarting of Teachers Scale (CPNTTS) [35] in order to reflect the nature of online teaching tasks. CPNTTS was developed by Chen et al. following SDT and includes three subscales: autonomy, competence, and relatedness [35]. Regarding revisions to the scale, for example, an original item belonging to autonomy need thwarting was: "I can't decide on my own how I want to teach." This item was revised to "During the epidemic, I had to follow a prescribed way of online teaching" in order to better contextualize the source of autonomy need thwarting as online teaching. Likewise, an original item belonging to competence need thwarting was: "There are situations that make me feel incapable," which was changed to "In the working environment during the COVID-19 epidemic, some online teaching situations made me feel incapable." In terms of relatedness need thwarting, an original item was "I feel rejected by the people around me," which was changed to "When conducting online teaching during the epidemic, I felt that I was rejected by other colleagues and administrators". The CPNTTS includes nine items scores on a seven-point Likert-type scale (from 1 to 7). Although CPNTTS has demonstrated sound psychometric properties [35], we conducted a strict re-examination of the reliability and validity of the scale since modifications were made for the purposes of the present study. The results confirmed that the factor structure of the revised version was consistent with the original CPNTTS scale, with the results of confirmatory factor analysis (CFA) demonstrating satisfactory fit on relevant indices (CFI = .966, NNFI = .955, RMSEA = .09 and SRMR = .05).

Moreover, factor loadings were between .63 to .88, which was deemed acceptable. The Cronbach's α for the sub-scales were as follows: autonomy (0.78), competence (0.84), and relatedness (0.88). Based on the above results, the revised version of CPNTTS was deemed to have acceptable validity and reliability.

Demographic Information

In addition to age, educational system (elementary or middle school), gender and years of work experience, two key demographic variables were also evaluated: status as homeroom teacher and previous online teaching experience before the school hiatus.

Statistical Analyses

We first provided descriptive statistics on our target variables (i.e., psychological distress, fear of COVID-19, PSU, PSMU, and PNT of online teaching). We also further reported the proportion of respondents who reported psychological distress, including depression, anxiety, and stress, based on the cutoff values of DASS [50]. Furthermore, the results of Pearson correlations were also provided.

Next, structural equation modeling (SEM) with LISREL 8.80 was used to test the two competing models (Figure 1: PSU and PSMU served as dependent variables, fear of COVID-19 as a mediator, psychological distress and PNT of online teaching as independent variables; Figure 2: Psychological distress served as a dependent variable, fear of COVID-19 as a mediator, PSU, PSMU and PNT of online teaching as independent variables. PNT of online teaching was also hypothesized as a moderator). In both models, key demographic variables including years of work experience, gender, status as homeroom teacher and previous online teaching experience before the school hiatus were included as control variables. Given that the factor structure of DASS-21 and CPNTTS both consisted of three subscales, the mean scores of each subscale were used as indicators for psychological distress and PNT of online teaching while other latent variables used the original items,. We carefully reviewed the quality of the two models and compared the model fit indices between the models without evaluating the possible moderating effect (relevant for Model 2) at this stage, since model fit must be first established.

After comparing the fit of the two competing models, a test for the moderating effect of PNT of online teaching (Model 2) was conducted. We referred to Little et al.'s approach of the residual centering [58] to conduct the moderating test using SEM. Through this approach, we used the residuals to form indicators for the product variable (i.e. Fear of COVID-19*PNT of online teaching). That is, for the model including the latent interaction construct, the residuals served as respective indicators. According to Little et al., for the interaction effect to be estimated in an unbiased manner, specific residuals of the interaction variable should correlate. As such, there were a total of 36 pairs of measurement errors added as correlated estimates (i.e., the three mean scores for the subscales of CPNTTS served as indicators for PNT of online teaching and the seven original items from FCV-19S served as the indicators for fear of COVID-19). In order to judge whether the moderating effect existed, we scrutinized the significance level of the latent interaction construct and compared the difference in proportion of variance explained (i.e. R^2) between the model without a moderating effect and the full model (i.e. the model including the moderating effect), which reflects the concept of an effect size [59].

Regarding the criteria for model fit evaluation, we adopted the following combined indices: X^2, comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). RMSEA values

of .06 or lower, SRMR values of .08 or lower, CFI values of .95 or higher, and NNFI values of .95 or higher are considered acceptable [60]. Moreover, the Akaike information criterion (AIC) andΔAIC (AIC_{higher} - AIC_{lower}) were used to compare models with acceptable fit indices in order to decide which model had the best fit. Specifically, a smaller AIC indicates a better model [61]; ΔAIC>10 indicates that, compared to the model with the lower AIC, the empirical data cannot provide any support to the model with the higher AIC. ΔAIC between 4 to 7 indicates the model with the higher AIC receives less empirical support as compared to model with the lower AIC. ΔAIC between 0-2 means the two models can considered to equally fit the data [62].

Results

Participant Characteristics

Table 1 includes key participant characteristics. The mean age of respondents was 35.09 years (*SD* = 19.08), with 6563 female teachers (72.7%). Most of the participants had the years of work experience over 10 years (5203 teachers, 57.6%). More the half of the participants served as homeroom teachers (5225 teachers, 57.9%) and most of them did not have prior experience in online teaching before the school hiatus (6387 teachers, 70.9%). In terms of subjects taught, most participants taught Chinese (2624 teachers, 29.05%), Mathematics (2222 teachers, 24.60%) and English (1601 teachers, 17.73%).

Table 1. Key characteristics for the participants of the study (N=9030)

Age in year; *M (SD)*		33.94 (8.81)
School type; n (%)		
	Primary school	5838 (64.65%)
	Middle school	3192 (35.35%)
Gender; n (%)		
	Male	2467 (27.3%)
	Female	6563 (72.7%)
Years of work experience; n (%)		
	Under 5 years	2207 (24.3%)
	6 to 10 years	1620 (17.9%)
	11 to 15 years	1268 (14.0%)
	16 to 20 years	1049 (11.6%)
	Above 21 years	2886 (32.0%)
Homeroom teacher; n (%)		
	Yes	5225 (57.9%)
	No	3805 (42.1%)
Prior online teaching experience; n (%)		
	Yes	2643 (29.30%)
	No	6387 (70.70%)
Subject taught; n (%)		
	Chinese	2624 (29.05%)
	English	1601 (17.73%)
	Mathematics	2222 (24.60%)
	Science	716 (7.93%)

	Social science	1008 (11.17%)
	Other (music, art, physics, politics)	859 (9.52%)

Descriptive Statistics and Pearson Correlations for the Observed Variables

Table 2 displays the mean values for our target variables (observed scores) and Pearson correlations. For psychological distress, the mean was 0.36 (*SD*=0.48). According to the cutoff points from DASS-21 manual (Lovibond & Lovibond, 1996), the proportion of respondents with mental health problems were as follows: depression (20.4%), anxiety (26.4%), and stress (10.2%). Moreover, mean values for other variables are as follows: level of fear of COVID-19 (2.13; *SD* = 0.59), PSU (2.76; *SD* = 1.03), PSMU (2.26; *SD* = 0.79), and PNT of online teaching (3.63; *SD* = 0.89) which were lower than the corresponding median values. Among the three subscales of PNT, the scores from high to low were competence (mean = 4.30, *SD* = 1.38), autonomy (mean = 4.02, *SD* = 1.09) and relatedness (mean = 2.58, *SD* = 1.08) (not shown in Table 2). The Pearson correlations indicated that psychological distress was positively associated with fear of COVID-19, PSU, PSMU and PNT of online teaching (*r* values ranged from 0.25 to 0.41, all significant at *P* < .001).

Table 2. Descriptive statistics and Pearson correlation matrix of the variables of interest

	Mean (SD)	1	2	3	4	5
1.Psychological distress [a]	0.36 (0.48)	1.00				
2.Fear of COVID-19 [b]	2.15 (0.59)	0.41*	1.00			
3.PSU [c]	2.76 (1.03)	0.34*	0.35*	1.00		
4.PSMU [d]	2.26 (0.79)	0.31*	0.27*	0.57*	1.00	
5.PNT [e]	3.54 (0.89)	0.25*	0.28*	0.26*	0.18*	1.00

*Note: All *P*-values < .001

[a] Assessed using the Depression, Anxiety and Stress Scale-21

[b] Assessed using the Fear of COVID-19 Scale

[c] PSU = Problematic smartphone use, assessed using Smartphone Application-Based Addiction Scale

[d] PSMU = Problematic social media use, assessed using the Bergen Social Media Addiction Scale

[e] PNT =Psychological need thwarting of online teaching, assessed using a revised form of the Chinese Psychological Need Thwarting of Teachers Scale

Model Comparisons

Using SEM, we separately provided model fit values for the standard and proposed models. For both models, the variables of years of work experience, gender, status as homeroom teacher and previous online teaching experience before the school hiatus served as control variables. According to the results of the I-PACE model (Figure 3) and the proposed model (Figure 4), it is clear that Model 2 (the proposed model) had an acceptable fit on all indices according to the criterion adopted by this study. Specifically, X^2 (348) = 6220.265, RMSEA = .043, SRMR = .071, NNFI = .982, and CFI = .985. However, the SRMR value for Model 1 (I-PACE) did not meet the criterion (i.e., 0.111) although other indices were acceptable (X^2 (349) = 6800.770, RMSEA = .045, NNFI = .981 and CFI = .983). Moreover, AIC was much lower in Model 2 (6394.265) as compared to Model 1 (6972.770), withΔAIC = 578.505 much higher than 10, strongly indicating that Model 1 (I-PACE) could not be supported by the empirical data as compared to Model 2 (proposed model).

Regarding to the above results, given that the ΔAIC value was much higher than 10, it is clear that the I-PACE model (Figure 3) should be omitted from further consideration according to the guidelines provided by Burnham and Anderson [62]. However, we report the results of the path coefficients for the I-PACE model in Figure 3, since, although the model does not fit the data, inclusion of this information can be useful for the purpose of interpreting the results of this study. In the context of model comparison, the models under consideration must be well founded (i.e. based on the theory) and well-supported by the empirical data [62].

Insert Figure 3 here

Korner-Nievergelt et al. suggest that that before using AIC to select the best model, all models in the set should fit the data well, with residual analysis serving as one of the most important fit indices [61]. SRMR can be roughly interpreted as the average standardized residual covariance, so higher values reflect an average high residual covariance [63]. Furthermore, a high value for SRMR may also indicate model misspecification [63]. As such, whether due to high residual covariance or model misspecification, we believe that without managing the residual covariance (e.g., adding the estimation of correlation among some residuals), the I-PACE model should be temporarily excluded from the subsequent analysis, since there is also no addition of the estimation of the correlation among residuals in the proposed model.

In Figure 4 (the proposed model), PSU and PSMU were positively associated with fear of COVID-19 (PSU: 0.33, t = 17.19, P < .001; PSMU: 0.15, t = 7.91, P < .001). Fear of COVID-19 and PNT of online teaching were both positively related with psychological distress (Fear of COVID-19: 0.45, t = 9.65, P < .001; PNT of online teaching: 0.12, t = 10.83, P < .001). Moreover, PSU and PSMU had an indirect positive effect on psychological distress (PSU: 0.15, t = 8.19, P < .001; PSMU: 0.07, t = 6.18, P < .001) through the mediator of Fear of COVID-19.

Insert Figure 4 here

Moderating Effect of PNT of Online Teaching

Finally, regarding the evaluation of the potential moderating effect of PNT of online teaching, the results showed that the coefficient for the latent interaction construct was 0.09, which was statistically significant (t = 5.68, P < 0.001). Since the coefficient was significant and positive, the interpretation is that PNT of online teaching enhanced the harmful effect of fear of COVID-19 on psychological distress. The R^2 in the model without the moderating effect included was 0.24, while the R^2 of the full model was 0.26. Therefore, a modest increase of 2% in variance explained was observed after adding the moderating effect.

Discussion

Due to the COVID-19 outbreak, many schools around the world were temporarily closed, and governments had to implement online education in a short time frame. In consideration of the vulnerability of elementary and middle school teachers who were restricted to their homes and required to conduct online teaching, the present study contributes to the literature as a

unique empirical study investigating the mental health among primary and secondary school teachers under COVID-19.

Principal Results

The results showed that more than 70 percent of teachers had no experience with online teaching before the school closures, reflecting the issue that teachers did not receive adequate training in online teaching prior to the pandemic. Moreover, the results indicate that around 10% to 26% of participants had mental health problems (from mild to severe), of which depression was the most serious. These results can be compared to the previously reported findings among Chinese adults of an overall prevalence of anxiety of 13.67% among teachers, including elementary, middle school, high school, and university teachers [9], and even earlier findings of only 4.98% in 2013 [64]. Potential reasons for this prevalence of reported mental health issues in the current study may be explained by the particularly vulnerable nature of elementary and middle school teachers [9-10], particularly in the context of online teaching [6,14] and with increasing fear of COVID-19 being perpetuated by PSU and PSMU [24-25].

In order to fully understand the mechanisms through which teachers' psychological distress can be impacted, we proposed and examined two possible models. The results demonstrated that only the proposed model (wherein PSU and PSMU serve as explanatory, rather than dependent, variables) was supported, suggesting that that excessive problematic Internet use behaviors are contributing risk factors of teachers' psychological distress, within the context of online teaching during COVID-19 in particular. That is, due to the requirements of online teaching, such as contacting parents and students online and preparing content for digital lessons, teachers must more frequently use their smartphones and social media [10] which, due to the often negative nature of online content regarding COVID-19 [3-4,22-23] harms their mental health as mediated by increased fear of COVID-19 [24-25]. Furthermore, drawing from the perspective of SDT, we proposed the existence of an impact of PNT of online teaching on teachers' mental health [37,48]. The results indicate that PNT of online teaching not only directly impacts the psychological distress but also deepens the association between fear of COVID-19 and psychological distress.

With data from more than 9000 primary and middle school teachers who engaged in online teaching during the COVID-19 outbreak, our large-scale survey contributes the literature on the increasing "second wave" of psychological damage caused by the COVID-19 pandemic [5] with validated findings grounded in empirically supported theory. Given this advantage, our research can support the hypothesis, to a certain extent, that primary and middle school teachers who are required to conduct online teaching may develop mental health problems, particularly when increased PSU and PSMU are contributing factors. Our study echoes that of Aperribai et al. [10] who found that teachers restricted to their homes due to the epidemic had almost double the average scores on the Short General Health Questionnaire (GHQ 12), which is a screening tool for potential mental disorders, such as anxiety [65], as compared to a comparison group.

However, we also note that the level of the psychological distress among primary and middle school teachers in this present study was not as serious as originally expected, in that the scores were lower than those of a few studies of the general adult population during COVID-19 adopting the same instrument (i.e. DASS-21) [3,27,51]. We speculate that this different may be attributed to two factors: a) the time frame of the studies and b) the countries in which the studies were conducted. In terms of the time frame, it should be noted that the study

conducted by Wang et al. [51], which also involved respondents from China, took place between March and April 2019 . As this period was at the peak of the epidemic in China, fear of COVID-19 was, arguably, much higher in comparison to responses collected by our study between the end of May to the end of June 2020. During the period evaluated by our study, the epidemic situation in China had eased considerably, which may have resulted in an overall lower level of fear of COVID-19 and the associated variables of PSU and PSMU. In terms of the country in which the research was conducted, it should be noted that the data evaluated by Boursier et al. [27] was collected in Italy during April 2020, during a period of lockdown. The strong impact of the lockdown on the Italian population has been documented, with symptoms similar to those caused by trauma [66], whereas the response by Chinese citizens was relatively less severe, with some scholars reporting that lockdown measures contributed to buffering the effects of social anxiety [12]. Likewise, the study by Sigurvinsdottir et al. [3], included European and American respondents and data from April and May 2020.

In terms of the association between problematic Internet use behaviors and psychological distress, our results support the endogenous nature of problematic Internet use behaviors in contributing to psychological distress, mediated by fear of COVID-19. While this finding is consistent with previous studies [4,20,38,44-46,67], wherein excessive use of technology devices was harmful to individuals' mental health, it contradicts many of the popular models, based on or similar to the I-PACE framework, which consider PSU and PSMU as exogenous variables in response to triggers such as stress [28,39].

Besides, fear as an initial psychological response to a threat (i.e., COVID-19) might subsequently lead to other forms of psychological distress. As such, the mediating role of the fear of COVID-19 as reported in our study supports the findings of other scholars [2]. That is, when teachers were required to more frequently use smartphones (e.g., communication with parents) or social media (e.g., using the Internet to design online courses resulting in receiving updated information from social media), problematic Internet use behaviors (i.e., PSU and PSMU) were potentially induced, leading to addictive behaviors and diminished psychological well-being.

Implications

Adopting the perspective of PNT [33-34] to interpret the phenomenon of decreased motivation for engaging in online teaching during the epidemic, a phenomenon frequently noted in the literature [7], is a main contribution of this study. The implication of the role of PNT of online teaching is that stakeholders should carefully address the issue of teacher frustration in terms of psychological needs. PNT includes three psychological needs that can be thwarted: autonomy, competence, and relatedness. Among these, lacking of the competence to conduct online teaching is a main source of psychological need thwarting, echoing the findings from other studies highlighting teachers' lack of sufficient skills in terms of technology were a main obstacle impairing teachers' implementation of online teaching [6-7,15]. Although the frustration caused by lack of competence cannot be ameliorated in a short period of time (particularly during an epidemic), the frustration of autonomy and relevance might be alleviated by the active intervention of school administrators. For example, principals are recommended to provide teachers more flexibility regarding online teaching, with less strict monitoring and stronger encouragement and actively expression of the care for teachers' safety, mental health, and working status. If it is possible to improve the online teaching environment such that one or more of the three psychological needs can be met, rather than thwarted, teachers' PNT may be significantly improved, since the three psychological needs are

closely related to each other [35]. On the contrary, if school administrators maintain pre-epidemic management strategies towards teachers during the epidemic, without making corresponding adjustments (i.e., providing more autonomy and relatedness), teachers' PNT of online teaching will naturally arise which, subsequently can harm teachers' mental health and diminish their stress-protective systems.

Limitations

Certain limitations of this study must be acknowledged. First, although the model based on the I-PACE framework was not supported in this study, we cannot conclude that the I-PACE framework is not suitable for explaining teachers' problematic Internet use behaviors in other contexts, such as those not involving online teaching. Also, by adding an additional latent variable, PNT of online teaching, to the I-PACE model, we may have influenced the fit of the overall model. Therefore, future research should be cautious in conducting model comparisons based on our study, with further residual analysis suggested in order to address the issue of the high value of SRMR observed for the I-PACE Model. Secondly, regarding the influence of PSU and PSMU on psychological distress, although we have provided some explanations (for example, teachers need to use mobile phones more extensively since they need to communicate with parents online), these suggestions cannot be directly supported by our data, as they were not specifically investigated by our questionnaire. While our proposed interpretations are based on China's educational environmental ecology, they may not be generalizable to other contexts. As such, further qualitative data collection regarding teachers' reasons for smartphone or social media use would add additional valuable interpretation to our present results. The third limitation is related to sample representativeness. Since timely collection of data was of key importance to this study, we aimed to complete the survey before the end of the second semester for primary and middle school schools in China (this specific time period was selected due to fact that teachers were required to work online from home due to COVID-19). As such, we conducted a rapid online survey using a non-random sampling frame. In this case, we are unable to confirm whether or not the ratio of rural and urban schools, for example, in our study was representative of teachers in China overall.

Conclusion

"Disrupted Classes, Undisrupted Learning" was the Chinese governments' official policy in response to the COVID-19 outbreak [6]. While previous research has focused on mental health problems stemming from home confinement from the perspective of students [11,13,38], the vulnerability of elementary and middle school teachers, who were required to conduct online teaching without sufficient preparation, has received little attention. As teachers are also victims of COVID-19's negative psychological effects, our large-scale investigation endeavored to investigate the psychological distress experienced by primary and middle school teachers, in consideration of the acknowledged potential for problematic Internet use behaviors and our novel application of PNT of online teaching as key factors influencing psychological distress.

Therefore, during this difficult time, in addition to clear finding that teachers should avoid falling into addictive or problematic Internet use behaviors, we also advocate the responsibility of school administrators in preventing the thwarting of teacher's psychological needs by attending to potential sources of stress (e.g. by avoiding overly strict requirements regarding teaching method, material, activities., etc.), so that teachers can have more autonomy in online teaching. Administrators can also strengthen the support system consisting of interpersonal collegial relationships in order to alleviate additional psychological need thwarting of

relatedness in regards to online teaching. Management style is important in mitigating teachers' psychological distress during situations such as COVID-19 lockdown and online teaching. As Richmond et al. proposes, plans made by administrators regarding teaching tasks during COVID-19 that should cautiously consider how the uncertainty brought about by online teaching may create even more stress on teachers [17] and, accordingly, offer support and care. As such, the implications of this study include the importance of creating environments that reduce teachers' psychological distress a) by providing support for teachers autonomy, competence, and relatedness in order to alleviate the PNT of teachers during online teaching, and b) by offering instructional alternatives and support or online use guidelines/limits in to reduce problematic Internet use behaviors, thereby mitigating teachers' fear of COVID-19.

Acknowledgements
All authors contributed to the conceptualization, writing, and editing of the paper.

Conflicts of Interest
None declared.

Abbreviations
AIC: Akaike information criterion
BSMAS: Bergen Social Media Addiction Scale
CFA: confirmatory factor analysis
CFI: comparative fit index
CPNTTS : Chinese Psychological Need Thwarting of Teachers Scale
DASS-21: Depression, Anxiety and Stress Scale-21
FCV-19S: Fear of COVID-19 Scale
ICT: information and communication technology
IGD: Internet Gaming Disorder
I-PACE: Interaction of Person-Affect-Cognition-Execution
IRB: Institutional Review Board
NNFI: non-normed fit index
PNT: psychological need thwarting
PSMU: problematic social media use
PSU: problematic smartphone use
RMSEA: root mean square error of approximation
SABAS: Smartphone Application-Based Addiction Scale
SRMR: standardized root mean square residual
SDT: Self Determination Theory
SEM: structural equation modeling

References

1. Shah K, Kamrai D, Mekala H, Mann B, Desai K, Patel RS. Focus on mental health during the Coronavirus (COVID-19) pandemic: Applying learnings from the past outbreaks. Cureus 2020 Mar;12(3):e7405-e. [doi: 10.7759/cureus.7405]
2. Lin CY, Broström A, Griffiths MD, Pakpour AH. Investigating mediated effects of fear of COVID-19 and COVID-19 misunderstanding in the association between problematic social media use, psychological distress, and insomnia. Internet Interventions 2020 Sep;21:100345. [doi: 10.1016/j.invent.2020.100345]
3. Sigurvinsdottir R, Thorisdottir IE, Gylfason HF, Health P. The impact of COVID-19 on mental health: The role of locus on control and internet use. Int J Environ Res Pub He 2020 Sep;17(19):6985. [doi: 10.3390/ijerph17196985]
4. Gao J, Zheng P, Jia Y, Chen H, Mao Y, Chen S, et al. Mental health problems and social media exposure during COVID-19 outbreak. J Plos One 2020 Apr;15(4):e0231924. [doi: 10.1371/journal.pone.0231924]
5. Peretti-Watel P, Alleaume C, Léger D, Beck F, Verger P; et al . Anxiety, depression and sleep problems: a second wave of COVID-19. Gen Psychiatr 2020 Sep; 33(5):e100299. [doi:10.1136/gpsych-2020-100299]
6. Zheng Z, Song N. The real dilemma of online teaching in primary and secondary schools in Western China and its beyond path. China EducTechnol 2020 Dec;12:22-28.
7. Aliyyah RR, Rachmadtullah R, Samsudin A, Syaodih E, Nurtanto M, Tambunan ARS. The perceptions of primary school teachers of online learning during the COVID-19 pandemic period: A case study in Indonesia. J Journal of Ethnic Cult Stud 2020 Jul;7(2):90-109. [doi: 10.29333/ejecs/388]
8. Fauzi I, Khusuma IHS. Teachers' elementary school in online learning of COVID-19 pandemic conditions. J Jurnal Iqra': Kajian Ilmu Pendidikan 2020 Jun;5(1):58-70. [doi: 10.25217/ji.v5i1.914]
9. Li Q, Miao Y, Zeng X, Tarimo CS, Wu C, Wu J. Prevalence and factors for anxiety during the coronavirus disease 2019 (COVID-19) epidemic among the teachers in China. J Affect Disorders 2020 Aug; 277:153-158. [doi: 10.1016/j.jad.2020.08.017]
10. Aperribai L, Cortabarria L, Aguirre T, Verche E, Borges Á. Teacher's physical activity and mental health during lockdown due to the COVID-2019 pandemic. Front Psychol 2020 Nov;11:2673. [doi: 10.3389/fpsyg.2020.577886]
11. Al-Sabbah S, Darwish A, Fares N, Barnes J, Almomani JA. Biopsychosocial factors linked with overall well-being of students and educators during the COVID-19 pandemic. Cogent Psychol 2021 Jan; 8(1):1875550. [doi: 10.1080/23311908.2021.1875550]
12. Zheng L, Miao M, Lim J, Li M, Nie S, Zhang X. Is lockdown bad for social anxiety in COVID-19 regions?: A national study in the SOR perspective. Int J Env Res PubHe 2020 Jun; 17(12): 4561. [doi: 10.3390/ijerph17124561]
13. Zhang L, Zhang D, Fang J, Wan Y, Tao F, Sun Y. Assessment of mental health of Chinese primary school students before and after school closing and opening during the COVID-19 pandemic. JAMA Netw Open 2020 Sep;3(9):e2021482. [doi:10.1001/jamanetworkopen.2020.21482]
14. Chaturvedi K, Vishwakarma DK, Singh N. COVID-19 and its impact on education, social life and mental health of students: A survey. Child Youth Serv Rev 2021Feb;121:105866. [doi:10.1016/j.childyouth.2020.105866]
15. Nilson LB, Goodson LA. Online teaching at its best: Merging instructional design with teaching and learning research. New Jersey: John Wiley & Sons; 2017: 2-3. ISBN:978-1-

119-24229-1
16. UNESCO. COVID-19 Webinar: A new world for teachers, education's frontline workers - COVID-19 education webinar #2. 2020 Mar 30. URL: https://en.unesco.org/news/covid-19-webinar-new-world-teachers-educations-frontline-workers-covid-19-education-webinar-2. [accessed 2021-03-05]
17. Richmond G, Cho C, Gallagher HA, He Y, Petchauer E. The critical need for pause in the COVID-19 era. J Teach Educ 2020 Aug;71(4):375-8. [doi: 10.1177/0022487120938888]
18. Smith PK, Kwak K, Toda Y. Reflections on bullying in eastern and western perspectives. In: Kwak K, Smith PK, Toda Y, editors. School bullying in different cultures: Eastern and western perspectives. UK: Cambridge: Cambridge University Press; 2016: p. 399-419. ISBN: 9781139410878
19. Iwaibara A, Fukuda M, Tsumura H, Kanda H. At-risk Internet addiction and related factors among junior high school teachers—based on a nationwide cross-sectional study in Japan. Environl Health Prev 2019 Jan;24(1):3. [doi: 10.1186/s12199-018-0759-3]
20. Chen IH, Pakpour AH, Leung H, Potenza MN, Su JA, Lin CY, et al. Comparing generalized and specific problematic smartphone/internet use: Longitudinal relationships between smartphone application-based addiction and social media addiction and psychological distress. J Behav Addict2020 Jun; 9(2):410-419. [doi: 10.1556/2006.2020.00023]
21. Sariyska R, Reuter M, Lachmann B, Montag C. Attention deficit/hyperactivity disorder is a better predictor for problematic Internet use than depression: Evidence from Germany. J Addict Res Ther 2015 Feb;6(209):1-6. [doi: 10.4172/2155-6105.1000209]
22. Riehm KE, Holingue C, Kalb LG, Bennett D, Kapteyn A, Jiang Q, et al. Associations between media exposure and mental distress among U.S. adults at the beginning of the COVID-19 pandemic. Am J Prev Med 2020 Nov;59(5):630-638. [doi: 10.1016/j.amepre.2020.06.008]
23. Spoorthy MS, Pratapa SK, Mahant S. Mental health problems faced by healthcare workers due to the COVID-19 pandemic–A review. Asian J Psychiat 2020 Jun;51:102119. [doi: 10.1016/j.ajp.2020.102119]
24. Fitzpatrick KM, Harris C, Drawve G. Fear of COVID-19 and the mental health consequences in America. Psychol Trauma-US 2020 Aug;12(S1):S17-S21. [doi:10.1037/tra0000924].
25. Feter N, Caputo EL, Doring IR, Leite JS, Cassuriaga J, Reichert FF, et al. Sharp increase in depression and anxiety among Brazilian adults during the COVID-19 pandemic: findings from the PAMPA cohort. Public Health 2021 Jan; 190: 101-107. [doi:10.1016/j.puhe.2020.11.013].
26. Ahmad AR, Murad HR. The Impact of social media on panic during the COVID-19 pandemic in Iraqi Kurdistan: Online questionnaire study. J Med Internet Res 2020 Apr;22(5): e19556. [doi:10.2196/19556].
27. Boursier V, Gioia F, Musetti A, Schimmenti A. Facing loneliness and anxiety during the COVID-19 isolation: The role of excessive social media use in a sample of Italian adults. Front Psychiat 2020 Dec;11: 586222. [doi: 10.3389/fpsyt.2020.586222]
28. Elhai JD, Yang H, McKay D, Asmundson GJG. COVID-19 anxiety symptoms associated with problematic smartphone use severity in Chinese adults. J Affect Disorders 2020 Sep;274:576-582. [doi: 10.1016/j.jad.2020.05.080]
29. Islam MS, Sujan MSH, Tasnim R, Ferdous MZ, Masud JHB, Kundu S, et al. Problematic internet use among young and adult population in Bangladesh: Correlates with lifestyle and online activities during the COVID-19 pandemic. Addict Behav Reports 2020 Dec;12:100311. [doi: 10.1016/j.abrep.2020.100311]
30. Panno A, Carbone GA, Massullo C, Farina B, Imperatori C. COVID-19 related distress is

associated with alcohol problems, social media and food addiction symptoms: Insights from the Italian experience during the lockdown. Front Psychiat 2020 Nov;11: 577135. [doi: 10.3389/fpsyt.2020.577135]
21. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000 Jan;55(1):68-78. [doi: 10.1037/0003-066X.55.1.68]
32. Deci EL, Ryan RM. Self-determination theory. International Encyclopedia of the Social & Behavioral Sciences 2015 Mar;91(2):486-491. [doi: 10.1016/B978-0-08-097086-8.26036-4]
33. Bartholomew KJ, Ntoumanis N, Cuevas R, Lonsdale C. Job pressure and ill-health in physical education teachers: The mediating role of psychological need thwarting. Teach Teach Educ 2014 Jan;37:101-107. [doi: 10.1016/j.tate.2013.10.006]
34. Bartholomew KJ, Ntoumanis N, Ryan RM, Bosch JA, Thøgersen-Ntoumani C. Self-determination theory and diminished functioning the role of interpersonal control and psychological need thwarting. Pers Soc Psychol B 2011 Jun;37(11):1459-1473. [doi:10.1177/0146167211413125]
35. Chen L, Gamble JH, Chen IH, Lee ZH, Fu QL. Psychometric properties and measurement invariance for a Chinese version of a Psychological Need Thwarting Scale for teachers. Int J Environ Res Pub He 2020 May;17(9):3247. [doi: 10.3390/ijerph17093247]
36. Cuevas R, Sánchez-Oliva D, Bartholomew KJ, Ntoumanis N, García-Calvo T. Adaptation and validation of the Psychological Need Thwarting Scale in Spanish physical education teachers. Span J Psychol 2015 Jul;18:E53. [doi: 10.1017/sjp.2015.56]
37. Shirom A, Ezrachi Y. On the discriminant validity of burnout, depression and anxiety: A re-examination of the burnout measure. J Anxiety Stress Coping 2003 Jan;16(1):83-97. [doi:10.1080/1061580021000057059]
38. Chen IH, Chen CY, Pakpour AH, Griffiths MD, Lin CY. Internet-related behaviors and psychological distress among schoolchildren during COVID-19 school suspension. J Am Acad Child Psy 2020 Oct;59(10):1099-1102. [doi: 10.1016/j.jaac.2020.06.007]
39. Brand M, Wegmann E, Stark R, Müller A, Wölfling K, Robbins TW, et al. The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. J Neurosci Biobehav R 2019 Sep;104:1-10. [doi: 10.1016/j.neubiorev.2019.06.032]
40. Peng S, Zhou B, Wang X, Zhang H, Hu X. Does high teacher autonomy support reduce smartphone use disorder in Chinese adolescents? A moderated mediation model. Addict Behav 2020 Jun;105:106319. [doi: 10.1016/j.addbeh.2020.106319]
41. Wolniewicz CA, Rozgonjuk D, Elhai JD. Boredom proneness and fear of missing out mediate relations between depression and anxiety with problematic smartphone use. Hum Beh Emerg 2020 Jun;2(1):61-70. [doi: 10.1002/hbe2.159]
42. Dang DL, Zhang MX, Leong KKH, Wu A. The predictive value of emotional intelligence for internet gaming disorder: A 1-year longitudinal study. Int J Environ Res Pub He 2019 Aug;16(15):2762. [doi: 10.3390/ijerph16152762]
43. Király O, Potenza MN, Stein DJ, King DL, Hodgins DC, Saunders JB et al. Preventing problematic Internet use during the COVID-19 pandemic: Consensus guidance. Compr Psychiat 2020 May; 100: 152180. [doi:10.1016/j.comppsych.2020.152180].
44. Chen IH, Strong C, Lin YC, Tsai MC, Leung H, Lin CY, et al. Time invariance of three ultra-brief internet-related instruments: Smartphone Application-Based Addiction Scale (SABAS), Bergen Social Media Addiction Scale (BSMAS), and the nine-item Internet Gaming Disorder Scale-Short Form (IGDS-SF9)(Study Part B). J Addict Behav 2020

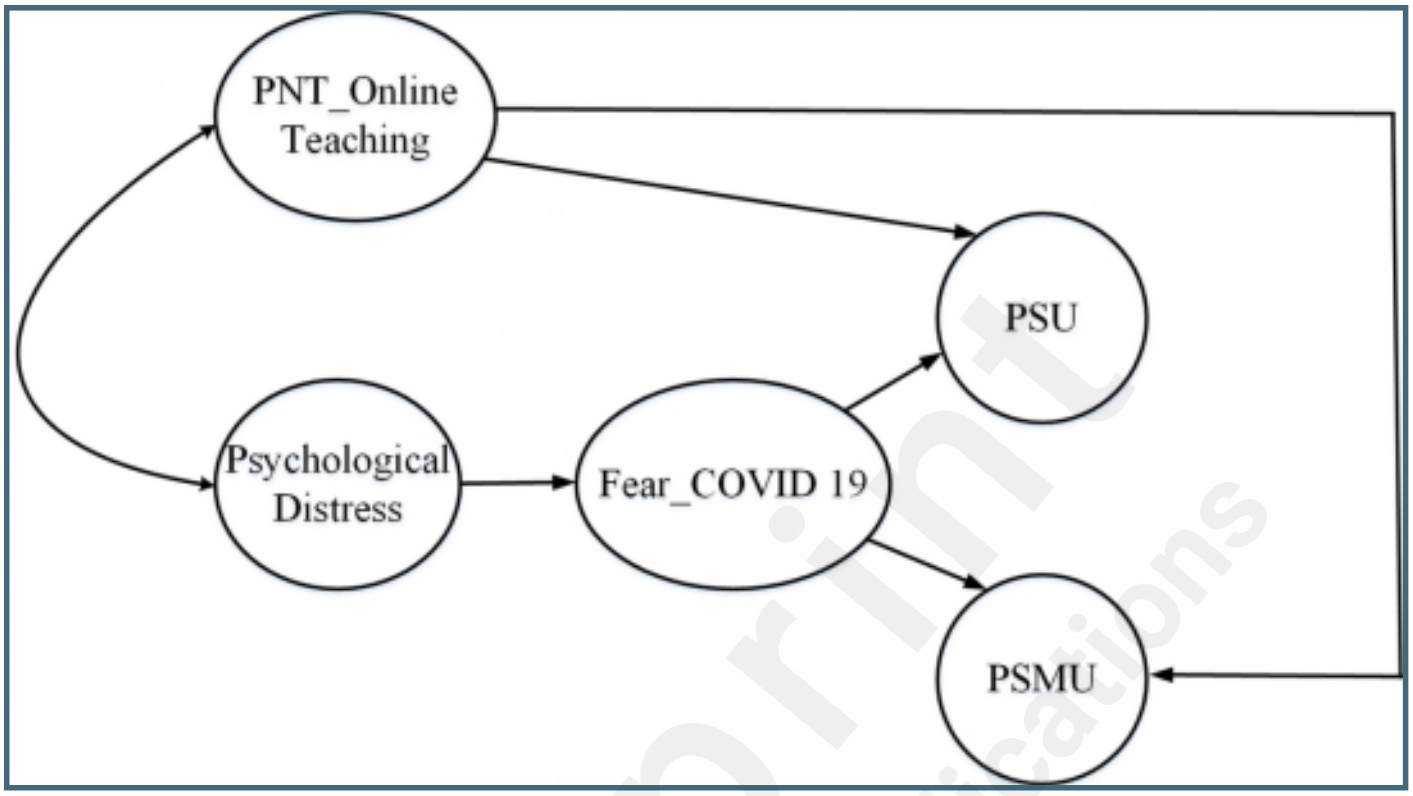
Feb;101:105960. [doi: 10.1016/j.addbeh.2019.04.018]
45. Ikeda K, Nakamura K. Association between mobile phone use and depressed mood in Japanese adolescents: a cross-sectional study. J Environ Health Prev Med 2014 May;19(3):187-93. [doi: 10.1007/s12199-013-0373-3]
46. Huang C. A meta-analysis of the problematic social media use and mental health. Int J Soc Psychiatr 2020 Dec:0020764020978434. [doi:10.1177/0020764020978434]
47. Hashemi SGS, Hosseinnezhad S, Dini S, Griffiths MD, Lin CY, Pakpour AH. The mediating effect of the cyberchondria and anxiety sensitivity in the association between problematic Internet use, metacognition beliefs, and fear of COVID-19 among Iranian online population. Heliyon 2020 Oct; 6(10): e05135. [doi:10.1016/j.heliyon.2020.e05135].
48. Evans S, Huxley P, Gately C, Webber M, Mears A, Pajak S, et al. Mental health, burnout and job satisfaction among mental health social workers in England and Wales. Brit J Psychiat 2006 Jan;188(1):75-80. [doi: 10.1192/bjp.188.1.75]
49. Neufeld A, Mossière A, Malin GJMT. Basic psychological needs, more than mindfulness and resilience, relate to medical student stress: A case for shifting the focus of wellness curricula. Med Teach 2020 Oct;42(12):1401-1412. [doi: 10.1080/0142159X.2020.1813876]
50. Lovibond SH, Lovibond PF. Manual for the depression anxiety stress scales. Sydney: Psychology Foundation of Australia; 1995:1-6. ISBN:0733414230
51. Wang C, Pan R, Wan X, Tan Y, Xu L, McIntyre RS, et al. A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. Brain Behav Immun 2020 Apr; 87: 40-48. [doi: 10.1016/j.bbi.2020.04.028]
52. Wang K, Shi H-S, Geng F-L, Zou L-Q, Tan S-P, Wang Y, et al. Cross-cultural validation of the Depression Anxiety Stress Scale–21 in China. Psychol Assessment 2016 May;28(5):e88. [doi: 10.1037/pas0000207]
53. Ahorsu DK, Lin C-Y, Imani V, Saffari M, Griffiths MD, Pakpour AH. The fear of COVID-19 scale: Development and initial validation. Int J Ment Health Addict 2020 Mar; 002708 . [doi: 10.1007/s11469-020-00270-8]
54. Csibi S, Griffiths MD, Cook B, Demetrovics Z, Szabo A. The psychometric properties of the smartphone application-based addiction scale (SABAS). Int J Ment Health Addict 2018 Apr;16(2):393-403. [doi:10.1007/s11469-017-9787-2]
55. Chen IH, Ahorsu DK, Pakpour AH, Griffiths MD, Lin CY, Chen CY. Psychometric properties of three simplified Chinese online-related addictive behavior instruments among mainland Chinese primary school students. Front Psychiat 2020 Sep;11:00875. [doi:10.3389/fpsyt.2020.00875]
56. Leung H, Pakpour AH, Strong C, Lin YC, Tsai MC, Griffiths MD, et al. Measurement invariance across young adults from Hong Kong and Taiwan among three internet-related addiction scales: Bergen Social Media Addiction Scale (BSMAS), Smartphone Application-Based Addiction Scale (SABAS), and Internet Gaming Disorder Scale-Short Form (IGDS-SF9)(Study Part A). J Addict Behav 2020 Mar;101:105969. [doi: 10.1007/s11469-020-00270-8]
57. Andreassen CS, Billieux J, Griffiths MD, Kuss DJ, Demetrovics Z, Mazzoni E, et al. The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. J Psychol Addict Behav 2016 Mar;30(2):252-262. [doi:10.1037/adb0000160]
58. Little TD, Card NA, Bovaird JA, Preacher KJ, Crandall CS. Structural equation modeling of mediation and moderation with contextual factors. In: Modeling contextual effects in longitudinal studies. New Jersey: Lawrence Erlbaum Associates Publishers; 2007;1:207-

230. ISBN:0805850198
59. Henseler J, Fassott G. Testing moderating effects in PLS path models: An illustration of available procedures. In Esposito Vinzi V, Chin W, Henseler J, Wang, H, editors. Berlin: Springer; 2010: p. 713-735. ISBN: 9783540328254
60. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct Equ Modeling 1999 Jan;6(1):1-55. [doi: 10.1080/10705519909540118]
61. Korner-Nievergelt F, Roth T, von Felten S, Guélat J, Almasi B, Korner-Nievergelt P. Model Selection and Multimodel Inference. In: Korner-Nievergelt F, Roth T, von Felten S, Guélat J, Almasi B, Korner-Nievergelt P, editors. Bayesian Data Analysis in Ecology Using Linear Models with R, BUGS, and STAN. Boston: Academic Press; 2015: p. 175-96. ISBN:9780128013700
62. Burnham KP, Anderson DR. Information and likelihood theory: A Basis for model selection and inference. In: Burnham KP, Anderson DR, editors. Model Selection and Multimodel Inference. New York, NY: Springer; 2002:49-97. ISBN:9780387224565
63. Shi D, Maydeu-Olivares A, DiStefano C. The relationship between the standardized root mean square residual and model misspecification in factor analysis models. Multivar Behav Res 2018 Oct;53(5):676-94. [doi: 10.1080/00273171.2018.1476221].
64. Huang Y, Wang YU, Wang H, Liu Z, Yu X, Yan J, el al. Prevalence of mental disorders in China: a cross-sectional epidemiological study. The Lancet Psychiat 2019 Feb; 6(3): 211-224. [doi:10.1016/S2215-0366(18)30511-X].
65. del Pilar Sánchez-López M, Dresch V. The 12-Item General Health Questionnaire (GHQ-12): Reliability, external validity and factor structure in the Spanish population. Psicothema 2008 Nov; 20(4): 839-843.
66. Delmastro M, Zamariola G. Depressive symptoms in response to COVID-19 and lockdown: A cross-sectional study on the Italian population. Sci Rep 2020 Dec; 10(1): 1-10. [doi:10.1038/s41598-020-79850-6]
67. Yen JY, Ko CH, Yen CF, Chen SH, Chung WL, Chen CC. Psychiatric symptoms in adolescents with Internet addiction: Comparison with substance use. Psychiat Clin Neuros 2008 Feb;62(1):9-16. [doi: 10.1111/j.1440-1819.2007.01770.x].

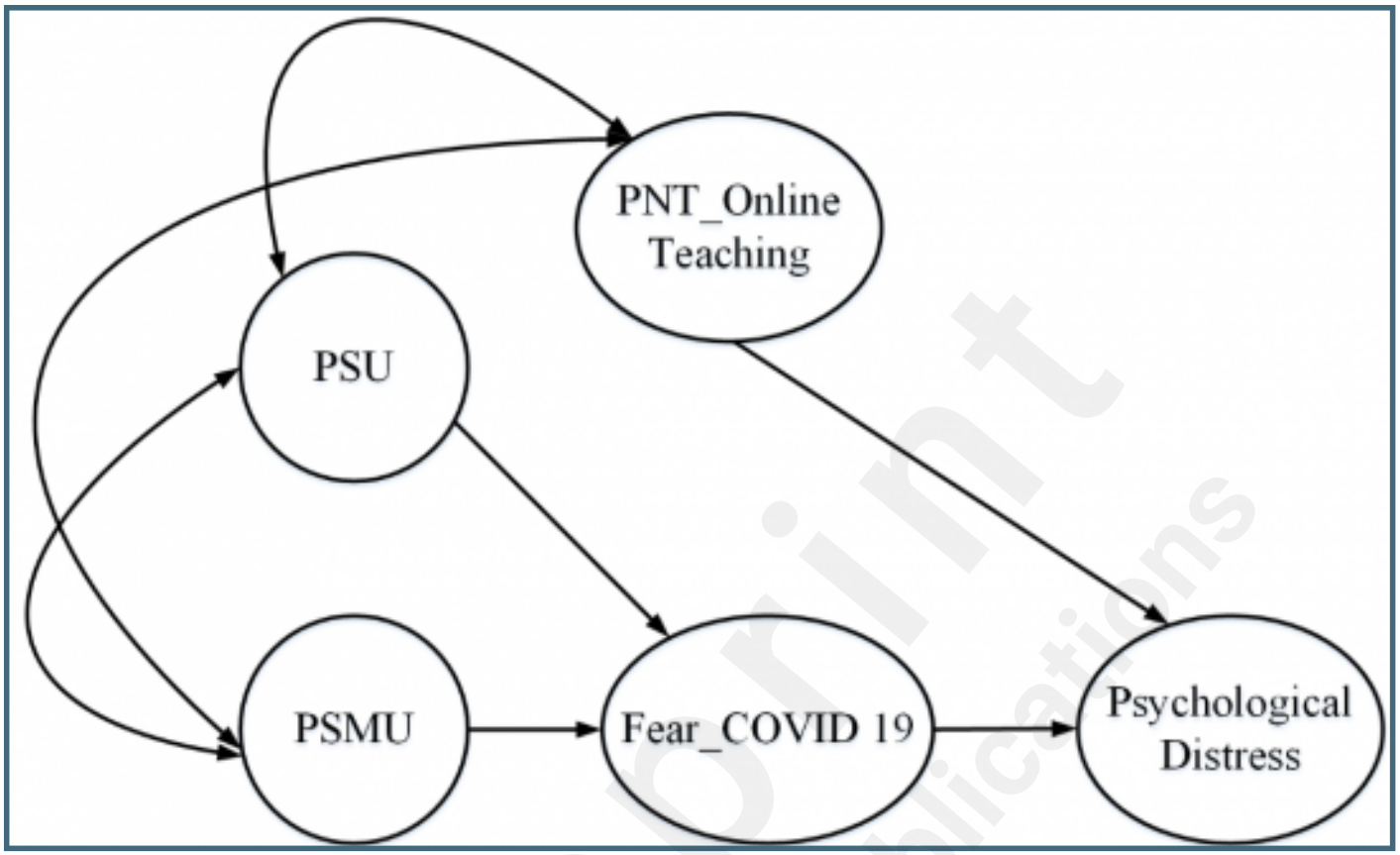
Supplementary Files

Figures

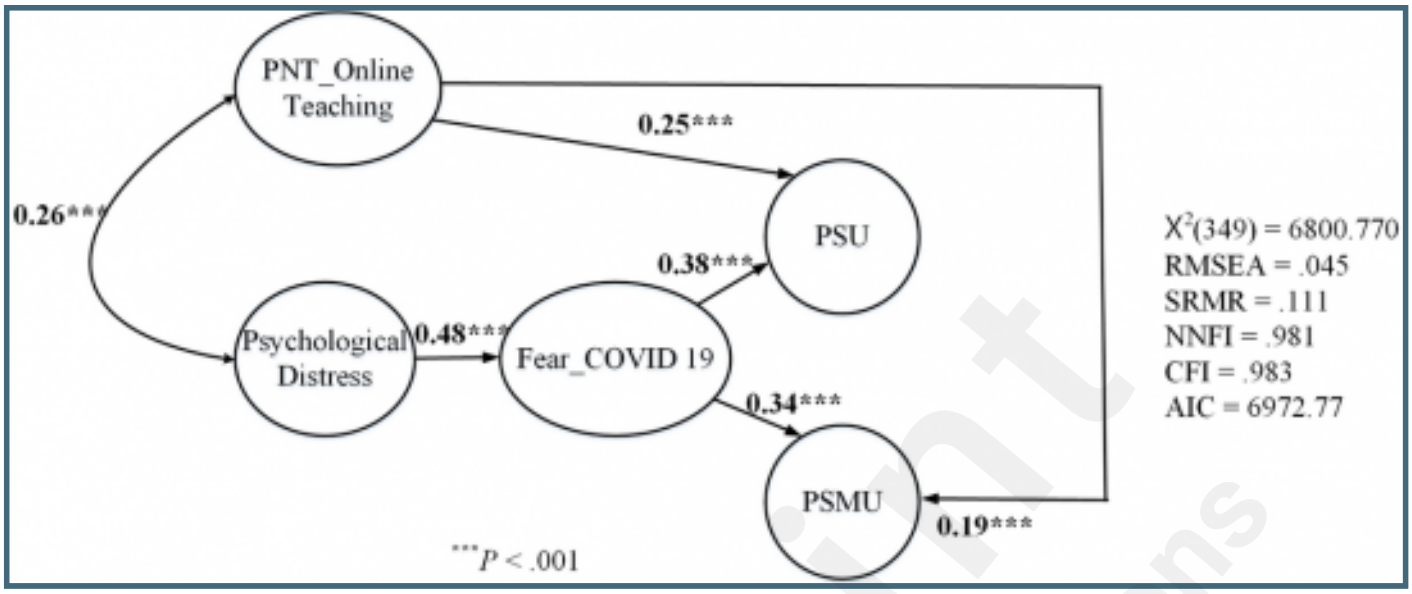
Structure of the I-PACE model based on a review of the literature.



Proposed model, with problematic Internet use behaviors as explanatory variables.



Structure Equation Modelling for the I-PACE model, including fit indices and path coefficients.



Structure Equation Modelling for the proposed model, including fit indices and path coefficients.