ACADEMIC, SOCIAL AND EMOTIONAL MALADJUSTMENT DUE TO THE USE AND ABUSE OF TECHNOLOGIES

EDITED BY: María Carmen Martínez Monteagudo, Beatriz Delgado, David Aparisi and Alexandra Leyrit

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ACADEMIC, SOCIAL AND EMOTIONAL MALADJUSTMENT DUE TO THE USE AND ABUSE OF TECHNOLOGIES

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The Influence of E-Learning and Emotional Intelligence on Psychological Intentions: Study of Stranded Pakistani Students

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The COVID-19 pandemic has forced the government to close the educational institutions globally, to contain the infection of the disease, which has affected the academic activities of local and international students significantly. This unexpected shift from offline classes to online learning has created psychological disruption among the students. At that backdrop, this study aims to investigate the influence of e-learning and emotional intelligence (EI) on the study stress, burnout, and performance of Pakistani students by applying emotion regulation theory. The data ($N = 387$) is based on international students, enrolled in 10 different universities in China. The results indicate that both e-learning and EI have significantly affected perceived study stress, burnout, and performance of students. These findings have provided evidence that online classes and EI can influence study stress, burnout, and performance of students. The study concludes that EI has significant impact on the psychological pressure of a student.

Keywords: e-learning, emotional intelligence, study stress, burnout, performance

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INTRODUCTION

Psychological pressure is the foremost impediment to academic success. Psychological stress can impact the inspiration, concentration, awareness, and social interactions of students, which are considered critical factors for students to attain academic success (Unger, 1998). The COVID-19 pandemic crisis has brought into focus the psychological pressure of various affected populations. Due to the coronavirus, strict precautions and delays in starting colleges and universities worldwide are expected to affect the mental health and well-being of students (Cao et al., 2020; UNESCO Education, 2020). Emotions are considered an important trait of the psychology of a student. Students are bound with different emotionally demanding states, such as homework, assignments, quizzes, examinations, and deadlines, are connected that encompass their psychological intentions (Tyng et al., 2017). Students are expected to show patients and positive intentions toward the study. Positive emotions have enhanced the psychological behaviors of students that lead to better outcomes (Corradino and Fogarty, 2016). A few studies have reported the psychological impact of the COVID-19 epidemic on the general community, medical staff, patients, children, and adults (Chen et al., 2020; Yang et al., 2020). However, no comprehensive study on the psychological well-being of Pakistani students, facing the COVID-19 crises, has been conducted to date. Therefore, it is critical to explore what aspects can ease the high psychological pressure rate among students? Although much research has investigated the emotional influences on study devotion, learning

and memory, and problem-solving in education sectors for long-term sustainability (Vuilleumier, 2005; Shen et al., 2009; Um et al., 2012), few are acknowledged the impact of e-learning (online classes), and emotional intelligence (EI) on psychological intentions of students, such as study stress, burnout, and performance (Berenson et al., 2008; Han and Johnson, 2012). The present study tends to expand on what is previously explored and identified the effect of e-learning and EI on the psychological pressure of students, such as study stress, burnout, and performance.

The feelings and emotions of students are directly linked with their study and career achievements, though career achievements demand a standard performance. Scholars realized that motivations of students direct their behavior toward educational achievements and academic success (Van Tilburg and Igou, 2013; Wigfield and Gladstone, 2019), but psychological pressure in terms of stress, tension, fear, and various psychosomatic problems are connected with a variety of destructive outcomes (Naquin and Gilbert, 1996). The psychological pressure is experienced when physical and emotional requirements of academic activities do not meet the competencies, needs, and resources of the students (Curran and Standage, 2017); hence, due to the COVID-19 outbreak, students educational activities have been dramatically affected in various aspects, such as online classes, postponing of physical events, and students mobility (Altbach and de Wit, 2020; Tesar, 2020), which caused strict travel restrictions and thousands of students psychological pressure influence their behavior negatively in term of canceling their plans for studying overseas. For instance, according to the Institute of International Education, nearly 90% of the US institutions have estimated a decrease in foreign student enrolment (Martel, 2020); British Council in 2020 indicated that 39% of Chinese scholars, which is a major source of overseas students in the United Kingdom, are hesitant about withdrawing their study plans (Durnin, 2020). Similarly, 59.95% of international students in China come from Asia, including more than 28,023 students from Pakistan (Ministry of Education in China, 2019). As a result, significant adverse psychological pressure has been reported among the study stress, burnout, and performance of students (Wang et al., 2020). No such research has been conducted in Pakistan yet. Therefore, this study aims to expand the existing literature by assessing the effect of e-learning (online classes) and EI on the psychological pressure (study stress, burnout, and performance) of students among overseas Pakistani students stranded in Pakistan.

The influence of online classes on work stress, burnout, and performance can be moderated by EI, but little existing research has observed direct and indirect impacts among these variables. The present study aimed to investigate the influence of e-learning (online classes) on work stress, burnout, and performance, and the potential moderation of EI of these effects. This research is based on emotion regulation theory (Gross, 1998), indicating that individuals assess the understanding, valence, and value relevance to control their feelings and emotions according to the existing situation. A person who possesses high emotional competencies is better tends to execute his or her skill (Kirk et al., 2008). A very valuable mechanism by which negative outcomes of sentiments can be coped is EI. Goleman (2001) recommended that individuals who possess strong social awareness are better at minimizing the destructive consequences of sentiments, and their overall performance also increased substantially. Garg et al. (2016) found that EI was directly related to adjustment to existing situations, and adjustment was directly connected to overall performance.

During uncertain situations, the EI supports individuals to identify their expectations and how to act appropriately. Students have to face such unanticipated situations quite often. They need to show positive feelings and emotions, such as patient, attention, hope, and prestige and encounter the requirement of their academic syllabus. These challenging situations enhance psychological pressure and might affect work performance, study stress, and burnout. However, EI can help to increase the work performance of students and simultaneously eliminate the effect of burnout and study stress.

CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

Emotional Intelligence

The concept of EI was originated in the 1920s, but it came to attention when it was categorized properly by Salovey and Mayer (1990). They stated, "the capability to observe one's own and other's mental state and sentiments, distinguish among them, and practice this information to guide individuals' thinking and actions" (Krishnan et al., 2018). EI intends psychological comfort and accomplishment in life (Carmeli et al., 2009), such as academic success (Petrides et al., 2004), work performance (Koman and Wolff, 2008), and work-related stress (Mikolajczak et al., 2007). By examining the link between EI and psychological pressure, Stevens et al. (2019) found that emotionally intelligent individuals are more confident, happy, and sociable; consequently, their EI traits inversely affect academic stress among students.

By examining the link between EI with psychological pressure coping with styles, Erözkan (2013) found that a high level of EI significantly coping with psychological pressure stress among students. Similarly, Fteiha and Awwad (2020) highlighted the positive relationship between EI and stress coping with methods in University students. Their research indicated that individuals with higher EI possess a greater capacity to withstand psychological pressure. Despite much research on the impact of EI on different work outcomes, the influence of EI on student performance, burnout, and study stress has been marginally considered in Pakistan.

Emotional Intelligence, Work Stress, Burnout, and Performance

Emotional intelligence is the internal capability of a human to understand manage the self-sensitive actions and reactions of an individual. Bar-On et al. (2006) refer to EI as a group of non-cognitive abilities and skills, which diminish the environmental demands and pressures. A number of scholars found that EI skills effectively handle pressure situations more successfully.

The academic requirements are extremely demanding and stressful; therefore, it is practical to suggest that EI coping with the psychological pressure of students and enhance their performance (Austin et al., 2005; Por et al., 2011). Besides other environmental and emotional demands, students have to handle academic demands, such as exams, assignments, presentations, maintain grades, and motivation for an academic career. In addition, the study of Enns et al. (2018) revealed that high EI is connected with good pressure management. He suggested that an emotionally intelligent individual can handle psychological pressure situations with a more efficient way to encounter challenges at school. Mohzan et al. (2013) found that the characteristics of high EI are related to positive educational development. They claimed that EI is dynamic to the health and academic success of a student.

The academic career of a student is associated with high work stress and burnout (Yucha et al., 2009; Jenaabadi et al., 2017). In an emerging country like Pakistan, due to the lack of resources, poor working environment, energy crises, and poor management, stress levels and burnout of a student further aggravate (Ali, 2012). Consequently, the physical and emotional problems of a student negatively affect their learning capabilities and academic performance. Friedman (2014) argued that excessive psychological pressure might arise physical problems for a student and possibly diminish his/her intellectual abilities. Karimi et al. (2014) study point out that the overall response to fight against stress and burnout is deeply reliant on feelings and emotions. Students having a high level of EI can attenuate burnout and work stress (Cazan and Năstasă, 2015) increase satisfaction level (Runcan and Iovu, 2013) and professional development (Năstasă, 2010). EI increases the psychological pressure resilience, well-being, and academic performance of students (MacCann et al., 2020).

Although it has been more than 15 months since Chinese universities were closed due to the coronavirus pandemic, student physical absenteeism increased due to stranded in their home countries, which caused psychological pressure, poorer academic achievement, huge gaps in practical skills, and development (Coe et al., 2020). Accordingly, Bonal and González (2020) indicated that not going to universities decreases learning opportunities and accelerate stress level for all, but specifically students from low developed nations. Suhaimi et al. (2014) study revealed that EI plays a big role in controlling crises in an emergency. Fiorilli et al. (2020) have posited that EI strongly prevents stress and burnout of students, enhancing academic performance. Bar-On et al. (2006) found that higher than average intellectual skills are more successful in coping with environmental and psychological pressure situations. EI indicated a direct effect to reduce the burnout level among the students during stressful environments; consequently, a high level of EI was significantly correlated with the performance of students (Yusoff et al., 2021). It is reasonably acceptable that several studies explored the relationship between EI on the work outcomes of nurses (Ioannidou and Konstantikaki, 2008; Alonazi, 2020; Mo et al., 2020). However, this study investigates the influence of EI on the performance, study stress, and burnout of students while stranded in Pakistan due to the COVID-19 crises. Therefore authors hypothesized:

H1: There is a significant positive relationship between emotional intelligence and work performance among students.
H2: There is a significant adverse relationship between emotional intelligence and study stress among students.
H3: There is a significant negative connotation between emotional intelligence and burnout among students.

Online Classes, Study Stress, Burnout, and Performance

The educational institution is advanced in the last few years, which is proved by the immense use during this COVID-19 (Chatterjee and Chakraborty, 2021). A lot of online platforms are available for classes (Nash, 2020). It was a challenge for an educational institution to organize its educational curriculum online. Mishra et al. (2020) stated that before the pandemic, online classes existed in advanced countries. However, no institution was prepared for a complete switch to online classes. Empirical research has proved that students feel that their learning skills improved through online classes as compared to physical education (Bojović et al., 2020), but the response is different from the perspective of Pakistani students. According to Williams et al. (2011), online learning systems are inadequate due to experiencing many challenges. Proper network adaptability is not possible, especially in rural areas where Internet facilities are barely found, and the learning experience is entirely different from physical classes (Williams et al., 2011). Adnan and Anwar (2020) observed the psychological burden of Pakistani students toward online courses during COVID-19. Their findings highlighted that online education can negatively affect desired performance in underdeveloped countries like Pakistan. Their psychological pressure influences the inability to access the Internet, technical issues, financial issues, and other educational resources, such as experimental labs (Adnan and Anwar, 2020).

The coronavirus pandemic is accompanied by strict measurement that has led students to confine in their homes; an alarming social life and education in quarantine have put students under psychological pressure. The lack of group learning activities, lab work activities, and experimental work is experienced by both instructors and students due to the online classes. All this has led to psychological stress and burnout by both students and teachers. Less physical involvement and spending most of the time at home create an immense negative impact on the performance of students (Chandra, 2020). Rohman et al. (2020) argued that online classes enhanced academic pressure, which directly impacts health, decision-making power, psychosomatic complaints, sleeping difficulties, worrying about the future, anxiety, depression, workload, etc. of students. According to Sahu (2020), the COVID-19 pandemics have brought many psychological shocks and a negative influence on the psychological well-being of students, which directly led to acute work stress and anxiety (Aktekin et al., 2001). Cao et al. (2020) examined the psychological influence on University students in China during the coronavirus pandemic. They found out a negative impact on the performance and a high level of

psychological burdens for the students. The previous studies heightened that uncertainty negatively impacts the academic development of students and influences the psychological pressure of students (Bayram and Bilgel, 2008; Wang et al., 2020).

Jæger and Blaabæk (2020) argued that online classes discouraged the learning competencies of students due to discrimination compared with better family facilities. As universities adopted online classes (Yen, 2020), the query arises "how this approach benefits students with lower-income families and remote areas?" Where several students belong from lower-income families (Fry and Cilluffo, 2019). Due to a lack of facilities and experimental lab work, students from rural and lower-income families have limited or no access to online classes. Similarly, the financial cost is another obstacle to take online classes (Adam et al., 2020). Sundarasen et al. (2020) study highlighted the significant contributor to stress and burnout was the sudden shift to online classes. They documented the financial constraints, online classes barriers, academic performance, and uncertainty about the future due to the lockdowns negatively affected the psychological intentions of students. According to Choi (2020), millions of students are worried about academic loss due to the unproductive way of learning. Hence, online classes indicated a strong impact on the psychological pressure and performance of a student (Jiang et al., 2021). Therefore, we constructed the following hypothesis:

H4: There is a significant negative relationship between online classes and work performance of student.
H5: There is a positive relationship between online classes and study stress.
H6: There is a positive association between online classes and student burnout.

THEORETICAL FRAMEWORK

Emotional intelligence is considered a pillar for educational, psychological, and management studies. The theory is rooted to understand oneself emotions and emotional reactions and identifying the experiences of different feelings and sentiments (Bliss, 2006). It also refers to tackling emotional disappointments, adapting behaviors, and the ability to avoid emotional stress, burnout, and learning to evade the negativity of feelings and emotions (Chandra and Mathur, 2016, p. 231). Richards and Pryce (2006) propose that individuals with a high level of EI are more proficient in reducing stress levels, burning out, and improving their performance. Higher level of EI more appropriately coping with the stress and burnout sources, which enhance work performance (Alonazi, 2020). According to Sadovyy et al. (2021), individuals with a high level of EI precisely use their emotional skills and abilities to diminish stress and burnout related to the pandemic. Accordingly, the work performance of emotionally intelligent individuals is superior to those with a low level of EI during the current pandemic (Alonazi, 2020; Rezvani et al., 2020). Educational activities are now switched into the new environment to maintain the development of students (Paloş et al., 2010). During the last decade, emotion has been considered a significant aspect of the learning process; past studies show that EI can stimulate the academic performance of students (Cleveland-Innes and Campbell, 2012). There is evidence that the emotional competencies of a student are associated with online learning. Students with emotional skills are expected to react more effectively than students with a low EI level. The emotional competencies reduce student psychological pressure, and consequently, the learning performance of students can be improved (McKnight, 2013). Similarly, Enns et al. (2018) found that a high EI is linked with better stress management. According to Enns et al. (2018), an emotionally intelligent individual can cope with stressful situations and encounter educational challenges effectively.

Previous studies on emotion regulation indicated that EI is directly associated with psychological management across multiple professions, including student learning (Pugh, 2008; Ergur, 2009) and academic performance (Williford, 2010). EI capabilities facilitate students to adapt the uncertain situation accurately and encouraging them to identify innovative solutions, which might influence their intellectual skills that lead to standard academic performance. According to Berenson et al. (2008), EI strongly moderates academic performance in distance and online classes. Another study by Grandey (2000) found that high levels of EI diminish work stress, burnout, and increase performance levels. Similarly, Wu et al. (2007) study results concluded that EI shows an effective role in reducing psychological pressure, interpersonal and environmental conflicts, and increasing positive work behavior and outcomes.

An increase in EI is connected to a decrease in stress. In the same vein, Márquez et al. (2006) collected a sample of students in Spain and found that higher EI is significantly associated with academic achievement. As stated above, psychologists claim that individuals who have EI skills are more successful than those who do not have EI. Despite its contributions toward success in other areas, there have a few studies conducted of EI as a predictor for success in online classes. The online classes continue due to COVID-19, which plays a greater role in the academic curriculum of students. Likewise, higher EI is connected with better psychological functioning (Zeidner and Matthews, 2018; Zysberg and Raz, 2019). Therefore, the authors investigate the possible moderating role of EI between online classes, study stress, burnout, and performance, as shown in **Figure 1**.

H7: Emotional intelligence moderates the impact of online classes on student's performance.
H8: Emotional intelligence moderates the impact of online classes on student's study stress.
H9: Emotional intelligence moderates the effect of emotional dissonance on student burnout.

RESEARCH METHODS

Data Collection Process

The study has used a quantitative approach to collect the data from stranded Pakistani students, due to COVID-19

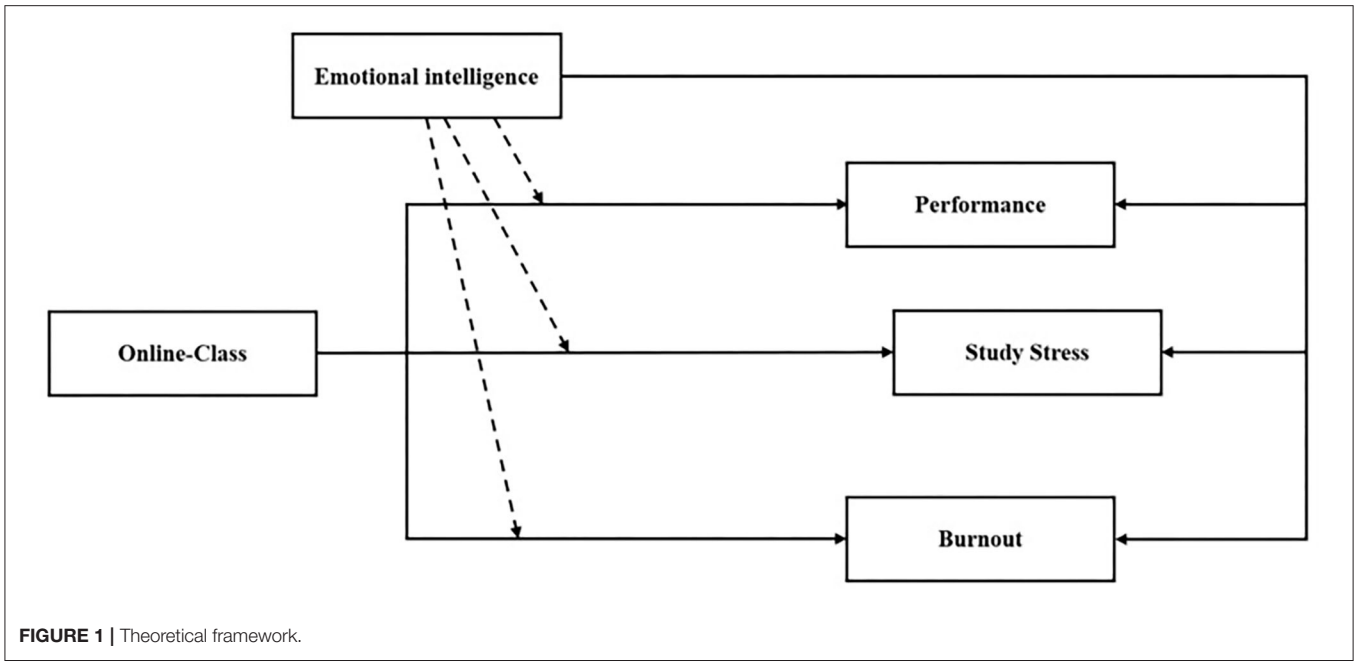

FIGURE 1 | Theoretical framework.

and restriction of cross-border movements, studying at various universities in China. The survey was divided into two sections: (a) the construct measurement items and their corresponding measurement scales, and (b) demographic variables, as shown in **Table 1**. The convenience sampling technique was employed because it is appropriate when it is difficult to obtain a complete sampling frame. This type of sampling is suitable because it permits a theoretical generalization of the findings. To ensure valid data collection, the authors hired trained research assistants, who used different social platforms to collect the data, such as Google surveys and social media platforms like Facebook, WeChat, and WhatsApp. Before filling the questionnaire, participants were asked to give their voluntary consent to participate in this study. Out of 429 filled questionnaires, the authors found 387 questionnaires valid and useful for the present study.

TABLE 1 | Demographic characteristics of respondents.

Variables		Frequency ($N = 387$)	Percentage (%)
Gender	Male	296	76.5
	Female	91	23.5
Age of Respondents	18–25	148	38.2
	26–30	164	42.4
	30–35	62	16
	36–40	13	3.4
Education (currently pursuing)	Undergraduate	102	26.4
	Master	189	48.8
	PhD	96	24.8
Geographical representation	Eastern	189	48.83
	Western	67	17.31
	Northern	83	21.5
	Northern	48	12.4
Marital status	Single	169	43.7
	Married	212	54.8
	Others	6	1.5

Measurements

Emotional Intelligence

To measure EI, the Schutte Emotional Intelligence Scale was used, developed by Schutte et al. (1998). This test contained 32 self-report items. Students were asked to rate their agreement with all 32 statements using a 5-point Likert scale ranging from "1 = strongly disagree, 5 = strongly agree." A sample item include "When I am in a positive mood, I motivate myself and solving problems is easy for me." The Cronbach's alpha of the EI scale was 0.88.

Stress

The items for psychological stress were precisely developed to measure students' stress manifestations during the coronavirus pandemic. It includes seven items on a 5-point Likert scale rage, 0 "Not at all stressful" to 4 "Extremely stressful." The designed instrument was constructed based on emotional and psychological models of stress (Lazarus and Folkman, 1984). Each question was developed to cover the specific stress domains that were subjected to the COVID-19 pandemic (i.e., study burden, social isolation, relationship with colleagues and professors, classroom studying, and on-campus physical activities). A sample item contains "I feel frustration due to too much work and lack of resources." The Cronbach's alpha of this scale was 0.83.

Burnout

To measure burnout of students (Schaufeli et al., 2002), 15-item scales were used, which include three dimensions: exhaustion (five items), depersonalization (four items), and personal accomplishment (six items). A sample items include "Do you feel exhausted because of your online classes" and "how often do you feel emotionally drained during the classes." The overall Cronbach's alpha of the burnout scale was 0.87.

Performance

To assess the academic performance of students, 12-item scales measuring well-being, emotionality, self-control, and social skills of a student were adopted from the study of Cooper and Petrides (2010). The questions were constructed based on the EI correlations with the academic scores (e.g., I truly regulate my emotions, which can facilitate me to perform efficiently). The Likert scale ranging from "high-performance score" (0) to "poor performance" (4). The Cronbach's alpha of this scale was 0.89.

E-Learning

To consider this measurement (Chakraborty et al., 2020), 11-item scale of e-learning was used to capture the academic performance, study stress, and burnout of a student (e.g., Learning in Physical classrooms are better than an online class). Moreover, students were enquired to specify how frequently they feel satisfaction or dissatisfaction. A Likert scale ranged from "frequently satisfaction" (0) to "frequently dissatisfaction" (4). The overall Cronbach's alpha was 0.86.

DATA ANALYSIS

Before analyzing the study hypotheses, we tested confirmatory factor analyses (CFAs) to compute the discriminant validities of reports of e-learning, EI, study stress, burnout, and academic performance of students. To analyze the model fit of CFA, we must consider the standard criteria of the various model fit indices. It has been recommended that root means square error of approximation (RMSEA) values <0.05 are better, however, values between 0.05 and 0.08 are indicated a satisfactory level of model fit (Mulaik et al., 1989). The CFI value that is close to 0.90, the Normed fit index (NFI) value and the incremental fit index (IFI) value that exceeds 0.90 recommended a satisfactory model fit (Bentler, 1990; Byrne, 1994). The root means square residual (RMR) value range 0–1 is acceptable, but a value <0.05 is considered well fit (Byrne, 1994). We run λ^2 differences among a single-factor and five-factor model to check which model appropriately fit to the data sample. The estimated five-factor model provided [χ^2 (113) = 268.4, $p < 0.001$, NFI = 0.914, CFI = 0.943, IFI = 0.952, RMR = 0.01, and RMSEA = 0.04] better results as compared with four-factor model shaped by linking study stress and burnout (χ^2 (116) = 585.6, $p < 0.05$, NFI = 0.825, CFI = 0.847, IFI = 0.838, RMR = 0.04, and RMSEA = 0.08) and more better compared to a single-factor model (CFI = 0.517, NFI = 0.567, IFI = 0.518, and RMSEA = 0.12).

RESULTS

To measure the discriminant validity refers to the amount to which the measures do not reflect some other variables, which are specified by low correlations concerning the measure of interest and the measure of other constructs. The correlation along with the mean and SD of the targeted variables is given in **Table 2**. The correlation results show a significant positive relationship between EI and academic performance (0.48, $p < 0.01$) and a significant negative relationship between EI and study stress (0.39, $p < 0.05$). Similarly, the correlation between EI and burnout (−0.35, $p < 0.01$). The relation between e-learning and academic performance (−0.36, $p < 0.01$), e-learning and study stress (−0.43, $p < 0.01$), and e-learning and burnout (−0.41, $p < 0.001$) shows a significant negative correlation, respectively.

Structural Model

The structure model measurement was run to examine the relationship between the targeted variables. The standardized regression analysis of the parameter paths is shown in **Table 3**. The analysis outcomes show a positive and significant influence of EI on academic performance (β = 0.37, $p < 0.001$). The EI shows a negative and significant impact on study stress (β = 0.18, $p < 0.001$) and burnout (β = 0.25, $p < 0.01$); therefore, our results supported Hypotheses 1, 2, and 3. Additionally, the effect of e-learning on academic performance (β = 0.21, $p < 0.01$) shows a positive significant relationships, supporting Hypothesis 4, the effects of e-learning on study stress (β = 0.45, $p < 0.001$) and burnout (β = 0.35, $p < 0.05$) shows a significantly negative relationship, consequently, our findings supporting Hypotheses 5 and 6, respectively.

Moderation Analysis

Finally, the present study hypothesized the interaction (moderation) impact of EI with e-learning on academic performance, burnout, and study stress. The moderation analysis results show a significant impact of EI with e-learning on academic performance (β = 0.21; $p < 0.05$) as shown in **Table 3**; hence, hypothesis 7 is accepted.

Table 3 also provides a significant moderation impact of EI with e-learning on study stress (β = −0.15; $p < 0.01$) and burnout (β = −0.17; $p < 0.01$); therefore, our results supported Hypotheses 8 and 9, respectively. This signifies that EI with e-learning possesses a moderating impact on academic performance, study stress, and burnout.

In order to map the interaction, an average centered interaction term was shaped with the product of e-learning and EI and used for the interaction. When two standard variables are considered simultaneously, their interaction is a significant important predictor as provided in **Table 3**. Precisely, the interaction term anticipated academic performance (β = 0.21, Δ in R^2 = 0.06, $p < 0.05$), study stress (β = −0.15, Δ in R^2 = 0.04, $p < 0.01$), and burnout (β = −0.17, Δ in R^2 = 0.05, $p < 0.01$) showing comprehensive support for the moderation impact in the hypothesized model. Specifically, EI moderated the relationship between e-learning and academic performance such that those who possess a high level of EI

TABLE 2 | Correlations analysis.

Variables	Mean	(SD)	α	1	2	3	4	5
1. Academic performance	4.09	0.32	0.89	1				
2. Study stress	3.04	0.48	0.83	−0.17	1			
3. Burnout	3.02	0.35	0.87	−0.22*	0.27*	1		
4. EI	4.15	0.89	0.88	0.48**	−0.39*	−0.35**	1	
5. E-Learning	3.97	0.48	0.86	−0.36**	0.43**	0.41***	−0.23**	1

*EI, emotional intelligence. *p < 0.05; **p < 0.01; ***p < 0.001.*

TABLE 3 | Statistical analysis results.

Hypothesis	Beta	*p*-value	Decision
EI → Academic performance	0.37***	0.00	Accepted
EI → Study stress	−0.18***	0.00	Accepted
EI → Burnout	−0.25**	0.01	Accepted
E-Learning → Academic performance	−0.21**	0.01	Accepted
E-Learning → Study stress	0.41***	0.01	Accepted
E-Learning → Burnout	0.35*	0.05	Accepted
E-Learning * EI → Academic performance	0.21*	0.05	Accepted
E-Learning * EI → Study stress	−0.15**	0.01	Accepted
E-Learning * EI → Burnout	−0.17**	0.01	Accepted

*EI, emotional intelligence. *p < 0.05; **p < 0.01; ***p < 0.001.*

demonstrated a weaker negative connection between e-learning and academic performance. Contrarily, those individuals having low EI displayed a stronger negative relationship between e-learning and academic performance.

Our results found that EI shows a moderating impact between e-learning and study stress, indicating that students having less EI had a strong connection between e-learning and study stress, whereas students who possess high EI demonstrated a weak relationship between e-learning and study stress. Moreover, similar outcomes were found with burnout; e-learning and burnout show a stronger relationship with those students who have a low level of EI.

DISCUSSION

Currently, students observed that their academic performance had been interrupted due to the COVID-19 pandemic. This has forced thousands of students to stay away from their universities. The academic performance and psychological intentions of students are disturbed due to the lack of their college campuses, friends, professors, visiting the library, experimental activities in laboratories, group discussions, projects, etc.

Our finding confirms that Pakistani students show high psychological pressure toward online classes. They experience high levels of study stress and burnout and a low level of academic performance. In addition, students with high EI demonstrated a low level of study stress and burnout and better academic performance. The present study confirmed the influence of e-learning on academic performance, study stress, and burnout moderated by EI. Specifically, we discovered that students were suffering high psychological pressure from online classes facing low levels of study stress and burnout and high academic performance when they possess a high level of EI. Therefore, the present study supported all our hypotheses.

Furthermore, the results have identified two critical factors helping to understand the psychological intentions of Pakistani students during this COVID-19 pandemic: (a) the findings of this research add to the literature by signifying that e-learning and EI are critically important for the academic outcomes of a student. Students may become frustrated, show intent to give up or withdraw from taking online classes, and engage in negative behaviors toward their studies due to the psychological pressure of online classes; (b) the findings of this research advocate that EI can moderate e-learning, consequently, cause less study stress, burnout, and the consequence of enhancing academic performance. EI is a skill that can be developed through training and gradually increasing over the years. Yilmaz (2009) conducted a study. He argues that providing EI training programs to University students can help handle their psychological pressure and enhance the level of EI of students.

The results of the present study claim that those students who are better to handle and manage positive and negative sentiments are more capable of reacting accurately according to the existing requirements and effectively regulating emotions to increase their well-being due to experience psychological stress and burnout. The outcomes obtained in this study can confirm that it is important to include an emotional training program in the educational institutions and online classes to improve the learning process. Furthermore, the study of EI allows the student to take more potential possibilities to adjust to different uncertain situations and crises to obtain academic success (Herrera et al., 2020). Our results are parallel to the Lam and Kirby (2002) study; they argued that EI could assist students to resolve academic and daily problems more efficiently and managing psychological pressure effectively (Herrera et al., 2020; Moreno-Fernandez et al., 2020). Less EI individuals have been experiencing high psychological stress during the learning process (Adeyemo and Ogunyemi, 2005).

Cazan and Năstasă (2015) suggest that one of the students' major aspects is showing enthusiasm and building a strong connection with the academic curriculum. For successful academic achievements, students have to proficiently display skills to cope with stressful situations, keep a positive work attitude, and interact with professors. In addition, it should be understood that physical and emotional demands emphasize building interpersonal capabilities, but they also include

productive relationships with friends, families, teachers, and other professionals in extremely hard and uncertain situations. Pedrosa et al. (2020) observed the connection between emotional challenges with the perspectives of students; they found that the psychological stress and burnout of students become more obvious. Consequently, regulation, controlling, and managing feelings and emotions are deemed compulsory for successful academic performance (Suleman et al., 2019; Halimi et al., 2020; MacCann et al., 2020).

CONCLUSION AND LIMITATIONS OF THE STUDY

To conclude, the present study examines the relationships among e-learning, EI, study stress, burnout, and academic performance of students, during the global pandemic. Our findings significantly support the previous literature that EI effectively copes with a negative effect and stress arising from the COVID-19 pandemic (Chandra, 2020). Similarly, the results of Estrada et al. (2021) also parallel with our findings that EI enhances academic performance and reduces psychological stress among students. Based on the empirical results, the authors suggest that EI development and training programs might be included in the academic curriculum for students, which may help to control the serious effects (study stress and burnout) link to high levels of psychological pressure experienced by students during online classes. EI training and development programs can enhance the ability of a student to control and mitigate stressful situations (Drigas and Papoutsi, 2020), and also support the students to improve their social adjustment and academic performance (Wang, 2019). As a result, this might increase the ability of students to face and manage uncertain situations effectively and, ultimately, will enhance their academic performance.

This study had some limitations. First, rely on self-report assessment in this research could raise concerns of response biases. Second, to advance the generalizability of the current conclusions, a future study can imitate this model on other professionals, such as University teachers, organization leaders, and employees of multinational companies. Moreover, this research investigated the moderating role of EI between e-learning and the psychological intentions of overseas students. Therefore, it would be fascinating to observe the impact of other variables (e.g., IQ and cultural intelligence). A noticeable limitation of the present study includes the sample size. We gathered and analyzed data from only 10 Chinese University students stranded in Pakistan, and the sample size was 387 students, which is not big data. Further study may consider a large sample of data, collecting from several different countries.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

All the authors contributed to the conceptualization, formal analysis, investigation, methodology, writing of the original draft, and writing review and editing. All the other authors contributed to the formal analysis, investigation, methodology, and writing review and editing. All authors have read and agreed to the published version of the manuscript.

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Risks in Adolescent Adjustment by Internet Exposure: Evidence From PISA

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Problematic use and abuse of the Internet has manifested new risks among adolescents that affect academic, social, and emotional adjustment. In the academic domain, the role of Internet use on school performance and learning is studied, including the level of competence as a factor in this domain. On the social level, we measure how Internet use affects school climate and problems related to bullying. On the emotional aspect, the relationship between Internet use and satisfaction and positive feelings is studied, including wellbeing as a construct part of this domain. To find these relationships, data obtained from the Program for International Student Assessment survey, 2018 edition are used. Structural equation modeling was used to determine the most significant relationships between the aspects studied and Internet use. Internet use includes four independent variables: two on abuse (time of use on a weekday outside of class and on a weekend) and two on problematic use (perception about forgetting time and perceived discomfort if the Internet does not work). The results answer three research questions: (1) how the constructs created relate to the four independent variables on Internet usage, (2) how the observed variables respond to the latent constructs, and (3) how all these constructs are related to each other. These results highlight the need to teach young people to use the Internet in a useful and healthy way, as a preventive measure, and help professionals who detect technology abuse to act with effective measures to prevent the psychological consequences, working on the academic, social, and emotional aspects that have shown the greatest relationship. The problematic Internet use is a complex problem and it is impossible and imprudent to relate it to isolated factors: It is necessary to consider different factors to better understand the problem.

Keywords: adolescence, abuse technologies, academic achievement, social adaptation, emotional development

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INTRODUCTION

Internet use and abuse can lead to Internet addiction in approximately 10 to 20% of users (Akar, 2017; Milková and Ambrožová, 2018). In addition, there are certain risks of Internet use related to problematic Internet use, such as cyberbullying, cyber dating abuse, online grooming, or sexting (Machimbarrena et al., 2018). The most frequent motivation for adolescents to use the Internet is the search for gratification (Cebollero et al., 2021), which in the case

of boys is found in entertainment and in the case of girls through evasion. This would explain why boys tend to spend more time on playing social videogames and girls on social media (Twenge and Martin, 2020), resources where the search for social gratification can lead to the development of problematic Internet use.

Most studies on problematic Internet use and abuse focus on the study of individual factors (Anderson et al., 2016), and although there are also quite a few studies on the influence of social factors, individual factors seem to have greater influence (Fumero et al., 2018), such as, for example, low effortful control (Pace et al., 2018). In a study by Chen (2018), in the specific case of Smartphones, it is shown that people with low self-esteem and low social skills are more likely to develop an addiction if they desire the approval of others and a sense of belonging to a group, i.e., the search for gratifications described by Cebollero et al. (2021).

To evaluate all these factors in adolescents, the Programme for International Student Assessment (PISA), promoted by the Organization for Economic Co-operation and Development (OECD), collects and analyzes hundreds of variables in thousands of 15-year-old students around the world. The latest published report shows relationships between some of these factors, grouped in pairs, such as the influence of Internet usage time on wellbeing or the relationship between bullying and school climate (OECD, 2019a). With all these data available, a comprehensive study of which factors have a stronger relationship with Internet use and abuse is essential. For this purpose, individual factors, both academic and emotional, must be considered on the one hand, and social factors on the other.

In academic domain, Internet use should be assessed in terms of learning and performance. On the one hand, moderate and appropriate Internet use can be perceived as usefulness for learning (Huang et al., 2019, 2020). To have an appropriate behavior toward the use of the Internet and to prevent its abuse, it is claimed the need to teach adolescents technological literacy to enhance socio-emotional learning, as well as self-regulation strategies (Schilhab, 2017).

Among adolescents, informal learning with the Internet is motivated by their needs and the influence of their peers (Pereira et al., 2019). Most students feel that learning through YouTube is easier than in class, and many would like to include this tool as another classroom resource (Sulaimanu et al., 2019). In this sense, there are areas where videos can be a great resource because it is easier to understand abstract concepts or concepts that are difficult to understand without visual support. For example, science videos are often used for content enjoyment with an informational use of YouTube (Rosenthal, 2017).

In addition, for informal learning to occur, certain characteristics must be present. For example, this learning occurs more often from browser-based tools than from social media, and computers are used rather than mobile technologies (Lai and Smith, 2017). On the other hand, the use of the Internet for lifelong learning can be much more beneficial if it is approached with a community and social structure than individually (Eynon and Malmberg, 2021), as it can be for language learning in community forums (Clothey, 2017; Liu et al., 2020). With these studies, it is possible to glimpse the benefits that the use of the Internet can offer to learning, if it is approached in an appropriate way.

Performance and learning outcomes can be enhanced by using digital learning (Lin et al., 2017). A well-studied case is the use of virtual laboratories for science, technology, and engineering (Potkonjak et al., 2016). The use of the Internet is also beneficial, and if used in a non-problematic way, it is a good predictor of academic success (Maniaci et al., 2021). In addition, students who use interactive activities and use different tools in a balanced way have higher academic performance than those who only search for information (Torres-Díaz et al., 2016). The use of more tools according to the purpose refers to a high technological literacy, so this is related to greater performance.

However, abuse of the Internet, or problematic use, can have the opposite effect and be detrimental in the academic domain, especially in performance. At a general level, there are contradictory results that do not allow a generalization on how the Internet affects academic performance. In a study with PISA 2015 data, Hu et al. (2018) obtained that the use of information and communication technologies (ICT) at school was positively associated with academic performance, while the use of ICT at home was negatively associated with performance. However, in another study conducted by Rozgonjuk et al. (2021) found that mathematics performance declined the longer the time spent on the Internet, both in and out of school, suggesting that performance may depend more on the time spent on the Internet rather than on where it is used.

However, if other factors, such as emotional factors, are considered when analyzing this relationship, the results are even stronger. On the one hand, the negative effect on performance may be due to low motivation to study, given the effect that problematic Internet use can produce in terms of loneliness, which directly affects motivation to use learning strategies (Truzoli et al., 2020). On the other hand, another mechanism affecting academic performance could be low cognitive-behavioral control, which is related to the stress that excessive use of social media can generate (Masood et al., 2020). Finally, the influence of media multitasking self-efficacy on learning performance in personal learning environments has been seen if students perceive problems in attention and in their learning self-regulation strategies (Wu, 2017).

A strong relationship has also been found between academic performance and bullying, a very serious and quite widespread social problem in society. Bullying victimization is associated with poor academic performance and problems with school attendance (Gardella et al., 2017), also affecting study time and academic engagement (Yu and Zhao, 2021). Students who experience bullying may have worse performance in mathematics, reading, and science (Zhao and Yu, 2020).

At this point, it is necessary to highlight the mediating role of emotional intelligence between academic performance and bullying (Martínez-Martínez et al., 2020). In a study conducted by these authors, students suffering cyberbullying

showed low emotional intelligence but did not always show low academic performance. Among all the students who suffered bullying, students with low emotional intelligence had the lowest performance, so that emotional intelligence seems to play an important role in the relationship between these variables. In addition, emotional intelligence plays a similar role for good emotional adjustment in adolescents who experience bullying (Cañas et al., 2020a), so this type of intelligence can be crucial to mitigate the effects of the Internet on poor academic, social, and emotional adjustment.

Internet abuse or its problematic use has a strong relationship with bullying, and especially cyberbullying. According to the results of PISA 2018 (OECD, 2019a), adolescents who spend more time on the Internet are more exposed to bullying, which suggests that in many cases it is cyberbullying, although it has not been measured as such in the study. Cyberbullying is a type of bullying through digital media (Clevenger et al., 2018).

Although an adolescent is more likely to become a victim of cyberbullying than a bully (Çevik et al., 2021), adolescents who are traditionally bullies and who spend more hours on the Internet are more likely to become cyberbullies (Brighi et al., 2019). Furthermore, as stated by Louw and Winter (2011), the characteristics of the internet, a private and unsupervised environment, may be conducive to students who desire acceptance and have a high need to belong, becoming cyberbullies, even if they are not traditionally bullies.

On the other hand, and in addition to the above, bullying is related to problems in social integration and online socialization, lack of school belonging, and loneliness (Yu and Zhao, 2021). So all these results are in line with what we have seen so far and underline the importance of creating a positive and safe school environment, which is known as school climate.

School climate has some predictive value for bullying, specifically the dimensions of academic self-esteem, teacher support, and feeling of affiliation (Ortega-Barón et al., 2016). The sense of approval and belonging to a group is a risk for people with low self-esteem to develop an Internet addiction (Chen, 2018), so having a good school climate can improve self-esteem and decrease the likelihood of developing such addiction. Therefore, at the social level, it is important to consider the school climate as a possible factor related to Internet abuse.

In a study conducted by Zhai et al. (2020), they found a negative association between the perception of school climate and problematic Internet use, mediated by the sense of belonging to the school and depressive symptoms, that is, the perception of a negative school climate reduced the sense of belonging to the school, thus generating depressive symptoms, and increasing problematic Internet use. Meanwhile, Li et al. (2020) obtained results in line with the previous ones, obtaining a negative association between an Internet use disorder and relationships between teachers and students, and relationships between schoolmates.

Regarding the emotional domain, the relationship between Internet use and wellbeing has been studied. On the one hand, the development of digital skills increases the perception of wellbeing among adolescents (Donoso et al., 2020) and leisure Internet use also has a positive association with wellbeing (Lifshitz et al., 2018). On the other hand, time spent on the Internet has a negative but non-significant relationship with wellbeing compared to other variables unrelated to technology (Orben and Przybylski, 2019). This idea is in line with other studies that relate Internet use and wellbeing through the mediation of psychological variables, abilities, and cultural beliefs, without finding a direct relationship between wellbeing and Internet use (Castellacci and Tveito, 2018). The influence of intrapersonal factors, such as low self-esteem, are greater than interpersonal factors on the risk of adolescents with higher Internet use to develop an addiction (Servidio et al., 2019).

As part of wellbeing, life satisfaction is a well-studied variable. No significant relationships have been found between the use of social networks and life satisfaction (Orben et al., 2019), although wellbeing does decrease if the use of social media is problematic (Marino et al., 2017). However, the relationship between higher smartphone and Internet use and lower wellbeing in adolescents has been shown (Twenge et al., 2018), especially when problematic Internet use leads to lower life satisfaction (Lachmann et al., 2018).

Moreover, within the emotional domain, the study of emotions and emotional regulation are of special interest to know how they are related to Internet abuse. The lack of emotional regulation is key to understanding the relationship between childhood trauma and Internet addiction (Evren et al., 2019). In cases of cyberbullying, where there is a clear problematic use of the Internet, both bullies and bullied show this lack of emotional regulation, in addition to more damaged emotional profiles (Cañas et al., 2020b).

In a study in adolescents carried out by Jensen et al. (2019), they found no significant relationship between an increased risk of mental health problems with the days that those adolescents spend more hours on the Internet. Furthermore, George et al. (2018) found that on the days with higher use of technology, there was an increase in symptoms of behavioral problems. So, it cannot be confirmed whether more sporadic Internet use influences mental health problems. However, in studies in which people with widespread problematic Internet and smartphone use are studied, problems of impulsivity, anxiety, and depression have been found (Cimadevilla et al., 2019; Grant et al., 2019).

Regarding the relationship between adolescents' emotions and the time of Internet use, the PISA 2018 study (OECD, 2019a) shows a clear association between higher negative feelings miserable and sad and higher Internet use, while feelings scared and afraid are slightly lower among heavy users [more than 40 hours(h)/week(w)] than among high users (30–39 h/w), although the trend is upward: the higher the use, the higher the negative feelings. As for the positive feelings: happy, lively, proud, joyful, and cheerful, there is a downward trend. That is, the more hours they spend on the Internet, the less they experience these feelings. There is a slight exception with low Internet users (0–9 h/w) who experience less of these feelings than moderate Internet users.

This study aims to determine the relationship of all the variables described (academic: performance and learning; social:

bullying and school climate; and emotional: wellbeing and emotions) with the use and abuse of the Internet to determine which factors may have a greater influence and which may have a lesser influence.

To create this theoretical model, the starting point was reflection on the dimensions corresponding to each factor to be studied as: academic, social, and emotional. The resulting dimensions had to be composed of several study variables that adequately responded to the corresponding dimension and factor. For this purpose, the indices created by PISA 2018 were reviewed. Most of the study variables were taken directly from these indices, specifically from the Scale indices, which are variables constructed by scaling multiple items (OECD, 2019a). To construct these indices, PISA selected related questions from a broader set, which was based on theoretical considerations and previous research (OECD, 2019b), that is, each index part from a conceptual framework studied in depth. In the case of wellbeing, it was decided to construct an additional variable from items corresponding to life satisfaction that were not included in any of these scales.

The purpose is to better understand how problematic Internet use affects the development of a poor adjustment in any of these factors. This knowledge will serve to detect problems in time attending to the problematic use and abuse of the Internet, and thus be able to design interventions that promote a healthy and fruitful use of it, preventing adjustment problems in these factors.

The questions guiding the research fall into three broad groups: (1) how the constructs created relate to the four independent variables on Internet usage, (2) how the observed variables respond to the latent constructs, and (3) how all these constructs are related to each other.

MATERIALS AND METHODS

Participants

Adolescents from 51 countries participant in PISA, in 2018. In total, there have been 612,004 students aged 15 years old who have participated in this program during the course 2017/2018. Of these, 292,946 participants did not answer any of the questions used for the analysis. Therefore, the data used in this study pertain to 319,058 participants, who answered all the questions.

Research Questions and Measures

To answer the research questions, a structural equation modeling (SEM) is used, a multivariate analysis technique to contrast models that propose causal relationships between variables (Ruiz et al., 2010), which arise to make regression models more flexible, and have a confirmatory rather than an exploratory function (Escobedo et al., 2016). This analysis is more appropriate than a confirmatory factor analysis because SEM expands the possibility of relationships between latent variables and encompasses a measurement model and a structural model (Schreiber et al., 2006). The purpose of SEM is to validate the theory that describes the relationships between variables with empirical data, that is, to confirm a theoretical model based on real information.

This study aims to confirm the relationship between the use of the Internet, including four independent variables (IV): (1) time spent in Internet during a typical weekday (Time_weekday), (2) time spent in Internet during a typical weekend (Time_weekend), (3) perception of forgetting time when using digital devices (Perception_time), and (4) perceived discomfort if no Internet connection is possible (Perceived_discomfort), and different academic, social, and emotional factors.

The measurement model starts from the construction of the dimensions or factors (related to academic, social, and emotional), while the structural model refers to the analysis of the effects between factors and with the Internet use variables, independent variables.

The latent constructs correspond to the factors created and are composed of different observed variables:

- *Academic dimension* is composed of the performance and learning factors, which include the variables: Learning goals (MASTGOAL), Motivation to master tasks (WORKMAST), Enjoyment of reading (JOYREAD), and Value of school (ATTLNACT). For a more detailed explanation of how each of these and other variables was measured, see OECD (2019a). On the other hand, to adequately measure the performance construct, related to the academic dimension, another construct called competence has been included.
- *Competence construct* is composed of the observed variables: Global competence (GLOBAL), Math competencies (MATH), Read competencies (READ), and Science competencies (SCIENCE), which are the averaged results of the items corresponding to each of the tests performed in PISA to measure the level of students in these areas. The results had to be averaged manually because the program used does not do it automatically.
- *Social dimension* is composed of the climate and bullying factors, which include the observed variables: Disciplinary climate (DISCLIMA), Fear of failure (GFOFAIL), and Exposure to bullying (BEINGBULLIED).
- *Emotional dimension* is composed of the wellbeing and feelings factors, which include the variables: Meaning in life (EUDMO), Sense of belonging (BELONG), and Positive feelings (SWBP). On the other hand, to adequately measure the wellbeing construct, related to the emotional dimension, another construct called specifically wellbeing has been included.
- *Wellbeing construct* is composed of 10 observed variables: from Satisf_1 until Satisf_10, which are the 10 items about wellbeing in PISA questionnaire.

The questions guiding the research fall into three broad groups: (1) how the constructs created relate to the four independent variables on Internet usage, (2) how the observed variables respond to the latent constructs, and (3) how all these constructs are related to each other.

In the first question, we start from the general hypothesis that all factors will be related to problematic use and abuse

of the Internet, although some factors will be more related than others. In the second question, all the observed variables are expected to respond to the latent constructs, since they have been selected based on the theoretical model proposed in PISA. In the third question, no specific hypothesis is established, since the objective is to explore the possible relationships between constructs in order to gain knowledge about their behavior.

In the structural model, latent constructs can play the role of both independent and dependent variables, causes, and effects of other variables. In addition, this model includes factor loadings, relationships between constructs and error terms for proper interpretation. The model is assessed from factor loadings (measurement model) and regression (structural model) to point out the effects between variables.

On the other hand, different fit indices are analyzed to determine the quality of the model, both global fit and incremental fit. Global fit indices directly measure the ability of the defined model to reproduce the observed data by comparing the estimated variance-covariance matrix with the empirical one. If the difference is equal to zero, a perfect fit is obtained. Incremental fit indices evaluate the model fit by comparing it to an alternative baseline model, so it is a relative fit. This alternative model is usually a null model, which assumes that there is no correlation between the observed variables.

Procedure and Data Analysis

For quality data collection in all countries participating in the study, PISA provides a document of technical standards and guidelines that is based on consistency, accuracy, generalizability and timelines for test implementation, data management and national standards to ensure cross-national, cross-cultural, and linguistic validity (OECD, 2015).

The PISA assessment framework uses objective tests that allow to know the level of competence in the different domains studied (reading, mathematics, and science), with questions that cover different processes and contexts to achieve an objective assessment. On the other hand, a questionnaire composed of scales is used to assess school-level constructs and non-cognitive or metacognitive constructs. The perception of learning, the social perception of school climate and bullying, and the emotional perception of emotions, satisfaction, and wellbeing correspond to subjective constructs that are assessed through this questionnaire (OECD, 2019b).

In this study, the analysis strategy consisted of three main phases. The first phase had included find out the average scores of the competencies were calculated from the 10 plausible values. With this, we were obtained the four variables related to the competence construct, belonging to the performance factor of the academic dimension. Secondly, missing values were analyzed. Most of the variables could be used because there was no major impact of missing values that could affect the results. However, global competence has more than 50% of the cases without data and has been discarded for the analysis. This provided the definitive variables for the study.

In the second phase, a first model was estimated that assumes that the IVs have effects on all the dependent variables, i.e., it analyzes the effects of the IV on each of the indexes in the database, without including the latent factors. With this first analysis, it was found that there were no significant relationships in general, and the model used in the study was developed, which includes the construction of the five dependent variables from the indexes and relates the IVs to these factors.

In the third and final phase, the model was improved, resulting in a definitive model that allows a much better adjustment of the relationships between the variables studied. To this end, non-significant effects (regression coefficients) were eliminated, and modification indexes were analyzed to check which possible effects could improve the model.

For data analysis, four main indices have been used for the overall assessment of the models, two of them are global fit indices and two are incremental fit indices.

The global fit indices used are Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR). The RMSEA reports how well the model fits the reference population. Lower values show better fit, and it is considered acceptable if this index is between 0.05 and 0.08. For its part, the SRMR summarizes the differences between the observed and estimated variance-covariance matrix, based on the study of the residuals. Although there are no fixed values established as cutoff points, finding a value above 0.1 indicates a problem of fit.

The incremental fit indexes used are Normed Fit index (NFI) and Comparative Fit Index (CFI). The NFI is the ratio between the chi-square values of the estimated model and the null model and varies between 0 and 1. To be considered an acceptable fit, the value should be above 0.9. The CFI is an improved version of the NFI, as it is less sensitive to the complexity of models with many parameters. Likewise, 0.9 is established as the cutoff point to consider a good fit.

RESULTS

The model used includes the effects of the IVs related to Internet use and among the five latent factors, that is, it studies the role of cause and effect of all the variables in the model (**Figure 1**). Based on this proposal, three models have been estimated as: The initial model does not include the effects among the latent factors. The intermediate model includes these effects but eliminates the non-significant effects of the initial model. To establish the effects between latent variables, I have used the modification indexes that indicate the improvement in the quality of the model if this effect is included, but it must also be justified with theory. The final model eliminates all non-significant effects and, as in the previous one, the intensity of the effect, not only the significance, must be checked.

The fit indices show a higher result for the models that include effects between latent factors (intermediate model and final model). The three models achieve acceptable values of the measured indices, becoming very good in the models that include the effects between factors (**Table 1**).

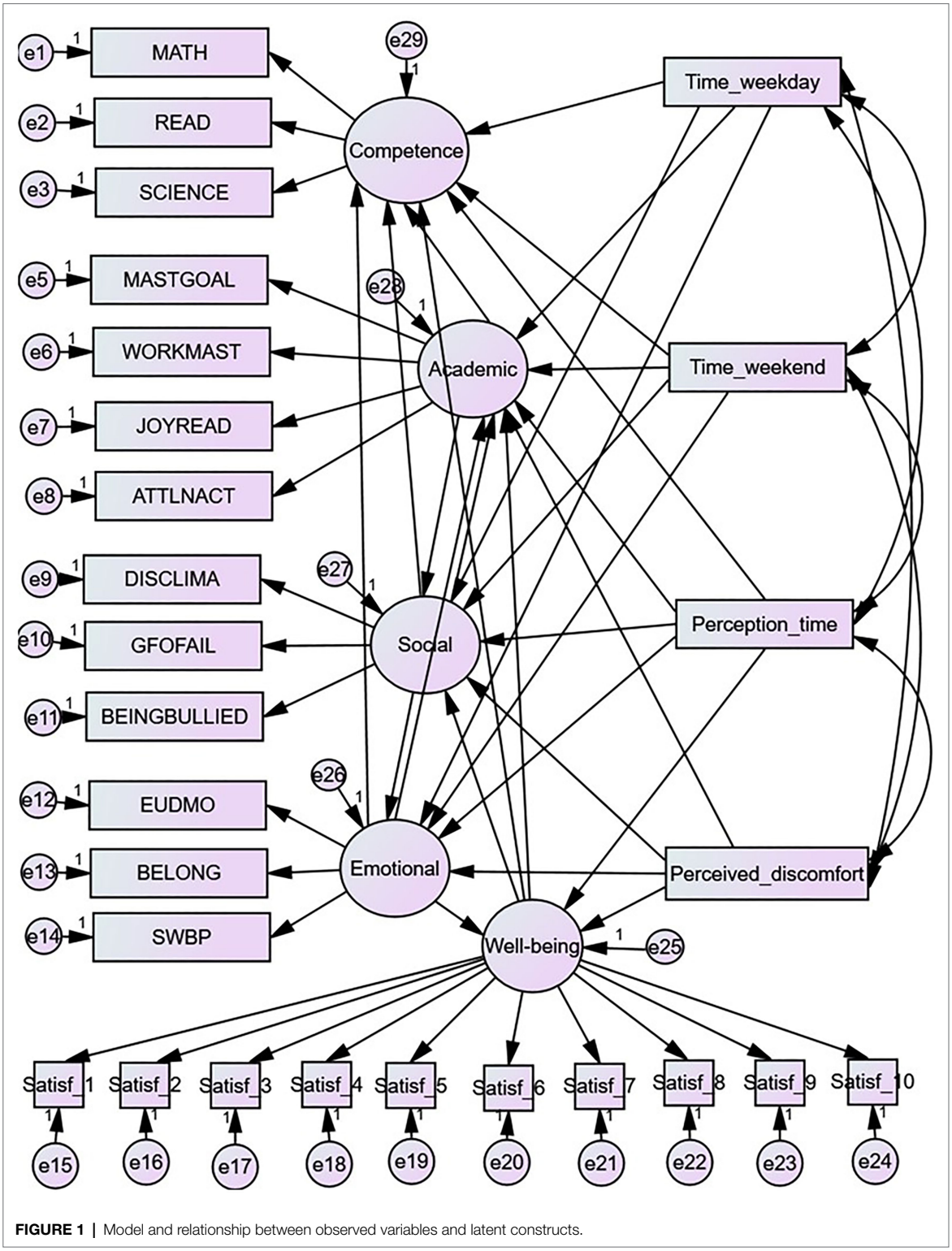

FIGURE 1 | Model and relationship between observed variables and latent constructs.

The global fit indices, RMSEA obtains a low score, which shows a good fit. Similarly, SRMR shows a low score and away from 0.1. Regarding the incremental fit indices, both NFI and CFI show values above 0.9, so we can consider that the intermediate model and the model have a good fit.

Tables 2–5 include effects from latent factors to independent variables in the final model, and these tables show the regression coefficients for each factor. These first results make it possible to answer the first research question of the study: (1) How the constructs created relate to the four independent variables on Internet usage.

TABLE 1 | Fit indices for the three models.

Model	NPAR	CMIN	DF	*p*	NFI	CFI	RMSEA	SRMR
Initial	76	809772.016	302	0	0.871	0.871	0.066	0.0698
Intermediate	86	616072.486	292	0	0.902	0.902	0.059	0.0424
Final	83	616100.928	295	0	0.902	0.902	0.059	0.0424

TABLE 2 | Results (regression coefficients and significant effects) for the first independent variable: time spent in Internet during a typical weekday (Time_ weekday).

Parameter	Regression coefficient	E.T.	*p*
Academic	–0.063	0.002	0.009
Competence	0.112	0.004	0.007
Social	–0.113	0.005	0.015
Emotional	–0.025	0.002	0.009
Wellbeing (non-significant)	0	0	–

For the analysis, non-significant effects ($p < 0.05$) in previous models were eliminated for the final model analysis. The only non-significant factor for time spent on the Internet during a weekday was wellbeing (**Table 2**). On the other hand, if the values are significant, it means that the value of the coefficient is the same as that which would be obtained in the population, even if the observed effects are small.

This is the case of the academic and emotional factors, whose coefficients are less than 0.1, the effects are small, but they are applicable to the entire population. Both the academic and emotional factors have an inverse relationship with daily Internet use, that is, the higher the Internet use, it means lower scores on these factors. Regarding the effects that most explain the time spent on the Internet during a typical weekday, it can be seen how competence is positively related, while the social factor is negatively related.

In the case of the variable Internet use on weekends, **Table 3** shows that both the academic factor and the wellbeing factor are not significant. The other factors (competence, social, and emotional) are significant, but their effect is very small (less than 0.1). In this case, we see that the competence factor maintains a direct relationship and the emotional factor a slight inverse relationship, as occurred with the time of use during the week. However, in contrast to weekday use, the hours of Internet use on weekends have a positive relationship with the social factor.

For the variable perception of forgetting time when using digital devices, **Table 4** shows significant relationships with all factors. However, its effect is very small, being less than 0.1 in all cases. Interestingly, the academic and competence factors have a direct relationship, meaning that the higher the perception of forgetting time, better are the learning outcomes. While the social and emotional factors have an inverse relationship, the higher the perception of forgetting time, worse are the results in the social and emotional domains. The wellbeing factor has a regression coefficient that is too small to be considered (less than 0.01).

Finally, in the case of the variable perceived discomfort if no Internet connection is possible, the competence factor is not significant. The social factor has the greatest effect of all, with an inverse relationship, in other words, the greater the perceived discomfort, the lower the score on the social factor. The remaining factors have a very small effect (less than 0.1), but positive in all cases, i.e., a direct relationship. Being a variable related to discomfort, it is curious that it does not have an inverse relationship with a greater effect on the emotional and wellbeing factors.

On the other hand, in **Tables 6–10**, the regression results of each of the latent factors are collected to answer the other two research questions of the study: (2) how the observed variables respond to the latent constructs and (3) how these constructs are related to each other.

To answer how the observed variables respond to the latent constructs, we must look at the variables related to the academic factor (**Table 6**). While Learning goals (MASTGOAL) and Motivation to master tasks (WORKMAST) have a high effect on the factor (>0.6), Enjoyment of reading (JOYREAD) and Value of school (ATTLNACT) have a much lower effect (0.28 and 0.38). Moreover, as explained in the research method, the Competence construct is considered part of the academic factor, and this can be confirmed given the relatively high effect it has shown (0.57).

Additionally, to answer how the academic factor is explained by other factors, we obtained an inverse relationship with a strong effect with the social factor, meaning that a higher academic score is associated with a lower social score.

In the case of the competence construct, **Table 7** shows that the three observed variables that respond to this construct (mathematics, reading, and science scores) explain the competence construct with a very high effect (>0.9). Since it is considered part of the academic domain, the relationship with the rest of the factors has not been measured.

Table 8 shows the observed variables that respond to the social factor. In this case, a medium-low effect (absolute values between 0.2 and 0.5) can be seen in the explanation of this factor due to the three variables. While Disciplinary climate (DISCLIMA) has a direct relationship with the social factor, that is, a higher score on the social factor, greater score on the school climate; Fear of failure (GFOFAIL) and Exposure to bullying (BEINGBULLIED) have an inverse relationship, with Exposure to bullying showing a stronger effect explaining the social factor. This means that if the fear of failure is lower and the exposure to bullying is lower, the social factor score will be higher.

In addition, **Table 8** shows how other factors are related to the social factor. In this case, it is interesting to note

TABLE 3 | Results (regression coefficients and significant effects) for the second independent variable: time spent in Internet during a typical weekend (Time_ weekend).

Parameter	Regression coefficient	E.T.	*p*
Academic (non-significant)	0	0	–
Competence	0.024	0.003	0.009
Social	0.055	0.004	0.013
Emotional	–0.019	0.002	0.005
Wellbeing (non-significant)	0	0	–

TABLE 4 | Results (regression coefficients and significant effects) for the third independent variable: perception of forgetting time when using digital devices (Perception_time).

Parameter	Regression coefficient	E.T.	*p*
Academic	0.072	0.005	0.005
Competence	0.075	0.003	0.007
Social	–0.065	0.003	0.006
Emotional	–0.028	0.002	0.009
Wellbeing	0.007	0.002	0.018

TABLE 5 | Results (regression coefficients and significant effects) for the fourth independent variable: perceived discomfort if no Internet connection is possible (Perceived_discomfort).

Parameter	Regression coefficient	E.T.	*p*
Academic	0.043	0.007	0.013
Competence (non-significant)	0	0	–
Social	–0.129	0.002	0.011
Emotional	0.018	0.002	0.023
Wellbeing	0.012	0.002	0.015

TABLE 6 | Results (regression coefficients and significant effects) for academic factor.

Parameter	Regression coefficient	E.T.	*p*
Competence	0.57	0.012	0.01
Social	–0.67	0.037	0.006
MASTGOAL	0.668	0.001	0.006
WORKMAST	0.631	0.002	0.009
JOYREAD	0.28	0.002	0.011
ATTLNACT	0.386	0.002	0.006

TABLE 7 | Results (regression coefficients and significant effects) for competence construct.

Parameter	Regression coefficient	E.T.	*p*
MATH	0.933	0	0.007
READ	0.945	0	0.008
SCIENCE	0.979	0	0.005

TABLE 8 | Results (regression coefficients and significant effects) for social factor.

Parameter	Regression coefficient	E.T.	*p*
Academic	0.354	0.058	0.008
Competence	0.716	0.013	0.009
DISCLIMA	0.326	0.003	0.012
GFOFAIL	–0.28	0.004	0.012
BEINGBULLIED	–0.432	0.002	0.006

that the academic factor explains the social factor directly with a medium-low effect (0.35), but if we focus on the competence construct, it explains the social factor with a high effect (>0.7).

For the emotional factor, **Table 9** shows how the observed variables respond with a medium effect (between 0.48 and 0.58), a direct relationship on this factor. Specifically, from highest to lowest effect, we find as: Meaning in life (EUDMO), Sense of belonging (BELONG), and Positive feelings (SWBP).

Also, **Table 9** shows that the emotional factor is not significantly explained by wellbeing, although wellbeing is explained by the emotional factor (**Table 10**). In addition, we see how the emotional factor is explained with a significant effect by academic and social factors. The academic factor is the smallest, which explains the emotional factor with a medium effect (0.45). Meanwhile, competence construct explains the emotional factor inversely and with a very strong effect. This means that those who have a higher level of competence will have a lower score in the emotional factor, which would explain why students with better grades may have more emotional problems.

In relation to this result, a very high effect of the social factor in explaining the emotional factor is observed. A possible hypothesis that could arise from the interaction between these last results is that students with higher grades (higher competence) are not always socially accepted, which would have a negative impact on their emotional side. Undoubtedly, these results need further investigation in subsequent studies.

Finally, **Table 10** shows how the observed variables that respond to the wellbeing construct all have a medium-high effect in explaining wellbeing (between 0.6 and 0.72), given that they are all specific items that have been chosen to evaluate wellbeing.

In the case of how this construct relates to others, as mentioned above, it has a direct relationship with a medium effect with the emotional factor. Initially, in the method, the wellbeing construct has been included as part of the emotional factor, so this relationship is confirmed. In addition, with the other factors, the wellbeing construct has a very low effect (less than 0.1), while the emotional factor had obtained quite high effects. This supports the theoretical proposal that wellbeing is part of the emotional factor, and the rest of the factors are explained by the emotional factor and not by the wellbeing construct. Future studies should confirm these relationships.

TABLE 9 | Results (regression coefficients and significant effects) for emotional factor.

Parameter	Regression coefficient	E.T.	*p*
Academic	0.452	0.038	0.012
Competence	–0.924	0.018	0.018
Social	1.12	0.026	0.009
Wellbeing (non-significant)	0	0	–
EUDMO	0.584	0.002	0.009
SWBP	0.545	0.002	0.012
BELONG	0.48	0.002	0.007

TABLE 10 | Results (regression coefficients and significant effects) for wellbeing construct.

Parameter	Regression coefficient	E.T.	*p*
Academic	–0.012	0.002	0.006
Competence	0.043	0.003	0.005
Social	–0.019	0.003	0.003
Emotional	0.279	0.002	0.012
Satisf_1	0.653	0.003	0.025
Satisf_2	0.623	0.003	0.012
Satisf_3	0.602	0.004	0.018
Satisf_4	0.668	0.003	0.019
Satisf_5	0.668	0.003	0.021
Satisf_6	0.722	0.003	0.01
Satisf_7	0.628	0.003	0.013
Satisf_8	0.713	0.002	0.025
Satisf_9	0.664	0.003	0.016
Satisf_10	0.694	0.003	0.009

DISCUSSION

The results found allow us to establish interpretations that improve our knowledge of how different factors related to the academic, social, and emotional domains are affected by the development of problematic Internet use. To discuss the results, research questions 1 and 2 will be interpreted first, to know how the academic, competence, social, emotional, and well-being factors respond to the independent variables related to Internet use, and to be able to explain which observed variables best explain each of these factors. Question 3 is then interpreted to find out what significant relationships exist between the different latent factors.

Problematic Internet Use in Academic, Social, and Emotional Domains

First, with respect to time spent using the Internet, we must differentiate between Internet use during a typical weekday and Internet use during a typical weekend. It is notable that wellbeing does not have a significant relationship with the time spent using the Internet, neither on weekdays nor on weekends. In this sense, the results support the idea that the relationship between both variables is not direct but affects other aspects, such as cultural (Castellacci and Tveito, 2018) or intrapersonal variables (Servidio et al., 2019), variables not related to technology (Orben and Przybylski, 2019), contrary to the results of other authors who do certify the relationship between time of Internet use and wellbeing (Lifshitz et al., 2018; Donoso et al., 2020).

The use of the Internet during the week is explained to a greater extent by the social factor, meaning that students who spend more time on the Internet may have more problems in the social sphere. According to the results, students who spend more time on the Internet during the week may have greater exposure to bullying, worse perception of school climate, and/or feel more fear of failure.

Weekday Internet use is also largely explained by the competence construct: Students who use the Internet longer during the week have higher scores in math, reading, and science. These results are in line with the studies of Huang et al. (2019, 2020), if their use is not problematic, because ICT use can improve performance and outcomes (Lin and Chen, 2017).

However, students who use the Internet more during the week have greater problems with the academic domain in general, i.e., learning. Among these problems are that these students are less able to set their learning goals and are lower motivated to manage their homework, and that they value school less highly. Also, although with a smaller effect according to Internet use, they have less fun with reading.

At this point, it is remarkable that, while adolescents who use the Internet more during the week obtain better academic results (competence), they have more problems with learning and the academic domain, in general. Further inquiry is required to adequately deepen this finding, as it may depend on the type of tools they tend to use, some more suitable than others for learning, as Lai and Smith (2017) expose.

The emotional factor also has a significant, although small, relationship with weekday Internet use: the higher the weekday Internet use, the lower the emotional satisfaction. Emotional satisfaction is given by perceived meaning in life, sense of belonging, and experiencing positive feelings. This could be in line with the results of Chen (2018) who saw that people with low self-esteem are more likely to develop addiction to their smartphones, in search of improving their personal satisfaction through increasing their sense of belonging to a virtual group.

Regarding Internet use on weekends, there is also a significant relationship, although with a much smaller effect, between the construct of competence and Internet use: the greater the Internet use on a typical weekend, higher levels of competence. In line with the findings of Maniaci et al. (2021), Internet use is a good predictor of academic success, provided it is not used in a problematic way. The emotional factor also explains Internet use on weekends: more Internet use, decreased emotional satisfaction. Both the results regarding competence and the emotional domain are in line with the observed results for weekday Internet use.

However, those who use the Internet for more hours on weekends have higher scores in the social factor, as opposed to those who use it during the week. This could be explained by a differential use of the Internet: While during the week

it would be used more for academic tasks, on weekends it would be used as a leisure resource. This hypothesis would also be supported by the fact that no significant relationship was found between Internet use on weekends and the academic factor. In view of these results, we do not share the findings of Hu et al. (2018) that greater use of ICT at home is associated with poor performance, nor the results of Rozgonjuk et al. (2021) students who spend more time on the Internet outside of school have lower math scores.

Time spent on the Internet can be considered as a problem related to Internet abuse. However, problematic Internet use can also occur even if only a few hours are spent on the Internet. For this reason, it was considered important to include other variables related to the perceptions of adolescents when they use it inappropriately. For this reason, the other two independent variables have been chosen to provide more clarity to the interpretation of the results.

An important issue in terms of problematic Internet use is the perception of forgetting time when using digital devices. In this case, although the effect of the factors is small, in all cases it is significant. In the case of the academic factor, and their related construct, competence, a direct relationship has been obtained with the perception of forgetting time. This means that, when this perception occurs more frequently, these factors are higher. Therefore, better students are more likely to develop this problem. At this point, the development of self-regulation strategies could help, as pointed out by Schilhab (2017). Meanwhile, the social and emotional factors have an inverse relationship with the perception of forgetting time. In this case, this problematic perception of losing track of time occurs more often when the scores in the social and emotional domains are lower.

The other important question for detecting problematic Internet use is perceived discomfort if no Internet connection is possible. In this case, the level of competence does not have a significant relationship with this problem, although the academic factor is significant and has a considerable effect. The higher the perceived discomfort, the higher the scores on this factor. These results seem to be related to the results obtained in the problem of perception of forgetting time while surfing the Internet. Adolescents with more problems in the use of the Internet seem to have a greater predisposition to learning if we do not consider the rest of factors. However, it is also important to consider other factors that have a greater effect in explaining this problem. In the case of perceived discomfort if no Internet connection is possible, the social factor has a greater intensity in explaining this problem, with an inverse relationship. This means that adolescents with higher perceived discomfort have lower scores in the social domain, in line with previous studies (Li et al., 2020; Zhai et al., 2020).

In this problem, emotional and wellbeing factors also have a significant relationship, although with a much smaller effect than social and academic factors. In these two cases, the relationships are direct: those who experience higher perceived discomfort, higher emotional satisfaction, and/or wellbeing. It is quite possible that the satisfaction and/or wellbeing experienced are related to the possibilities offered to them by the Internet, such as the need for social interaction according to Chen (2018). In these cases, it would be appropriate to explore further how the problem is related to these factors and to include an intermediate explanatory variable to control the effect of experiencing satisfaction due to Internet use.

Relationship Between the Latent Factors

Regarding the third research question about how the relationship between the latent factors is, it has been obtained that the academic factor is more explained by the social factor, although in an inverse way, followed by the competence construct (which is part of the academic factor according to the theoretical proposal). These results are in line with proposals that there is a strong relationship between bullying and achievement and commitment to study (Gardella et al., 2017; Zhao and Yu, 2020; Yu and Zhao, 2021). At this point, it is worth recalling the need for training on emotional intelligence to mediate these effects (Martínez-Martínez et al., 2020; Cañas et al., 2020a).

For its part, the social factor is largely explained by the competence construct, but not as part of the academic factor, which has shown a much lower relationship with the social factor. The higher the level of competence, a positive and safe school environment is generated, increasing the sense of belonging to the school, which could explain the relationship with the social factor (Yu and Zhao, 2021).

On the other hand, the emotional factor is highly explained by the social factor, whose relationship can be explained by the high need for social approval experienced by many adolescents, which undoubtedly affects their emotional satisfaction and wellbeing, through obtaining gratifications, according to Cebollero et al. (2021). The emotional factor is also largely explained by the level of competence, although in an inverse manner. And, as has occurred with the social factor, the effect is much smaller if the academic factor is considered as a whole.

Finally, an unexpected result was that the wellbeing construct does not explain the emotional factor, since the relationship is not significant. However, the emotional factor does explain wellbeing, so the relationship to confirm the theoretical model between both constructs should be investigated in future studies.

As a conclusion to this study, it is confirmed that problematic Internet use is a complex problem, so there may be multiple relationships between factors related to academic, social, and emotional factors that are influenced by the way in which this resource is used. It is impossible and imprudent to relate the development of problems in the use of the Internet to isolated factors, and therefore, it is necessary to consider different factors to better understand the relationships between all of them and address the problem in a comprehensive manner.

The main practical implications of the results obtained are related to the aspects to which we should pay more attention when a problem is detected in a specific area. In other words, by obtaining stronger relationships between certain variables, we can interpret that if there is a problem in a given variable,

TABLE 11 | Summary of relevant practical implications.

If a problem is detected in …	Be especially careful with problems in …
Time spent during a typical weekday	Social factor
Perceived discomfort if no internet connection is possible	Social factor
Academic factor	Ambitious learning goals and motivation to master task
Competence factor	All domains: math, read, science
Social factor	Exposure to bullying
Emotional factor	Perception about meaning in life, and ability to sense positive feelings
Wellbeing factor	Emotional factor

the variables that have obtained stronger relationships will be the ones most likely to develop new problems.

Table 11 shows a summary of the main practical implications of the study. First, the problems with the Internet that can generate greater problems in specific factors are shown and, subsequently, each of the factors studied is shown, together with the dimensions that have obtained a greater relationship and, therefore, can develop the next problems.

Even so, it is important to re-emphasize that the relationships between all the factors and dimensions must always be considered, since all of them show relationships, whether major or minor, so that secondary problems may arise in any of them.

Therefore, this study brings to this field of research the importance of considering the influence of problematic Internet use and abuse on different factors in a related way, and not as isolated factors.

One limitation of the study may be that it worked with so many variables and so many data, which may have influenced the results of the analyses. To mitigate these drawbacks, as far as possible, new hypotheses and research questions have been proposed throughout the discussion of the results, which will serve as future lines of research on problematic Internet use.

Another limitation has been the need to create an additional variable to measure wellbeing, since there is no specific scale among the scale indexes created by PISA. This implies less theoretical support, and less validity, given that no additional tests have been carried out. In this sense, a future line of action would be to test the consistency of the wellbeing variable created, in the same way that the rest of the scale indices have been validated by the PISA program.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found at: https://webfs.oecd.org/pisa2018/SPSS_STU_QQQ.zip.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

BO-R conducted the main literature search, drafted the theoretical framework, and wrote the results, discussion and conclusions. ACS and BM reviewed the theoretical framework, contributed complementary sources, reviewed the article, and provided complementary ideas. All authors agreed on the research approach and data analysis.

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Internet Addiction and Emotional and Behavioral Maladjustment in Mainland Chinese Adolescents: Cross-Lagged Panel Analyses

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Adolescence is a developmental stage when adolescents are vulnerable to addictive behaviors, such as Internet addiction (IA), which refers to pathological use of the Internet. Although there are views proposing that the links between IA and adolescent problem behavior may be bidirectional in nature, few studies have examined the reciprocal relationships between IA and other maladjustment indicators, and even fewer studies have simultaneously employed both emotional and behavioral maladjustment indicators in a single study. To address the above research gaps, the present study investigated how IA is associated with both depression and delinquency among Chinese adolescents. Two waves of data were collected at two consecutive years, respectively, with 1 year apart, from 3,010 students (Mean age = 13.16, SD = 0.81; 57.48% boys) in four junior high schools in mainland China. These students completed the same questionnaire containing measures of IA, depression, and delinquency at each wave. The proposed cross-lagged panel model fitted the data very well, and there were significant positive reciprocal effects between IA and depression as well as delinquency after controlling for background socio-demographic factors. Gender differences were also observed in multi-group comparisons. Specifically, IA showed a stronger longitudinal impact on delinquency among boys than among girls. While depression significantly predicted IA in 1 year among boys, such a prediction was not significant among girls. These findings delineate the bidirectionality of the associations between IA and emotional and behavioral maladjustment indexed by depression and delinquency, respectively. The findings also suggest that researchers and practitioners have to take gender differences as well as different developmental indicators in understanding the bidirectional influences between IA and adolescent behavioral and emotional development.

Keywords: internet addiction, depression, delinquency, longitudinal study, junior secondary school students

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INTRODUCTION

The Internet has become an essential part of people's daily life, including children and adolescents. For example, 25.4% of the children aged 10–14 in Hong Kong were found to spend 20–50 h per week using the Internet in 2007; the figure increased to 42.0% in 2017 (Chung et al., 2019). With the fast-growing number of Internet users and increasing time online, the problem

of Internet addiction (IA) and its adverse health consequences have become a major public concern (Caplan, 2003). IA, also known as "problematic Internet use," "pathological Internet use," or "compulsive Internet use," is characterized by having an excessive level of preoccupation or behaviors regarding Internet usage, which would usually result in distress and functional impairments (Weinstein et al., 2014). Some researchers considered IA a type of psychological disorder under the category of impulse-control and/or obsessive–compulsive disorder, as it shows symptoms similar to many substance use disorders, including "excessive use," "withdrawal phenomena," "tolerance," and "negative repercussions" (Young, 1998). However, Pies (2009) argued that there are no well-established physiological measures (e.g., blood pressure) or data for withdrawal or tolerance among individuals with IA. Further, as Internet is merely a medium or platform rather than a substance, the pathological need to use Internet may merely represent a behavioral manifestation of psychopathology or defense mechanisms (Pies, 2009). The enduring debate regarding the definition of IA has been mentioned in many studies, and scholars agree that the diagnostic criterion of IA is still open for discussion (Pies, 2009; Stip et al., 2016; Yu and Shek, 2018; Martins et al., 2020). However, a common consensus is that individuals can display different levels of addicted behavior related to Internet use, which has been commonly operationally conceived as a continuous construct indicated by integrated scores in different assessment tools (Liang et al., 2016; Yu and Shek, 2018; Tian et al., 2021).

Across various age groups, adolescents are most vulnerable to develop IA since they commonly lack effective self-regulation ability to control Internet surfing and they tend to be risk-taking and impulsive (Cerniglia et al., 2017). Indeed, a relatively high and growing prevalence of IA among adolescents has been reported in both East and West societies, with the problems being most prevalent in Asian societies (Chung et al., 2019; Pan et al., 2020). In China, Wu et al. (2016) revealed a 10.4% prevalence rate of IA among 14–24-year-old young people in Anhui province; Xin et al. (2018) reported that the overall IA prevalence among adolescents aged 10–18 years in Guangzhou was as high as 26.5%; Xu et al. (2020) found that 32.5 and 19.8% of secondary school students in Macau and mainland China showed IA problems, respectively.

The worrying picture of the IA problem is not limited to its high and growing prevalence, but also related to its comorbidity with a wide range of other developmental issues. Ample findings demonstrated that IA co-exists with multiple adverse developmental outcomes. It was reported that IA and other addictive problems (e.g., gaming or substance addiction) shared common cognitive and behavioral characteristics, such as reward deficiency and impulsivity, changes in brain functions, such as hyperactivity of nucleus accumbens but diminished activity of ventral medial prefrontal cortex (Jorgenson et al., 2016; Cerniglia et al., 2017). In addition, IA was associated with social, emotional, and behavioral maladjustment. For example, In Xu et al.'s (2020) study, students categorized as having IA showed poorer academic performance and relationships with others (e.g., classmates, teachers and family), as well as more severe depressive symptoms and physical health issues. The positive linkage between IA and depression was also reported in many other studies (Kim et al., 2008; Wartberg et al., 2016; Wu et al., 2016). Furthermore, misconduct, such as delinquency characterized by rule-breaking or offenses carrying risks to oneself, others, family, school, and society, has also been found to be associated with IA. For example, Kim et al. (2008) considered delinquent behavior as one factor explaining significant variance in IA among Korean adolescents. Positive associations between IA and delinquent problems were also identified in other places such as China (Guo et al., 2021) and Europe (Evren et al., 2014; Wartberg et al., 2016).

Despite the observation on the association between IA and other maladjustment, the causal effects between these two domains remain inconclusive. On the one hand, the mood enhancement hypothesis (Zillmann, 1991) suggests that the use of Internet depends on the user's mood. When an individual has developmental problems, such as depression and delinquency, he or she is more likely to experience negative feelings and frustrations in the social world. As a result, the individual would prefer interacting with others online rather than off-line as the former is less threatening (Xin et al., 2018). The Internet -mediated virtual world provides a more comfortable and safer environment where the depressed or delinquent adolescents can "meet" and share feelings with others who may have similar experiences. To some extent, Internet is used to relieve negative feelings and escape real-life problems. In such a context, adolescents with developmental adjustment problems may gradually spend more time online, leading to excessive and compulsive use of Internet. In this line of reasoning, most previous studies considered IA a consequence of other developmental problems (Evren et al., 2014; Lam, 2014; Fayazi and Hasani, 2017).

On the other hand, a growing body of literature has also regarded IA as a predictor of negative development (Lam and Peng, 2010; Shek et al., 2018a; Yu and Zhou, 2021). This line of research usually upholds the social displacement hypothesis (Kraut et al., 1998). This framework suggests that the overuse of Internet would compete one's time and energy to engage in face-to-face interactions with friends and family, creating neglect of daily routines, impairment of social skills, isolation from social life, which eventually leads to social and emotional problems such as depression and delinquency (El Asam et al., 2019). In line with this notion, IA was found to negatively influence adolescents' social and emotional skills (Brunborg and Andreas, 2019; Yu and Zhou, 2021). Furthermore, young people's social comparisons through online platforms (e.g., social media) tend to be unrealistic, resulting in feelings of failure and frustration that would create subsequent emotional and behavioral problems (Brunborg and Andreas, 2019).

Although there are theoretical accounts and empirical evidence suggesting the bidirectional relationships between IA and depression and delinquency, only few longitudinal studies have tested this possibility (particularly depression) and the findings are not consistent. For example, van den Eijnden et al. (2008) found no significant cross-lagged predictions between IA and depression in a 6-month longitudinal study. Gámez-Guadix (2014)

only found a reciprocal relationship between depressive symptoms and one specific component of IA (i.e., social problems associated with Internet use) but no such effect was found between depression and other components of IA, such as deficient self-regulation and preference for online interactions. In a more recent study, IA was found to significantly predict adolescents' hopelessness and low satisfaction but no evidence was found for the reverse effects (Yu and Shek, 2018). Nevertheless, another two recent studies identified significant reciprocal predictions between IA and depression among Chinese adolescents (Lau et al., 2018; Tian et al., 2021). While the bidirectional relationship between IA and depression is equivocal, no research to date has ever investigated the reciprocal effects between IA and delinquency. As depression and delinquency are important indicators of adolescent maladjustment in emotional and behavioral domains, respectively, there is a call for more longitudinal studies in this field to test the reciprocal relationships between IA and both depression and delinquency.

The previously mentioned equivocal findings regarding the IA-depression association may be partially attributable to gender effect, which was not examined in those studies showing inconsistent findings. While some studies observed that adolescent boys reported higher levels of IA but a lower level of depression than did adolescent girls (Evren et al., 2014; Ha and Hwang, 2014; Bağatarhan and Siyez, 2020), other studies identified no gender difference in the prevalence of IA (Yu and Zhou, 2021) or depression (Zhu et al., 2021). Similarly, gender differences in the relationship between IA and depression also remain unclear. Liang et al. (2016) identified a significant prediction of depression on subsequent IA only among boys but not among girls. The authors thus argued that boys may be more likely to turn to Internet for mood regulation, while girls may tend to seek help from others in the surrounding environment when they are not happy. However, in another two studies, girls with depressive symptoms were at a higher risk of developing IA than boys with similar problems (Ha and Hwang, 2014; Bağatarhan and Siyez, 2020). The authors also found that most girls used Internet for social networking, whereas boys used it for entertainment (e.g., playing online games). This observation suggests that when girls are faced with emotional difficulties, they are also likely to express unhappy feelings through the Internet.

As for delinquency, while adolescent boys have been found to typically report more delinquent behavior than do adolescent girls (Kofler et al., 2011; Stockdale and Coyne, 2020; Zhu and Shek, 2021a), gender differences in IA-delinquency association remain unknown. Some scholars contended that compared with girls, boys are more likely to act out stresses, difficulties, or unhappy feelings through deviant and rule-breaking behavior such as delinquency (Kofler et al., 2011). In this sense, boys, rather than girls, are more likely to express negative experiences related to IA through delinquent behavior, leading to a stronger IA-delinquency association among boys than among girls. Unfortunately, no research has ever examined this possibility. In view of the current inconclusive findings and the lack of research, it is necessary to investigate gender differences in the bidirectional relationships between IA and maladjustment in different domains.

In response to the call for addressing the above-mentioned issues, we attempted to investigate the possible reciprocal effects between adolescent IA and their emotional (i.e., depression) and behavioral (i.e., delinquency) maladjustment simultaneously in one single study. To do so, cross-lagged panel modeling (CLPM) analyses were carried out to analyze two waves of longitudinal data. In view of the existing literature showing positive linkages between IA and other problem behaviors (Lam, 2014; Liang et al., 2016), we hypothesized positive reciprocal relationships between IA and both delinquency (Hypothesis 1) and depression (Hypothesis 2). We would also explore gender invariance on the expected reciprocal impacts using multi-group comparisons.

Following previous practice (Yu and Shek, 2018; Zhu and Shek, 2021b), we tested four competing models (see **Figure 1**) to check whether the reciprocal effects model would best fit the data. In Model 1, only autoregressions were modeled (i.e., no predictions effects between IA and other problem behavior). Compared with Model 1, prospective effects of IA on depression and delinquency were further specified in Model 2, while prospective effects from depression and delinquency to IA were added in Model 3. The last model (Model 4) further modeled reciprocal longitudinal relationships between IA and depression and delinquency. Based on our hypotheses, we expected that Model 4 would show the best model fit.

MATERIALS AND METHODS

Participants and Procedures

We tested the above hypotheses among junior secondary school students (i.e., early adolescents) who have to face growing developmental challenges in different domains, such as academic stress, peer pressure, conflicts with parents, difficulties in managing emotions, and so on. It is widely agreed that IA and emotional and behavioral maladjustment (e.g., depression

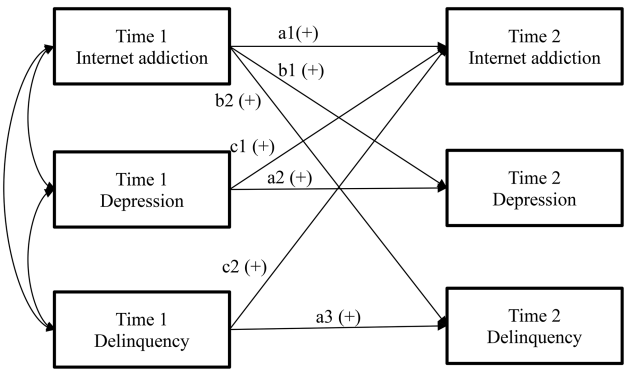

FIGURE 1 | Conceptual models (residuals and covariates are omitted for parsimony). Model 1: No cross-lagged associations (b and c paths are dropped). Model 2: Internet addition effects model (c paths are dropped). Model 3: Depression and Delinquency effects model (b paths are dropped). Model 4: Reciprocal effects model (all paths are included).

and delinquency) are more common in adolescents than in children, and there is a steady increase in IA, depression, and delinquency over time among some early adolescents (Houghton et al., 2018; Shore et al., 2018; Yu and Shek, 2018; Zhu and Shek, 2021a). Thus, it is theoretically and practically (e.g., early intervention) meaningful to address the research gaps regarding the relationship between IA and depression and delinquency among this group of students.

This study used two waves of data collected from junior secondary school students in four schools in mainland China (Shanwei, Zhaoqing, Jiujiang, and Suzhou). In September 2016 (i.e., Time 1), a total of 3,010 Grade 7 and Grade 8 students (age range = 11–15 years; Mean age = 13.16, SD = 0.81; 57.48% adolescent boys) in these schools completed a survey investigating their psychosocial adjustment (e.g., delinquency, depression, and IA). The majority of these respondents (83.26%) reported that they lived in an intact family. Besides, 2,648 students responded to the same survey in 1 year (i.e., Time 2), suggesting a total of 362 dropouts and thus an attrition rate of 12.03%. The retained sample ($N = 2,648$) and the dropouts (N = 362) did not differ in their demographic attributes (age, gender, and family intactness) and baseline IA, delinquency, and depression. Nevertheless, the whole sample (N = 3,010) was used for final data analysis. A 1-year interval between the two assessments is convenient in terms of school administrative operations (i.e., not to disturb the school too frequently), and such "short-term" longitudinal study is not uncommon in the research field (Lam, 2014; Yu and Shek, 2018; Stockdale and Coyne, 2020).

This study obtained ethical approval from the "Human Subjects Ethics Subcommittee" at the authors' institution. Before launching the project, all involved parties, including schools, adolescents, and parents, were well informed about the study objectives, the confidentiality of data collected, voluntary participation, free withdrawal at any time, and anonymous data analyses and dissemination. All parties had given their consent to join the study before data collection.

Measures

Internet Addiction

The Chinese Internet Addiction Test (CIAT) was translated and validated by Shek et al. (2008) based on Kimberly Young's 10-item questionnaire that included 10 typical symptoms of IA (Suler, 2004). Students responded "Yes" or "No" to the 10 questions based on their experience in the past 1 year. The sample questions included "Do you feel preoccupied with the Internet or online services and think about it while off-line?" and "Have you repeatedly made unsuccessful efforts to control, cut back, or stop Internet use?" Participants' IA was indexed by the number of "yes" answers they provided in the CIAT. Thus, the score has a possible range between 0 and 10, with a higher score indicating a higher level of IA symptoms. In this study, we treated CIAT scores as continuous variables because cutoff scores were not validated in Hong Kong. Further, this scale has been frequently used in previous studies to assess adolescents' IA level as a continuous variable (Chi et al., 2016; Shek et al., 2018b; Yu and Shek, 2018; Yu and Zhou, 2021). In this study, Cronbach's αs of the scale (0.78 and 0.80 at Wave 1 and Wave 2, respectively) indicated adequate scale reliability. McDonald's omegas (ω) also indicated adequate reliability.

Depression

The 20-item validated Chinese "Center for Epidemiological Studies-Depression" scale (CES-D) was employed to measure students' depression (Radloff, 1977; Zhu et al., 2021). Among the 20 items, 16 items assessed negative symptoms (e.g., "I felt lonely") and the other four were reversely coded positive items (e.g., "I enjoyed life"). Students indicated the frequency they showed each symptom in the previous week using responses from "0″ ("rarely or less than 1 day") to "3″ ("most or all of the time or 5–7 days"). Although the scale items assessed depressive symptoms from different dimensions (e.g., somatic complaints and negative affect), an overall score (e.g., average score or total score) is commonly used to indicate the level of depression in literature (Lau et al., 2018; Chi et al., 2019; Przepiorka et al., 2019). In our study, an average score was computed for each participant to indicate the level of depression. Cronbach's αs of this scale in the present study were 0.87 and 0.89 at two waves, respectively. McDonald's omegas (ωs) showed similar results.

Delinquency

We measured students' delinquency in terms of how frequently ("0 = never"; "6 = more than 10 times") they had engaged in 12 misconducts (e.g., "cheating," "stealing," "running away from home," and "trespassing") in the past 1 year (Shek and Zhu, 2019). Some of the listed delinquent behaviors, such as "stealing" and "damaging others' properties," are illegal behavior violating the law. However, some behaviors, such as "having sexual intercourse with others" and "running away from home," are minor offenses but still considered adolescent problem behavior in mainland China. The average score across the items was used in the present study. Cronbach's α values of this scale (0.74 and 0.78 in Wave 1 and Wave 2, respectively) suggest adequate scale reliability in the present study. McDonald's omegas (ωs) also suggested adequate reliability of the scale.

Several control variables were also measured in this study. These included age, gender, and non-intact family. These control variables were commonly used in previous studies (Yu and Shek, 2018; Zhu and Shek, 2021b).

Data Analysis

Mplus 8.5 was used to analyze cross-lagged panel models with the "full information maximum likelihood estimation" employed to handle missing values. This method makes use of all available information for each participant, and it has been proved to yield unbiased results in analyzing longitudinal data (Muthén and Muthén, 2018). First, the four competing models shown in **Figure 1** were tested using path analysis and adequate model fit was decided by following indices and criteria proposed by Kline (2015): "Comparative Fit Index" (CFI > 0.95), "Tucker-Lewis Index" (TLI > 0.95), "Root Mean Square Error of Approximation" (RMSEA <0.08), and "Standardized Root Mean Square Residual" (SRMR <0.08). As the four models were

nested models, chi-square difference tests were used to examine which model best fit the data (Schermelleh-Engel et al., 2003). Second, multi-group (boys vs. girls) analyses were conducted based on the best-fitted model to explore adolescent gender effect. Before the above-mentioned formal analyses, we also performed confirmatory factor analyses (CFA) with invariance tests across gender and over time for each key measure (i.e., one-factor structure for IA and delinquency and three-factor structure for depression). Results showed that the measures were invariant across gender and over time (i.e., changes in CFI and RMSEA were less than 0.01), allowing us to use the scale score (e.g., the average or total score) of each measure for boys and girls at the two waves in the path analyses of the cross-lagged panel models. As scale validation is not the focus of the present study, related findings have been reported elsewhere (Zhu and Shek, 2020b; Zhu et al., 2021).

RESULTS

As shown in **Table 1**, IA was positively correlated with depression and delinquency in both cross-sectional and longitudinal levels after Bonferroni correction ($p = 0.05/9 = 0.006$). There were also positive correlations between depression and delinquency among adolescents. These results are in line with our expectations. Besides, three covariates also had significant associations with adolescent IA, depression, and delinquency, except for an insignificant relationship between gender and depression. Specifically, younger adolescents, or girls, or those who live in intact families reported lower levels of IA and delinquency, and younger or those who live in intact families reported lower levels of depression.

Results of model comparisons of the four competing models are presented in **Table 2**. All models demonstrated acceptable model fit. However, Model 2 (with IA effects) and Model 3 (with depression and delinquency effects) yielded a better model fit than did Model 1 (only autoregressions), with $\Delta\chi^2_{(2)} > 32$, $p < 0.001$. As predicted, Model 4 (i.e., reciprocal effects between IA and emotional as well as behavioral problem) better fitted the data than did Model 2 and Model 3, with $\Delta\chi^2_{(2)} > 25$, $p < 0.001$. Thus, in line with our expectation, the reciprocal impacts model showed best model fit ($\chi^2_{(11)} = 56.517$, CFI = 0.986, TLI = 0.959, RMSEA = 0.038, SRMR = 0.020). Regression coefficients suggested positive reciprocal effects between IA and depression as well as between IA and delinquency (β ranged between 0.06 and 0.13, $ps < 0.001$; see **Table 3**, the whole sample). These results support Hypothesis 1 and Hypothesis 2.

Several multi-group tests by gender on the reciprocal effects model (i.e., Model 4) were performed to explore adolescent gender effect. Results are shown in **Table 2**. From Model 4b to Model 4c, one cross-lagged path was constrained to be equal between boys and girls in each comparison model. Compared to the unconstrained model (Model 4a) where all cross-lagged paths were freely estimated, Model 4b (an equality constraint on the cross-lagged path from IA to depression) and Model 4e (an equality constraint on the cross-lagged path from delinquency to IA) did not show significant chi-square differences ($\Delta\chi^2_{(1)} < 3.84$, $p > 0.05$). However, Model 4c (an equality constraint on the cross-lagged path from IA to delinquency) and Model 4d (an equality constraint on the cross-lagged path from IA to delinquency) yielded significant chi-square differences from Model 4a: $\Delta\chi^2_{(1)} = 7.68$ and 6.93 ($ps < 0.01$). As such, the final model (Model 4f) freely estimated predictive effects from IA to delinquency as well as that from depression to IA while constrained the other two paths to be equal across gender.

Regression coefficients of cross-lagged paths in Model 4f are depicted in **Table 3**. Although the positive prospective predictions of IA on delinquency were significant for both boys and girls (boys: $\beta = 0.14$, $p < 0.001$; girls: $\beta = 0.07$, $p < 0.05$), the effect appeared stronger among boys. In addition, the longitudinal effect of depression on IA was significant only among boys (boys: $\beta = 0.10$, $p < 0.001$; girls: $\beta = 0.02$, $p = 0.59$). These results implied that the IA and emotional and behavioral problems had reciprocal effects on each other, and some effects were similar among boys and girls while some showed significant gender differences.

TABLE 1 | Descriptions of variables and correlations among the variables.

S. No.	Variables	Descriptions			Correlations							
		Mean	SD	α/ω	1	2	3	4	5	6	7	8
1.	Age	13.16	0.81		--							
2.	Gender[a]				–0.08***	--						
3.	Family intactness[b]				0.02	0.003	--					
4.	T1 IA	2.31	2.36	0.78/0.78	0.09***	–0.15***	0.09***	--				
5.	T1 DP	1.80	0.49	0.87/0.87	0.08***	0.03	0.07***	0.33***	--			
6.	T1 DE	0.45	0.54	0.74/0.75	0.11***	–0.15***	0.09***	0.38***	0.27***	--		
7.	T2 IA	2.30	2.44	0.80/0.80	0.06**	–0.10***	0.05***	0.46***	0.23***	0.25***	--	
8.	T2 DP	1.79	0.52	0.89/0.89	0.06**	0.04	0.05**	0.24***	0.47***	0.23***	0.35***	--
9.	T2 DE	0.42	0.57	0.78/0.76	0.07***	–0.12***	0.06**	0.27***	0.21***	0.43***	0.32***	0.26***

[a] *1 = male and 2 = female.*

[b] *1 = intact; 2 = non-intact; T1 = Time 1; T2 = Time 2.*

***p < 0.01; ***p < 0.001.*

IA, internet addiction; DP, depression; DE, delinquency.

TABLE 2 | Model fit indexes and comparison for different models of the relationship between internet addiction and depression and delinquency.

Models	χ^2	*df*	CFI	TLI	RMSEA (90% CI)	SRMR	Model comparison	$\Delta\chi^2$	Δdf
Model 1: No cross-lagged effects	153.132	15	0.958	0.908	0.056 (0.048, 0.064)	0.045			
Model 2: Internet addiction effects	82.042	13	0.979	0.947	0.043 (0.034, 0.052)	0.028	M2 vs. M1	71.09***	2
Model 3: Depression and delinquency effects	120.845	13	0.967	0.917	0.053 (0.045, 0.062)	0.037	M3 vs. M1	32.29***	2
Model 4: Reciprocal effects	56.517	11	0.986	0.959	0.038 (0.028, 0.048)	0.020	M4 vs. M1	96.62***	4
							M4 vs. M2	25.53***	2
							M4 vs. M3	64.33***	2
Multi-group (boys vs. girls) tests on the reciprocal model									
Model 4a: Unconstrained model	48.050	16	0.990	0.966	0.037 (0.025, 0.049)	0.022			
Model 4b: Constrain internet addiction → depression	48.827	17	0.990	0.969	0.036 (0.024, 0.048)	0.022	M4b vs. M4a	0.77	1
Model 4c: Constrain internet addiction → delinquency	55.730	17	0.988	0.962	0.039 (0.028, 0.051)	0.024	M4c vs. M4a	7.68**	1
Model 4d: Constrain depression → internet addiction	54.975	17	0.988	0.963	0.039 (0.028, 0.051)	0.023	M4d vs. M4a	6.93**	1
Model 4e: Constrain delinquency → internet addiction	48.156	17	0.990	0.969	0.035 (0.024, 0.047)	0.022	M4e vs. M4a	0.11	1
Model 4f: free internet addiction → delinquency, and depression → internet addiction, constrain other paths (final model)	48.934	18	0.990	0.971	0.034 (0.023, 0.046)	0.022	M4f vs. M4a	0.88	2

**$p < 0.01$; ***$p < 0.001$.

TABLE 3 | Regression weights of paths in the reciprocal model for the whole sample, boys, and girls.

Predictor	Dependent variable	β		
		Whole sample	Boys	Girls
Time 1 Internet addiction	Time 2 Depression	0.10***	0.11***	0.09***
Time 1 Internet addiction	Time 2 Delinquency	0.13***	0.14***	0.07*
Time 1 Depression	Time 2 Internet addiction	0.06**	0.10***	0.02
Time 1 Delinquency	Time 2 Internet addiction	0.06**	0.06**	0.05**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

DISCUSSION

The present study investigated cross-lagged effects between Internet addiction (IA) and emotional and behavioral problems (depression and delinquency) over 2 years among Chinese adolescents. The results reveal that baseline IA measured at Time 1 significantly and positively predicted depression and delinquency in 1 year (i.e., at Time 2). Meanwhile, higher levels of depression and delinquency at Time 1 also significantly predicted a higher level of IA at Time 2. These results indicate that the associations between IA and depression and delinquency were bidirectional, echoing previous findings which suggested that pathological use of Internet can be caused by emotional and behavioral maladjustment in adolescence (Cerruti et al., 2017; Bağatarhan and Siyez, 2020) and also further worsen these problems (Yu and Shek, 2018; Chi et al., 2019). While most previous studies focused on one of the two predictions, especially the association between IA and depression (Lam, 2014), our study investigated the two aspects simultaneously and included delinquency as well, thus providing additional and comprehensive evidence for the dynamic relationship between IA and other developmental issues.

In line with previous findings, our results suggest that some adolescents are more vulnerable to the development of IA than others, including those having other emotional and behavioral symptoms (Cerniglia et al., 2017; Chung et al., 2019). It has been found that adolescents with depression and/or delinquency would suffer from increased negative experiences and painful feelings in personal and social life, such as loneliness, hopelessness, poor academic performance, conflicts with parents, and parent–child relationships (Kofler et al., 2011; Cerniglia et al., 2017; Zhang et al., 2018). As a result, Internet surfing may serve as a dissociative strategy to cope with the distress and frustrations (Davis, 2001; Cerniglia et al., 2017), as adolescents can share feelings with others in a virtual world and get recognition and responses as well. This may allow the adolescents feel accompanied and satisfied, which they are not able to have in the real world due to insufficient effective social connections (Yao and Zhong, 2014). Thus, adolescents with developmental problems tend to spend more time on the Internet, using a seemingly adaptive "self-soothing" for resolution of problems they are facing and relief of associated negative feelings. Obviously, future studies should further explore whether coping mechanisms would mediate the impact of negative emotions on IA.

Despite the possibility that Internet may benefit depressed and delinquent adolescents to some extent (such as providing peer support and a sense of achievement), the cross-lagged effects from IA to depression and delinquency were also significant in the current study, with relatively larger coefficients

than the reverse effects. These findings indicate that overuse of the Internet could worsen developmental problems even to a larger extent. This echoes the previous observations that IA among adolescents acts as a precursor of low well-being, poor self-esteem, and loneliness rather than an outcome (Yao and Zhong, 2014; Yu and Shek, 2018). One interpretation is that addictive behavior, including IA, is associated with significant structural changes in brain regions involving in cognitive control and reward processing (Jorgenson et al., 2016). Such changes further result in impairments in adolescents' emotional and behavioral capacity, leading to ineffective coping and developmental problems (Fayazi and Hasani, 2017; Yu and Zhou, 2021). Meanwhile, excessive Internet usage inevitably reduces face-to-face interactions with parents and peers, which may impair relationships with peers and family members and reduce social support (Wang et al., 2018; Xin et al., 2018), all of which in turn damper adolescent healthy development but lead to maladjustment in multiple aspects (Wang et al., 2018; Shek and Zhu, 2019; Zhu and Shek, 2021a).

While the overall bidirectional relationships between IA and depression and delinquency are supported in the present study, some previous findings failed to identify cross-lagged effects between IA and depression (Yao and Zhong, 2014) or only supported one direction causality (Yu and Shek, 2018). We argued that such inconsistent findings may partially be attributed to gender differences that were not examined in the previous studies. The present study found that boys reported higher levels of delinquency and IA than did girls, while gender was not significantly related to depression level. Besides, baseline depression significantly predicted subsequent IA in 1 year only among boys but not among girls, which is in line with Liang et al.'s (2016) observation. These findings suggest that the relationship between adolescent IA and depression is dependent on gender. In particular, male adolescents are more prone to turn to Internet (e.g., playing online games) to alter or escape negative feelings associated with depression. It is possible that compared with girls, boys are less inclined to seek social support and use effective emotional regulation strategies and they are more likely to suppress or avoid emotional expression (Gross and John, 2003; Nolen-Hoeksema, 2012). This is particularly the case in Chinese contexts where boys are socialized to be tough and emotionally suppressive while girls are encouraged to be more sensitive (Yeh et al., 2017).

The reciprocal relationship between IA and delinquency did not vary across gender, although the effect of IA on delinquency appeared to be stronger among boys. These observations are not consistent with Liang et al.'s (2016) study, which found that IA significantly predicted future depression only among girls. The authors argued that compared with boys, girls with IA are more likely to reduce off-line social contact and suffer from social isolation, which often leads to depression. However, in our study, boys were more likely to show negative consequences of IA, especially behavioral problems. There are several explanations for this observation. First, it may be due to relatively higher levels of IA among boys. Second, it might be related to different ways in which the Internet is used by boys and girls. Previous studies found that compared with girls who usually use Internet to search and exchange information, boys use Internet more for pleasure through multiple online activities such as playing online games (Jones et al., 2009; Liang et al., 2016). It can be argued that the unique behavioral pattern underlying IA among boys may be more closely related to poor self-regulation and cognitive impulsivity, which eventually elevates the likelihood of delinquency. Nevertheless, the exact mechanisms underlying the present gender differences warrant further investigation in the future.

The present findings suggest that scholars, educators, youth workers, and parents need to pay attention to adolescents' emotional and behavioral issues when designing prevention and intervention programs to deal with excessive use of Internet. At the same time, regulating adolescent children's online activities may be a way to help prevent depression and delinquency. However, it is noteworthy that the values of regression coefficients between IA and delinquency and depression were not large, which suggests that IA can explain only a small proportion of variance in depression and delinquency and vice versa. Similar observations have been reported in previous studies (Liang et al., 2016; Tian et al., 2021). It is noted that the cross-lagged model is a conservative analytic tool that controls the effects of autoregression (i.e., the stability of key constructs) and covariates (age, gender, and family intactness in this study). Thus, the lagged path coefficients in cross-lagged models are normally not high (Adachi and Willoughby, 2015; Wu et al., 2020; Zhou et al., 2020). Researchers recommended that the so-called "small" effect in the longitudinal study should not be treated as "trivial" but actually "meaningful" (Adachi and Willoughby, 2015, p. 116).

Nevertheless, it can be argued that IA, depression, and delinquency are complex developmental disorders shaped by multiple ecological factors and causal pathways. For example, these developmental problems may be affected by individual (e.g., positive youth development attributes) and contextual factors (e.g., parenting and family functioning) simultaneously (Shek et al., 2018b; Zhou et al., 2020; Zhu and Shek, 2021a,b; Dou and Shek, 2021), which may lead to the associations among IA, depression, and delinquency. In this case, effective prevention and intervention youth programs may need to focus more on promoting adolescents' competence and skills in a holistic manner instead of only targeting at eliminating one specific disorder, including IA (Shek et al., 2018a, 2020; Chung et al., 2019; Shek, 2019). Evidence in positive youth development research field strongly suggests that strengthening protective factors on both intrapersonal (e.g., emotional competence) and interpersonal (e.g., social skills) levels is a promising way to prevent and curb adolescent developmental problems, including depression, delinquency, and IA (Ciocanel et al., 2017; Taylor et al., 2017; Zhu and Shek, 2020a).

Although the reciprocal associations between IA and depression and delinquency and the gender differences elucidated in the present study have valuable theoretical and practical implications, the findings should be interpreted in light of several limitations. First, only two waves of data were collected for each variable, which makes it impossible

to test whether the reciprocal associations would change over time. Obviously, there is a need to collect more waves of data over a longer time span in the future. Second, with two waves of data, we employed traditional CLPM, which could have poor performance when there is correlated trait variance in the constructs under investigation (Hamaker et al., 2015). Thus, random-intercepts CLPM (RI-CLPM) is recommended to partial out any between-person differences and ensure that the cross-lagged effects reliably reflect within-person fluctuations (Mulder and Hamaker, 2021). Therefore, in future studies, RI-CLPM should be used with at least three waves of data to further clarify the reciprocal relationships between IA and other emotional and behavioral problems. Third, this study did not examine why there are gender differences in the associations between IA and other developmental issues. Future research will benefit from including additional variables that may help explain the identified gender effect. Fourth, given that the participants in this study were recruited from four cities located in East, South, and Central China, the current findings may not be generalized to all Chinese adolescents. Future research could further involve Chinese adolescents living in other regions, such as North and West China, Hong Kong, and Macau. Fifth, because of administrative convenience for each participating school, we collected data at the beginning of a new semester, when adolescents may face increasing adaptation challenges and thus might report high levels of emotional and behavioral maladjustment. Although no such adverse effect was reported by the schools, future research could consider collecting data at a different time point (e.g., at the end of a semester).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Subjects Ethics Subcommittee at The Hong Kong Polytechnic University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

XZ contributed to the design of the project, data collection, and data interpretation of the work, drafted the work, and revised it based on the critical comments provided by DS. DS conceived the project, obtained the funding, and edited the manuscript. CC drafted the work. All authors contributed to the article and approved the submitted version.

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Exploration of Psychological Mechanism of Smartphone Addiction Among International Students of China by Selecting the Framework of the I-PACE Model

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The I-PACE (interaction of person-affect-cognition-execution) model explains that the causes of addiction are the result of individual susceptibility (genetic and personality), psychopathological factors (negative emotions), and cognitive and affective factor interaction. The issue of smartphone addiction and its emerging effects are now becoming an essential social enigma. This study is aimed at exploring how personal, affective, cognitive, and execution factors accelerate the mechanism of smartphone addiction among international students. Randomly selected, six hundred international students have constituted the population for our study. All participants were asked to complete self-administered questionnaires. The questionnaire included demographics (gender, place of stay, educational level, and reason for smartphone usage), Mobile Phone Addiction Index, Loneliness Scale (UCLA), Rosenberg Self-Esteem Scale, Beck Depression Inventory, Perceived Stress Scale, Eysenck Personality Questionnaire, and Simplified Coping Style Questionnaire. Statistical analysis was performed using SPSS. 20.3% (n = 122) of international students are agonized with smartphone addiction, while 79.7% (n = 478) use smartphones at an average level. Students' place of stay, neuroticism personality, social desirability, self-esteem, loneliness, depression, perceived stress, and passive coping are associated with smartphone addiction. Loneliness and depression show a strong positive significant correlation, among other variables while loneliness, neurotic personality, depression, low self-esteem, stress, and passive coping are risk factors for smartphone addiction. This study reveals that international students are a high-risk group for smartphone addiction. It has a great deal of impact on students' behavior and psyche. Multiple social, psychological, affective, and cognitive factors affect smartphone addiction. It would be beneficial to direct the students to limit their phone usage and indulge in other healthy physical activities to complete academic goals.

Keywords: I-PACE model, international student, smartphone addiction, lonelineness, stress

INTRODUCTION

A smartphone is the groundbreaking technology of our time. A smartphone is a portable device with ever-increasing advanced features, including a portable computer system, recording and relaying devices, and enhanced memory. These characteristics make the use and ownership of smartphones a common social phenomenon (Smartphone, 2016). According to an international analysis report (2011), smartphones' penetration rate among adults aged 21–30 in China was 68.4%, increasing with each passing year (Xinhua Net, 2011). As per the New York Times (2017), adults and teenagers check their smartphones 150 times a day, or after every 6 min (Kiran et al., 2019). The latest Filipino survey found that the prevalence of smartphone addiction was as high as 60% in the adult population (Buctot et al., 2020). There is no doubt that smartphones bring convenience and positive results. On the other hand, it has been observed that, especially among the young population, its excessive use is causing addiction at an alarming rate. The issue of smartphone addiction and its' emerging effects are now becoming an essential social conundrum.

Furthermore, Smartphone addiction, a kind of behavioral addiction, refers to the uncontrollable overuse of smartphones, and preoccupation with it leads to obsession. It may be due to tackling problems in real life, concealment of the actual use from friends and family, or abating the withdrawal symptoms. The addiction prompts continuing usage even after knowing adverse corollaries. Smartphone addiction is also distinguished as a disorder of smartphone usage or smartphone dependence (Billieux, 2012; Billieux et al., 2015).

College students experience high levels of stress which may be due to the frequency of exams, long and tedious academic coursework, and concern about the future (Gazzaz et al., 2018). When confronting with these stresses, students are more likely to turn to their smartphones for stress relief. College students also use more smartphones because of extra leisure time and less parental control. Due to smartphones' frequent use, Students might become addicted to the virtual world and disengaged from real life, affecting their physical and mental health (Schwebel et al., 2012). A Chinese survey (2016) has found that 21.3% of college students have smartphone addiction (Long et al., 2016). In addition, a survey report from South Korea (2013) reported that 25.5% of college students were at risk of smartphone dependence (Jun, 2015). Therefore, smartphone addiction among students had already aroused widespread attention.

Regarding international students, Smartphones are invaluable for connecting with family and friends. International students become more vulnerable to smartphone addiction due to loneliness, cultural adaptation, and adjustment stress (Yeh and Inose, 2003; Lee and Rice, 2007; Poyrazli and Lopez, 2007; Wang, 2009; Poyrazli, 2014). As international students spend their time in a new culture far away from their families and hometown. They experience boredom, loneliness, stress, and anxiety about their family's health. As a way of coping, they often use smartphones. Smartphone usage can alleviate their stress and worries, as well as academic burden, admiration, breakup, and so on (Lin et al., 2015).

However, smartphone addiction is likely to create a series of health problems such as distorted vision, neck stiffness, wrist or back pain (Kim and Kang, 2013; Lee et al., 2015) psychological troubles (Demirci et al., 2015) sleep disorders, interpersonal conflicts, academic failure, and other issues (Lam et al., 2009; Mok et al., 2014). Kim et al. (2015) investigated that smartphone addicts are most likely to have health-related issues, such as physical complaints (headache, dry eyes, and carpal tunnel syndrome) and psychological problems (fear, depression, sadness, and anxiety) (Küçer, 2008; Lee and Seo, 2014). A range of studies conducted on personality factors affecting smartphone overuse had concluded that self-esteem acts as a mediator (Wang et al., 2017) while neuroticism and extraversion personalities, and self-control play an intermediary role in Smartphone addiction (Cho et al., 2017). Also, some exploratory surveys have shown that depression and loneliness are factors leading to smartphone addiction (Mok et al., 2014; Demirci et al., 2015). Similarly, HyunChul Youn and his co-workers have confirmed that levels of depression are positively correlated with smartphone addiction (Choi et al., 2015). Stress is the risk factor of addictive behavior and cause of addiction recurrence (Sinha, 2008; Lam et al., 2009). Numerous explorations have discovered that there is a positive correlation between using smartphones and stress (Harwood et al., 2014), while various epidemiological researches have also reconnoitered the impact of coping styles on smartphone addiction. Cheng et al. pointed out that the lack of positive coping strategies led to smartphones' excessive use (Cheng et al., 2015), and Tang et al. (2014) alleged that a negative coping style was significantly associated with the risk of smartphone addiction.

The formation and maintenance process of psychological mechanisms of smartphone addiction is still unclear. In 2014, Brand proposed the I-PACE (interaction of person-affect-cognition-execution) model; he believed that the causes of addiction were the result of individual susceptibility (genetic and personality), psychopathological factors (negative emotions), cognitive and affective factors interaction (Brand et al., 2014). This model was latterly used to study gambling addiction and Internet addiction (Dong et al., 2019; Ioannidis et al., 2019). I-PACE model is adopted because this theoretical model has the goal to summarize the main processes underlying both the development and the maintenance of smartphone addiction (Brand et al., 2016). This model also provides a theoretical basis for addictive behaviors and clinical practice (Brand, 2017).

The significance of our study let off from the fact that the number of smartphone users is seriously escalating which means that more and more individuals are expected to become smartphone addicts. Therefore, We attempt to hit this growing field of interest and expect to provide researchers with a theoretical framework on smartphone addiction. Another expected contribution of our study is the detection of the frequency of smartphone addiction among international students. This may provide awareness for rational use of the smartphone for both physical and mental health. We also hope to illuminate psychological therapy and counseling by edifying the characteristics of smartphone addicts and the relationship between smartphone addiction and several variables.

Based on the I-PACE model, the study aims to analyze the problems of smartphone addiction from multiple aspects. I-PACE model is elected to explain the personal (personality and self-esteem), affective (loneliness and depression), cognitive (stress perception), and execution (coping style) factors interaction in smartphone addiction. International students are selected as China is the world's leading country and offers a research-oriented forum for international students worldwide (Ye, 2006; Zhang and Zhou, 2010; Henze and Zhu, 2012) and to learn about various cultures, psychosocial development, and multicultural competence. And there are only a few pieces of research on this ever-expanding population of international students. The research outcome will elucidate the psychological mechanism of the development and maintenance of smartphone addiction among international students in China. Moreover, will also provide a theoretical basis for the prevention and intervention of smartphone addiction among college students. This is the first study to explore the psychological mechanism of smartphone addiction based on the I-PACE model and targeted international students of Harbin, China The purpose of the present research is to explore the current status of smartphone addiction among college students based on different demographic characteristics, investigate the relationship between various components of I-PACE model and smartphone addiction, examine the effect of personality, biological psychology, psychopathology, and social cognition on smartphone addiction and to identify the risk factors of smartphone addiction.

MATERIALS AND METHODS

Participants

This observational population study adopted cluster sampling to recruit international students with bachelor's, master and doctoral programs living in Harbin, China. The participants who met the conditions for inclusion in this study were international students living only in Harbin, China, and participated voluntarily. Exclusion criteria include living outside Harbin, under the age of 18, voluntary problems, and jobholders. The study included 700 students, of which 100 chose to withdraw due to the exclusion criteria, so 600 students finally constituted the study sample. The average age of the participants was 23.63 years (SD = 3.862), with a range of 18–38 years. A total of 59.5% (n = 357) of the study population were male and 40.5% (n = 243) were female.

Procedure

The data collection period was from August 2019 to December 2019. The well-trained graduate students sent complete questionnaires and an instruction package to different universities in Harbin, China. It was requested to give 25 to 30 min after class to complete the questionnaire package. Before participation, informed consent was distributed among all participants. Participants were informed that they were not obliged to participate; all responses were anonymous and they were free to refuse to answer any questions. Questionnaires were collected immediately after completion and checked to ensure quality and avoid errors. All records were kept in a locked computer and under strict supervision.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Ethical Approval

Before data collection, ethical approval was obtained from the Institutional Review Board of the School of Public Health, Harbin Medical University. Before collecting data, participants were informed about the research and their role in participation.

Psychological Measures

A questionnaire package designed to obtain sociodemographic information (gender, place of stay, educational level, and reason for smartphone usage) was given to the participants. Furthermore, the participants were requested to complete the Mobile Phone Addiction Index, Loneliness Scale (UCLA), Rosenberg Self-Esteem Scale, Beck Depression Inventory, Perceived Stress Scale, Eysenck Personality, and Simplified Coping Style questionnaires. All questionnaires were in the self-report format.

Mobile Phone Addiction

Louis Leung of Hong Kong University developed Mobile Phone Addiction Index (Leung, 2008). This scale consists of 17 items that measure four dimensions of smartphone addiction: inability to control cravings (seven items), anxiety and feeling lost (four items), withdrawal and escape (three items), and productivity loss (three items). Participants answered these items on a 5-point scale (ranging from 1 = never to 5 = always). MPAI has good validity and reliability and is widely used in the diagnosis of smartphone addiction. The higher the score, the higher was smartphone addiction. In our research, the measure showed good reliability (Cronbach's $\alpha = 0.86$).

Personality

Personality was assessed using the Eysenck Personality Questionnaire (EPQ; Eysenck and Eysenck, 1975). The original English version contains 90 items; however, the Chinese version has 88 items because some unnecessary elements have been eliminated. The EPQ questions elicit dichotomous responses (e.g., "Do you have a lot of different hobbies?"). Expert translators translated the Chinese version of EPQ into the English language and used it to collect international data. EPQ measured individuals' personalities across four dimensions: neuroticism/anxiety, psychoticism, extroversion, and social desirability (a lie scale). The measure presented good reliability in our study (Cronbach's α is 0.89, 0.79, 0.81, and 0.82 for neuroticism/anxiety, psychoticism, extroversion, and social desirability, respectively).

Self-Esteem

The Rosenberg Self-Esteem Scale evaluated the respondent's judgment of his or her self-worth (e.g., "On the whole, I am satisfied with myself") (Rosenberg, 2015). This scale consists

of 10 items. The participants rated each item on a 4-point scale ranging from strongly disagree to strongly agree, with higher scores indicating a higher level of self-esteem. In the current study, the measure showed good reliability (Cronbach's $\alpha = 0.96$).

Loneliness

A short form of the UCLA Loneliness Scale developed by Russell (1996) was used to access loneliness Respondents were asked to express how they feel about eight statements using a 4-point Likert-type scale, ranging from 0 = never to 3 = always (e.g., "How often do you feel unhappy doing so many things alone?"). The greater the score, the higher would be the loneliness. The measure exhibited good reliability in our survey (Cronbach's $\alpha = 0.81$).

Depression

The Beck Depression Inventory consists of 21 items to assess the severity of depression (Beck et al., 1961). Each question uses a 4-point scale to ask about the specific symptoms of the recent feelings (e.g., "sadness, hopelessness"). The total score indicated the degree of depression. In the current study, the measure showed good reliability (Cronbach's $\alpha = 0.86$).

Stress Perception

The Perceived Stress Scale consists of 14 items to evaluate stress perception (e.g., "Feeling nervous and stress?") (Cohen et al., 1983). The participants rated each item on a 5-point Likert scale ranging from 1 = never to 5 = very much, with higher scores indicating a higher level of perceived stress. In the current study, the measure showed good reliability (Cronbach's $\alpha = 0.94$).

Coping Strategies

Coping style was measured by Simplified Coping Style Questionnaire (SCSQ; Xiao and Xu, 1996). It consists of 20 items, and respondents responded on a four-point Likert scale rated from 0 (never) to 3 (always) (e.g., "Let the pressure off through work or study and activities"). It measured both active coping and passive coping styles. Positive coping style consisted of prosocial approach behaviors that focused on the stressor itself which included 12 items. The negative coping style consisted of some avoidant behaviors that were not focused on the negative events which included eight items. For the current study, the measures showed good reliability (Cronbach's α is 0.88 and 0.84 for positive and negative coping styles, respectively).

Statistical Analysis

Statistical analysis was performed using SPSS 22.0. Both smartphone addicts and non-addicts were included in our study. Demographic data including age, gender, place of stay, educational level, and smartphone usage reasons were recorded as numbers and percentages. The proportion of missing data was less than 1%, which was handled through mean imputation. A chi-square test was used to compare smartphone addiction in different demographic variables, and correlation analysis was used to measure the strength of the relationship between variables (Prematunga, 2012; McHugh, 2013). Bivariate logistic regression was used to analyze the risk factors of smartphone addiction (Denis, 2018).

RESULTS

Sociodemographic Data of Participants

The present study comprised 600 international students from Harbin, China. The incidence of smartphone addiction was 59 and 41% in male and female students, respectively. Out of these participants, 6.3% lived with parents/family, 83.7% alone in the dormitory, and 10% alone in a rented apartment. 61.7% ($n = 370$) of the participants were bachelor students, 20.3% ($n = 122$) were studying master courses and 18% ($n = 108$) were Ph.D. students. 26.0% of the subjects used smartphone for social media, 18.2% for calls, 49.3% for internet, 0.3% for mail, 0.2% for short message services, 0.8% for playing games, 0.7% for making videos/pictures and 4.5% used smartphone for other purposes (**Table 1**).

Prevalence of Mobile Phone Addiction

20.3% ($n = 122$) of international students was smartphone addicts while 79.7% ($n = 478$) used smartphone at normal level.

Comparison Between Demographic Variables and Smartphone Addiction

Table 1 explains the comparison between demographic variables and smartphone addiction. Students' place of stay ($\chi 2 = 13.51$, $p = 0.036$) had a significant positive impact on smartphone addiction while gender and level of education had no significant correlation for smartphone addiction.

Strength of the Relationship Between Smart Phone Addiction and Components of I-PACE Model

Personality components (extrovert personality, psychoticism personality, lying personality, and self-esteem) were negatively correlated with smartphone addiction, while active coping revealed no significant correlation for smartphone addiction. In contrast, neuroticism personality, affective (loneliness and depression), cognitive (perceived stress), and executive (passive coping style) components of the I-PACE model had a significant positive correlation with smartphone addiction. Loneliness

TABLE 1 | Smartphone addiction based on demographics.

Demographic variables	Smartphone addicts *n* (%)	Smartphone non-addicts *n* (%)	$\chi 2$	*P*-value
Gender				
Female	50 (41%)	193 (40.3%)	0.204	0.903
Male	72 (59%)	285 (59.7%)		
Place of stay				
With parents/family	11 (9%)	27 (5.6%)	13.151	0.011
Alone in dormitory	100 (82%)	402 (84.2%)		
Alone in apartment	11 (9%)	49 (10.2%)		
Educational level				
Bachelor	82 (67.2%)	288 (60.3%)	3.712	0.446
Masters	22 (18%)	100 (20.9%)		
Ph.D.	18 (14.8%)	90 (18.8%)		

and depression presented a strong positive relationship with smartphone addiction, among other variables (**Table 2**).

Predicting Smartphone Addiction

Based on a bivariate logistic model, the possibility of smartphone addiction was significantly higher in those international students who have loneliness, neurotic personality, stress, depression, low self-esteem, and passive coping style (**Table 3**).

DISCUSSION

China has become the topmost destination for international students, but little is known about this escalating and diversified community of higher education in China. Compared with the smartphone addiction rate of different populations in various countries, the risk of smartphone addiction among international students in China is higher (Jiang et al., 2018). The present study interposes empirical evidence relating to the psychological mechanism of development and maintenance of smartphone addiction in the light of the I-PACE model. The I-PACE model includes pre-disposing variables, affective and cognitive responses to internal or external stimuli, executive and inhibitory control, and decision-making behavior, resulting in the practice of specific internet applications (Brand et al., 2016). With an increasing interest in the I-PACE model, to our knowledge, no study to date has yet assessed I-PACE-based smartphone addiction among international students of various cultural origins in a collectivistic culture or else attempted to integrate all the components of the I-PACE model in single research about smartphone addiction.

The current study illustrated that the prevalence rate of smartphone addiction in international students was 20.3%. Similarly, a Chinese study (2018) revealed that international students in China are at high risk for severe loneliness and smartphone addiction, more than 5% of the participants reported intense loneliness, and more than half of the participants exhibited smartphone addiction symptoms (Jiang et al., 2018). Moreover, we found no significant association between smartphone addiction and gender, but the number of smartphone addicts was higher among males (59%) than females (41%). Similar findings were reported by Devís-Devís et al. (2009). In contrast, some researchers have reported that female participants have more prevalence of smartphone addiction than males (Tavakolizadeh et al., 2014; Demirci et al., 2015; De-Sola Gutiérrez et al., 2016). However, some studies observed no significant difference between females and males regarding smartphone addiction (Yen et al., 2009; Dixit et al., 2010; Ahmed and Qazi, 2011). A large number of male participants in our study could explain why a high proportion of males were addicted. Furthermore, additional studies still need to unravel the inconsistent prevalence of smartphone addiction in males and females.

There was no significant association between education and smartphone addiction, but smartphone addiction varied by education. Specifically, we found that users displayed the highest smartphone addiction levels with the lowest educational attainment. Our results are consistent with the evidence suggesting that adolescents seem to be more addicted to smartphones than other age groups (Selian and Srivastava, 2004; Bianchi and Phillips, 2005; Assabawy, 2006; Wajcman et al., 2007; Attamimi, 2011; Ishii, 2011; Divan et al., 2012; Goundar, 2012; Samaha and Hawi, 2016). It's not entirely clear why smartphone users with relatively low education levels are more addicted; Maybe these adolescents have poor self-regulation ability to compulsive use of smartphones. Our research also found that students living in dormitories were more addicted to smartphones than students living with their families. Considering previous researches on the theme, Moore and Schultz's study (1983) yields a similar result (Moore and Schultz, 1983). The logic behind the scenes may be students who were alone and stay away from home use more smartphones to keep themselves busy and overwhelm loneliness.

Almost half of the participants in the research group stated the main reason for using smartphones was internet surfing. Our results are consistent with a previous survey conducted by Toda et al. (2004) which found that messaging and connecting to the internet were the most common causes of using smartphones (Toda et al., 2004). Furthermore, Roberts et al. (2014) also reclaimed that females use smartphones for messaging and social

TABLE 2 | Pearson correlation matrix for observed variables.

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Smartphone addiction	–										
2. Extrovert personality	−0.018**	–									
3. Neuroticism personality	0.214**	0.385**	_								
4.psychotics personality	−0.017**	0.236**	0.339**	–							
5. Lying personality	−0.013**	−0.073**	−0.185**	−0.057	–						
6. Self-esteem	−0.151**	0.003**	−0.011	0.089**	0.081**	–					
7. Loneliness	0.327**	−0.10**	−0.166**	−0.225**	−0.021	−0.081**	–				
8.Depression	0.368**	−0.12**	−0.143**	−0.135**	−0.005	−0.213	0.382**	–			
9. Perceived stress	0.113**	−0.115**	−0.233**	−0.257**	0.042	−0.039	0.323**	0.297**	–		
10. Active coping	−0.063	−0.052	−0.106**	−0.061**	0.004	−0.067**	0.140**	0.169**	−0.006	–	
11. Passive coping	0.107**	0.025	−0.009	0.037	0.02	−0.095**	−0.071	0.008	−0.088**	0.036	–

***Correlation is significant at the 0.05 level.*

TABLE 3 | Risk factors for development and maintenance of smartphone addiction.

Variables	*B*	SE	*P*-value	Exp (*B*)	LC	UC
Intercept	0.960	1.223	0.433			
Extrovert personality	0.051	0.047	0.275	1.053	0.960	1.154
Neuroticism personality	0.049	0.040	0.031	1.050	0.971	1.136
Psychoticism personality	−0.068	0.053	0.198	1.071	0.965	1.188
Lying personality	−0.072	0.051	0.052	1.074	0.972	1.187
Self-esteem	−0.065	0.183	0.015	0.937	0.654	1.343
Loneliness	0.141	0.033	0.001	0.869	0.814	0.927
Depression	0.193	0.106	0.005	0.825	0.670	1.015
Perceived stress	0.001	0.020	0.043	0.999	0.960	1.039
Active coping	−0.022	0.028	0.426	1.022	0.968	1.079
Passive coping	0.048	0.018	0.007	0.953	0.920	0.987

networks (Nazir, 2017). Similarly, Albiar and his co-workers (2012) explored that for males, smartphone use is simultaneously based on text messages, voice conversations, and surfing internet applications (Billieux et al., 2008; Albiar et al., 2012). In our study, self-esteem was negatively correlated with smartphone addiction. This finding is congruent with the cognitive-behavioral model of pathological usage of the Internet, which indicates that people with maladaptive cognitions such as low self-esteem are inclined to get addicted to the internet (Davis, 2001). Our results are braced by some empirical studies, which show that low self-esteem can predict smartphone addiction (Walsh et al., 2011; Hong et al., 2012; Park and Kim, 2015).

According to our research, smartphone addiction has a significant positive relationship with neuroticism and a significant negative correlation with psychoticism, extroversion, and social desirability (Lie personality). Likewise, a study conducted on Chinese adolescents reported that those who were addicted to the internet scored higher on the neuroticism and psychoticism dimensions of personality while scoring lower on the Lie dimension (Cao and Su, 2007). Furthermore, another survey verified that typical internet addicts exhibit anxiousness (neuroticism) and social contact problems (Van Rooij et al., 2010). Eysenck and Eysenck (1975) findings also support our study, that is, people who scored high on the Lie scale tend to score low on psychoticism and extraversion. Highly neurotic people are often afraid, sad, embarrassed, nervous, stressed, and anxious (McElroy et al., 2007; Devaraj et al., 2008), they use more smartphones to overwhelm stress and keep themselves busy. Moreover, Montag et al. (2010) found a significant negative correlation between internet addiction and the Lie dimension.

Affective components (Loneliness and Depression) of the I-PACE model have a strong positive correlation with smartphone addiction, among other components. Our verdicts resonate well with prior results from multiple studies that looked at the relationship between affective psychological traits (Depression and loneliness) and smartphone addiction. Association between smartphone addiction and depression in this study corresponds to another study among university students in Turkey by Orsal et al. (2013) who reported an alarming association between phone addiction and depression. Smartphone addiction was detected to increase as the severity of depression increased among the students (Chen and Katz, 2009; Thomée et al., 2011; Harwood et al., 2014). The link between Depression and smartphone addiction may not just be established among university students, but it may apply to the general adult population. Due to a sense of disconnection from both the host and their native countries, international students have to deal with and endure a certain level of loneliness; due to this, they become smartphone-addicted (Wei et al., 2005; Janta et al., 2014; Matar Boumosleh and Jaalouk, 2017). In a study of Chinese university students, loneliness was positively associated with depression, which emerged as the most potent independent trigger of smartphone addiction (Bian and Leung, 2015). Similarly, in a Turkish university student survey, loneliness demonstrated a significant positive association with smartphone addiction. It appeared as an independent indicator of the cyberspace-oriented relationship score (Enez Darcin et al., 2016).

In addressing the significant positive relationship between smartphone addiction and perceived stress, outcomes were consistent with the opinion of Beranuy et al. (2009) who believed that using a smartphone in a situation of stress can be looked upon as a form of substitute gratification or as a kind of addiction (Beranuy et al., 2009). The more stress students perceive, the more likely they are to become addicted to the smartphone. This is consistent with the general strain theory which holds that all kinds of strain or stress experienced by individuals will lead to negative emotions and then lead to problem behavior (Jun and Choi, 2015). Many studies have shown that stress is an important risk factor for individual addictive behavior (Mai et al., 2012; Wang et al., 2021). The influence of perceived stress on smartphone addiction has begun to gain empirical support (Chiu, 2014; Yang et al., 2020). Correspondingly, researchers also linked smartphone usage as a way of coping with stress and contentment with life (Lepp et al., 2014, 2015). So, the perceived stress has positive predictive power for smartphone addiction (Chiu, 2014).

Based on a bivariate logistic model, the possibility of having smartphone addiction symptoms was significantly higher in those international students who had a neurotic personality, low self-esteem, loneliness, depression, stress, and passive coping style. Passive coping was positively linked with smartphone addiction, while active coping was negatively related. The reason behind this may be that those who are more vulnerable to stress have passive coping strategies and use more smartphones to overcome stress (Brand, 2017). Likewise, previous surveys have shown a moderate positive association between negative coping style and smartphone addiction in students (Zhao et al., 2017) and a moderate negative association between active coping style and smartphone addiction (Li et al., 2016; Yang et al., 2017). Results were also consistent with previous findings, suggesting that emotion-focused or negative coping style is a significant predictor of internet addiction (Sugiarta and Dewi, 2021).

Overall results supported the I-PACE model that specific personal characteristics (low self-esteem, neuroticism, and social desirability), affective (loneliness and depression), cognitive (perceived stress), executive (passive coping style) components resulted in adverse emotional reactions through the perception

of the situation and lead to certain addictive tendencies (Brand et al., 2016).

Using a smartphone can take people away from the social world to the world of fantasy. While the smartphone provides an excellent opportunity to socialize on the surface, they fetch people into a large virtual world. Students' communities, whose emotional and cognitive development has not yet been completed, are heading away from the real world and constructing a virtual world for themselves. Moreover, with the extent of their absorption into the charisma of this virtual world, they move away from their families and friends and become more depressed. Also, within the virtual world of smartphones, In addition, they become depressed and expectant in the virtual world of smartphones. They express their thoughts and feelings in a few words superficially and cannot express themselves adequately. All this demonstrated that the longer students stay in the virtual world they set up for themselves, the more depressed they will be in this situation (Çağan et al., 2014).

When explaining the findings of this study, some limitations should be considered. Firstly, the research is based on participants' self-reports, which may be vulnerable to common-method variance. Future researchers could correct this bias by measuring smartphone addiction and other dimensions behaviorally. Secondly, this study was cross-sectional and cannot infer causality. Further studies should apply longitudinal or experimental designs to confirm the causal assumptions in this study. Thirdly, the model in this study was tested on a sample of college students rather than a clinical sample. Thus, these results should not be generalized in other samples. Future research can benefit from testing the model in other samples, such as the clinical samples. Lastly, the sample was not large enough, and the sample was collected from Harbin, China, only. So, we cannot generalize it to the whole, and the questionnaires were too large, which was very difficult for respondents. Thus, future studies can expand the size of the samples and shorten the inventory size to validate the findings.

CONCLUSION

Our research contributes to the literature by examining the psychological mechanisms of smartphone addiction development based on the I-PACE model. Multiple social, psychological, and cognitive factors accelerate the mechanism of smartphone addiction. In China, international students are a high-risk group for smartphone addiction. Loneliness, depression, neurotic personality, passive coping, low self-esteem, and perceived stress are menace factors for smartphone addiction. Smartphone addiction intrudes on their academic performance and affects their mental and physical health to varying degrees. It would be beneficial for the education department to guide students to use smartphones scientifically and rationally to improve their physical and mental health. It would also direct students to establish good social adaptability for happy and smooth completion of university study and life escort. This finding would have some important implications for policymakers who develop means to prevent and intervene in smartphone addiction among college students. It would be also advantageous for mental health improvement and clinical settings.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Harbin Medical University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AM designed the study, interpreted and analyzed the data, and drafted the manuscript. TB and WW contributed to data analysis and data interpretation. VZ, NA, SS, EZ, XQ, XY, ZQ, JZ, and YY helped draft the manuscript. All authors contributed to the design of the survey and read and approved the final manuscript.

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Mobile Phone Addiction and Academic Procrastination Negatively Impact Academic Achievement Among Chinese Medical Students

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The problem of mobile phone addiction and academic procrastination among medical students has been widely acknowledged. This study aimed to explore the influence of demographic factors on mobile phone addiction, academic procrastination, and academic achievement among medical students. Further, it investigated the association between mobile phone addiction, academic procrastination, and academic achievement. This cross-sectional study was conducted between May and June 2019. A total of 3 511 medical students participated in an online questionnaire survey (effective response rate = 81.7%). Demographic factors, the Scale of Academic Achievement, the short scale of the Mobile Phone Problem Use (MPPUS-10), and the Academic Procrastination Scale–Short (APS-S) were used. Hierarchical multiple regression analysis revealed that the average scores for academic procrastination, mobile phone addiction, and academic achievement were 2.66 ± 0.91, 5.13 ± 1.53, and 4.51 ± 0.71, respectively. Moreover, there were significant differences in gender, grade, leadership experience, and family monthly income across mobile phone addiction, academic procrastination, and academic achievement. Mobile phone addiction was negatively associated with learning dedication, learning performance, and relationship facilitation. Academic procrastination was negatively associated with learning dedication, learning performance, relationship facilitation, and objective achievement. Mobile phone addiction and academic procrastination was revealed as prevalent among Chinese medical students, and negatively influences their academic achievement. It is critical to establish a more efficient learning environment for Chinese medical students to minimize the negative impact of mobile phone addiction and academic procrastination.

Keywords: medical students, academic achievement, mobile phone addiction, academic procrastination, medical education

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INTRODUCTION

Medical education is essential for promoting the development of healthcare systems worldwide. Its primary objective is to train medical personnel to provide high-quality services to the public during their careers. Academic learning in medical school is crucial for students to acquire the knowledge and skills to become qualified doctors. Additionally, most countries lack talented

and qualified physicians, resulting in a sustained demand to cultivate qualified medical students. Academic achievement is defined as the sum of medical students' learning consequences, attitudes, and behaviors (Yanfei et al., 2011). It comprises two aspects: behavioral performance and objective achievement. Academic achievement is often regarded as an index for evaluating training outcomes in theoretical and practical courses (Özcan et al., 2019). Studies suggest that academic achievement is associated with learning strategies (Rugutt, 2005), outcome expectations (Nabizadeh et al., 2019), thinking skills, learning styles (Shirazi and Heidari, 2019), lifestyle (Heidari, 2017), self-esteem (Jirdehi et al., 2018), family support (Abdulghani et al., 2014), and social and psychological factors (Džubur et al., 2020). Conversely, academic procrastination is a psychological factor, which is negatively correlated with academic achievement among college students as reported by a study done on Turkish medical students (Karatas, 2015). Moreover, with the rapid development of the Internet, mobile phone addiction has emerged as an important factor affecting students' academic achievement (Ibrahim et al., 2018). Considering cross-cultural differences, continuous attention should be given to academic achievement and its influencing factors among medical students in China.

According to the 47th Statistical Report on Internet Development in China, "As of December 2020, the number of online surfers by cellphone in China has reached 986 million."[1] Simultaneously, the penetration rate of mobile phones in Chinese university campuses is close to 100% (Rong and Hong, 2018). Mobile phones have proven useful for medical students as practical learning tools that enable them to "learn anywhere" (Payne et al., 2012). Moreover, mobile phones have a wide range of functionality in elevating the accessibility of learning and realizing equal opportunities for education. However, excessive and problematic use has caused adverse effects on the learning behavior of medical students (Ibrahim et al., 2018). Mobile phone addiction is defined as the uncontrolled use of mobile phones in inappropriate or harmful situations (Bianchi and Phillips, 2005) and is common among contemporary college students (Gao et al., 2018). Studies have found that adolescents and young people have been exposed to mobile phone addiction, which hinders their academic performance (Lepp et al., 2015; Xavier et al., 2018). Moreover, mobile phone addiction is negatively associated with academic performance among university students globally, and high-frequency mobile phone users spent less time on academic attention, interest, and investment (Amez and Baert, 2020). The study of medicine presents unique challenges with numerous courses and immense amounts of necessary scientific knowledge and practical skills, requiring medical students to dedicate more time and energy to studying it (Reed et al., 2014; Yeh and Park, 2015). However, in China, medical students with mobile phone addiction dedicate their limited energy resources to their mobile phones, resulting in decreased academic performance and a series of negative outcomes that potentially impact the medical profession (Siyu et al., 2020). Based on the characteristics of medical students, this study aimed to investigate the relationship between mobile phone addiction and academic achievement among medical students in China.

Procrastination is a common phenomenon, often occurring in a pragmatic and technologically advanced society (Steel, 2007), causing poor mental health, diminished success, increased stress, and reduced well-being (Jaffe, 2013; Glick and Orsillo, 2015). Academic procrastination is a type of situational procrastination (Karimi Moonaghi and Baloochi Beydokhti, 2017), and is defined as an initiative delay in the learning process and intended course (Steel, 2007). Although many studies have explored academic procrastination in different educational settings, the university context has been the most common (Karimi Moonaghi and Baloochi Beydokhti, 2017). For example, the prevalence of academic procrastination was 68% among college students in Iran (Rafii et al., 2014) and between 70 and 80% in Sweden (Rozental and Carlbring, 2014). Recent research has focused on academic procrastination and academic achievement among college students, finding a negative correlation between them (Karatas, 2015). Moreover, medical students are more prone to academic procrastination than college students (Forough et al., 2015; Hayat et al., 2020). Medical students must manage course schedules, teaching content, and academic tasks; thus, they are subjected to longer schooling, containing multiple courses and academic tasks. They therefore experience heavy academic burdens, and high pressure (Ross et al., 2010; Kötter et al., 2017), resulting in negative emotions and academic procrastination (Artino et al., 2012). In China, academic procrastination occurs more among medical than non-medical college students, and academic procrastination is further influenced by gender, life satisfaction, and anxiety among this population (Yao et al., 2021). However, few studies have directly explored the relationship between academic procrastination and academic achievement among Chinese medical students.

Therefore, this study aimed to explore the influence of demographic factors on mobile phone addiction, academic procrastination, and academic achievement among medical students. We further explored the association between mobile phone addiction, academic procrastination, and academic achievement.

MATERIALS AND METHODS

Study Design and Procedures

A cross-sectional online survey was conducted in Heilongjiang Province, China, ensuring time-effectiveness, cost-effectiveness, and accessibility of the research (Chang and Vowles, 2013). Four medical colleges were selected as survey sites: Harbin Medical University, Jiamusi Medical College, Mudanjiang Medical University, and Qiqihar Medical University. The colleges differed in size, major setting, and academic competence. Moreover, medical students from the selected colleges came from different provinces in China. We used a multistage stratified convenient sampling method; participants from different classes and grades were randomly selected. The procedures of this survey were approved by the Ethics Committee of the Institutional Review Board of Harbin Medical University before starting the online

[1] http://www.cnnic.net.cn/hlwfzyj/hlwxzbg/hlwtjbg/

investigations and observed throughout the questionnaire survey process. Before the formal investigation commenced, Harbin Medical University was selected as our pilot survey site, and 300 questionnaires were issued and collected via the Internet. These pilot data were used for questionnaire improvement and hence were excluded from the main analysis. Finally, we consulted medical education experts, college administrators, and medical teachers (a total of four experts); based on their feedback, the questionnaire was modified.

Data Collection

The minimum sample size was calculated as 1,824 medical students, according to the standard requirements and calculation method recommended by Zhou et al. (2017). Furthermore, considering the response rate and data quality, the recommended sample size was expanded to 5,000. The survey was conducted between May and June 2019. Before the investigation commenced, we obtained informed consent from the participants. The online questionnaire survey was hosted by "Questionnaire Star."[2] Each medical student who agreed to participate in the study was informed of the topic and content of the survey. The questionnaire URL was distributed to participants to complete in their spare time; each participant could only reply once. We carefully monitored the questionnaire collection process and effectively managed the data on Questionnaire Star. Additionally, we checked the collected questionnaires daily for quality control purposes. Such a survey method has been successfully employed in other completed studies (Zhang et al., 2018; Shi et al., 2021). Questionnaires were distributed to a total of 5,921 participants, and 4,297 questionnaires were successfully returned. The inclusion criteria were: (1) medical students studying at the selected medical college, (2) voluntarily and truthfully responding to the online questionnaire survey, and (3) having complete answers. The exclusion criteria were: (1) taking less than 8 minutes (which was confirmed as the minimum answering time in the preliminary survey) to answer the questionnaire, and (2) answering quality control questions incorrectly (for example, "Did you fill out the questionnaire carefully?"). Ultimately, 3 511 questionnaires were valid (effective response rate = 81.7%).

Measures

Demographic Characteristics

Information on five demographic characteristics was collected from a self-designed questionnaire, comprising sex, region, year of study, leadership experience, and family income. Region was divided into two categories: "rural" and "urban." The year of study was recorded as a continuous variable, from 1 to 5. Leadership experience was divided into "student leaders" and "ordinary students." Options for family income included " $\leq$ ¥5,000," "¥5,001–¥10,000," "¥10,001–¥20,000," and " $\geq$ ¥20,001."

Academic Achievement

Academic achievement was measured using 19 items developed by Yanfei et al. (2011). Academic achievement was divided into two sides: behavior performance and objective achievement. Behavior performance included three subscales: learning performance (6 items), relationship facilitation (6 items), and learning dedication (3 items), totaling to 15 items. Each item of behavioral performance was rated on a 6-point Likert scale (1 = *strongly unapplicable*, and 6 = *strongly applicable*). Objective achievement comprised four items for the participants' self-evaluation of achievement (recreational and sports activities, moral education, intellectual education, and total score) using a 5-point Likert scale. The higher the participants' self-evaluation, the higher their subjective achievement. Cronbach's alpha for the overall scale was 0.936 and those for the subscales were 0.895 (learning performance), 0.907 (relationship facilitation), 0.902 (learning dedication), and 0.874 (objective achievement).

Mobile Phone Addiction

Mobile phone addiction was measured using the Chinese adaptation (Hongjuan et al., 2017) of the short scale of Mobile Phone Problem Use (MPPUS-10) (Milena et al., 2015). The MPPUS-10 is a 10-item scale consisting of five dimensions: craving (1 item), negative life consequences (2 items), peer acceptance (1 item), withdrawal (3 items), and loss of control (3 items). Answers are recorded on a 5-point Likert scale (1 = *strongly unapplicable* to 5 = *strongly applicable*), with higher scores indicating higher mobile phone addiction. The MPPUS-10 has demonstrated adequate reliability and validity in previous studies in China (Hongjuan et al., 2017; Jianfang, 2018). For example, Hongjuan et al. (2017) used the MPPUS-10 to investigate middle school students in Beijing, and Cronbach's alpha was 0.87 (Hongjuan et al., 2017). Additionally, the MPPUS-10 was used for stratified sampling to investigate problematic mobile phone use among high school students in China, where Cronbach's alpha was 0.83 (Jianfang, 2018). In this study, Cronbach's alpha was 0.825.

Academic Procrastination

The Academic Procrastination Scale–Short (APS-S) was adopted to measure the severity of the effect of procrastination on students' academic tasks (Yockey, 2016). It has a total of five items, with each item examining the respondent's learning experience. Answers were rated on a 5-point Likert scale (1 = *totally agree* and 5 = *totally disagree*). Higher scores indicated a greater tendency to procrastinate on academic tasks. Cronbach's alpha was 0.901 in this study.

Statistical Analysis

IBM SPSS Statistics 23.0 was used to analyze the data. Participants' demographic characteristics (sex, region, grade, leadership experience, and family income [RMB]) were collected to provide sample information. Variance analysis was used to test for associations between demographic characteristics and mobile phone addiction, academic procrastination, and academic achievement. Multiple linear hierarchical regression analysis was performed to examine the relationships among the variables. $P < 0.05$ (two-tailed significance test) was considered significant for all statistical tests in this study.

[2]http://www.wenjuan.com/

RESULTS

Demographics and Characteristics

The percentages of participants who were female, lived in urban areas, and were student leaders were 65.99, 54.09, and 35.46%, respectively. There were 30.82, 28.51, 22.67, 6.69, and 11.31% participants in grades one, two, three, four, and five, respectively. Regarding participants' family monthly income levels, 41.81, 48.45, 9.00, and 0.74% participants indicated incomes ≤ ¥5,000, ¥5,001–10,000, ¥10,001–20,000, and ≥ ¥20,001, respectively.

Descriptive Statistics

As shown in **Table 1**, descriptive statistical analysis was used to analyze the mean distribution of mobile phone addiction, academic procrastination, and the four dimensions of academic achievement. This included objective achievement, relationship facilitation, learning performance, and learning dedication.

Difference Between Participants' Characteristics and Scores of Multiple Variables

Scores for learning dedication differed significantly according to participants' demographics, including sex, grade, and leadership experience. The descriptive associations between participants' characteristics and mobile phone addiction, academic procrastination, objective achievement, relationship facilitation, and learning performance scores are shown in **Table 2**.

Multiple Linear Hierarchical Regression Analysis Models for Participants' Academic Achievement

Academic achievement was negatively correlated with mobile phone addiction ($r = -0.780$, $p < 0.01$) and academic procrastination ($r = -0.285$, $p < 0.01$). Additionally, mobile phone addiction was positively correlated with academic procrastination ($r = 0.457$, $p < 0.01$). Subsequently, a multiple linear hierarchical regression analysis was performed to examine the influence of mobile phone addiction and academic procrastination on academic achievement after controlling for the effects of the demographic variables.

Table 3 represents the influence of mobile phone addiction on academic achievement, and **Table 4** shows the influence of academic procrastination on academic achievement. We found that mobile phone addiction was significantly negatively associated with learning dedication ($\beta = -0.080$, $p < 0.01$), learning performance ($\beta = -0.112$, $p < 0.01$), and relationship facilitation ($\beta = -0.033$, $p < 0.05$). Meanwhile, academic procrastination was significantly negatively related to learning dedication ($\beta = -0.220$, $p < 0.01$), learning performance ($\beta = -0.322$, $p < 0.01$), relationship facilitation ($\beta = -0.171$, $p < 0.01$), and objective achievement ($\beta = -0.154$, $p < 0.01$).

TABLE 1 | Means (*M*) and standard deviations (*SD*) of the basic variables and dimensional inventory of academic achievement ($n = 3,511$).

	M ± *SD*	Min–Max
Mobile phone addiction	5.13 ± 1.53	1–10
Academic procrastination	2.66 ± 0.91	1–5
Objective achievement	3.42 ± 0.77	1–5
Relationship facilitation	4.62 ± 0.77	1–6
Learning performance	4.52 ± 0.77	1–6
Learning dedication	4.29 ± 0.92	1–6

DISCUSSION

This study investigated the association between academic procrastination, mobile phone addiction, and academic achievement among Chinese medical students. Further, the scores for academic procrastination and academic achievement were higher than those reported by previous studies examining college students from non-medical universities in China (Haiqin et al., 2013; Jiajia et al., 2014). These differences may be attributed to different survey tools and variations in target populations, such as medical versus non-medical students. Moreover, the score for mobile phone addiction was higher than that reported among adults aged 18–34 years using MPPUS-10 in a Lebanese study (Marc et al., 2018). Chinese medical students are influenced by professional and environmental factors and are faced with immense academic pressure and strict standards; thus, they are prone to social anxiety and are vulnerable to mobile phone addiction (Linlin et al., 2015). These findings suggest that academic procrastination and mobile phone addiction levels among Chinese medical students are above the average and should be given increased attention.

Influence of Sociodemographic Characteristics on Mobile Phone Addiction, Academic Procrastination, and Academic Achievement

Sex, grade, leadership experience, and family monthly income were found to affect male medical students. This may lead to anxiety and poor sleep quality, which may subsequently cause higher mobile phone addiction (Chen et al., 2017). Studies have suggested that males score higher than females in their locus of control and that both groups differ in their learning styles, which may impact their levels of learning dedication and objective achievement (Khan and Iqbal, 2014; Wehrwein et al., 2015). Additionally, medical students with leadership experience have better self-awareness, self-planning, self-execution, self-assessment, and self-correction skills (Dan, 2013) and serve as role models to other students. Therefore, they need to have better academic achievement and thereby have a low level of academic procrastination (Yao et al., 2021). Understanding the influence of demographics on mobile phone addiction, academic procrastination, and academic achievement can inform interventions and policies aimed at medical students to reduce their mobile phone addiction and academic procrastination.

TABLE 2 | Variance analysis and description of each variable.

Variables		*N* (%)	Mobile phone addiction	Academic procrastination	Academic achievement			
					Learning dedication	Learning performance	Relationship facilitation	Objective achievement
			M ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*
Gender	Male	1,194 (34.01)	5.24 ± 1.64	2.68 ± 0.98	4.35 ± 1.00	4.51 ± 0.86	4.64 ± 0.84	3.37 ± 0.84
	Female	2,317 (65.99)	5.07 ± 1.48	2.64 ± 0.88	4.27 ± 0.87	4.52 ± 0.72	4.60 ± 0.73	3.44 ± 0.73
	t/F		9.536**	1.624	6.175*	0.169	1.774	6.585*
	P		0.002	0.203	0.013	0.681	0.183	0.010
Region	Rural	1,612 (45.91)	5.16 ± 1.54	2.66 ± 0.90	4.28 ± 0.89	4.53 ± 0.73	4.60 ± 0.75	3.41 ± 0.76
	Urban	1,899 (54.09)	5.11 ± 1.53	2.65 ± 0.93	4.30 ± 0.94	4.51 ± 0.80	4.63 ± 0.79	3.43 ± 0.78
	t/F		1.032	0.088	0.425	0.833	0.918	-0.142
	P		0.310	0.767	0.515	0.361	0.338	0.706
Grade	One	1,082 (30.82)	5.16 ± 1.49	2.65 ± 0.92	4.36 ± 0.87	4.56 ± 0.74	4.70 ± 0.73	3.42 ± 0.72
	Two	1,001 (28.51)	5.14 ± 1.51	2.60 ± 0.88	4.31 ± 0.93	4.54 ± 0.79	4.62 ± 0.79	3.42 ± 0.79
	Three	796 (22.67)	5.21 ± 1.56	2.71 ± 0.93	4.19 ± 0.99	4.47 ± 0.810	4.52 ± 0.80	3.38 ± 0.81
	Four	235 (6.69)	4.90 ± 1.55	2.63 ± 0.90	4.24 ± 0.89	4.40 ± 0.73	4.54 ± 0.72	3.40 ± 0.79
	Five	397 (11.31)	5.00 ± 1.63	2.70 ± 0.94	4.32 ± 0.86	4.54 ± 0.73	4.65 ± 0.75	3.49 ± 0.80
	t/F		2.760*	1.853	4.347**	3.048*	7.052**	1.292
	P		0.026	0.116	0.002	0.016	<0.001	0.271
Leadership experience	Student leaders	1,245 (35.46)	5.12 ± 1.55	2.58 ± 0.94	4.44 ± 0.94	4.62 ± 0.79	4.81 ± 0.77	3.67 ± 0.75
	Ordinary students	2,266 (64.54)	5.14 ± 1.53	2.70 ± 0.90	4.21 ± 0.89	4.47 ± 0.75	4.51 ± 0.75	3.28 ± 0.75
	t/F		0.173	13.154**	49.398**	30.673**	126.183**	225.279**
	P		0.677	<0.001	<0.001	<0.001	< 0.001	<0.001
Family monthly income (RMB)	≤5,000	1,468 (41.81)	5.13 ± 1.55	2.66 ± 0.94	4.28 ± 0.92	4.50 ± 0.77	4.60 ± 0.78	3.39 ± 0.77
	5,001–10,000	1,701 (48.45)	5.14 ± 1.51	2.64 ± 0.89	4.29 ± 0.89	4.51 ± 0.75	4.62 ± 0.75	3.43 ± 0.76
	10,001–20,000	316 (9.00)	5.08 ± 1.57	2.67 ± 0.94	4.34 ± 1.03	4.62 ± 0.84	4.66 ± 0.83	3.49 ± 0.82
	≥20,001	26 (0.74)	4.90 ± 1.85	2.80 ± 1.12	4.74 ± 0.94	4.69 ± 0.80	4.71 ± 0.88	3.77 ± 0.89
	t/F		0.309	0.405	2.552	2.558	0.519	3.672*
	P		0.819	0.749	0.054	0.051	0.669	0.012

*$P < 0.05$, **$P < 0.01$, Pearson Correlation is significant at the 0.01 level (2-tailed).*

Impact of Mobile Phone Addiction on Academic Achievement

In this study, academic achievement was divided into four dimensions. Learning performance examined students' completion of learning; relationship facilitation assessed students' interpersonal communication ability; learning dedication focused on students' enthusiasm and initiative for learning; and objective achievement involved the self-evaluation of moral education, intellectual education, arts and sports, and comprehensive achievements (Yanfei et al., 2011). The four dimensions of academic achievement are considered to accurately assess medical students' learning consequences, learning attitude, and learning behaviors under medical education standards in China (Li et al., 2020). Our results revealed that mobile phone addiction has a negative impact on learning dedication, learning performance, and relationship facilitation. One study posited that a relationship exists between mobile phone use and academic achievement among university students (Ahmed et al., 2020). Another study involving college students in Hainan showed a 40.5% mobile phone addiction rate (Yan et al., 2017). Similarly, in our survey of medical students in Northeast China, we found that the problem of mobile phone addiction was widespread (Yan et al., 2017). Therefore, Chinese medical students with mobile phone addiction were likelier to report problems in learning dedication, learning performance, and relationship facilitation. Further, incorrect and excessive mobile phone use may lead to a higher risk of depression (Alhassan et al., 2018), poor sleep quality (Liu et al., 2017), loneliness (Li et al., 2016), and academic burnout (Ma et al., 2020). This negatively impacts medical students' learning and life, and affects their learning dedication, learning performance, and relationship facilitation. However, our study also found that mobile phone addiction did not affect objective achievement. This may be because mobile phones are regarded as study tools that are used to access course materials, search for library catalogs, discuss course assignments with peers, take notes, and so on. Moreover, as the use of mobile phones is often closely related to college studies, students may believe that there is little or no correlation between mobile phone use and objective achievement (Dukic et al., 2015).

TABLE 3 | Influence of mobile phone addiction on academic achievement.

Variables	M_1 (β)	Academic achievement			
		M_2 (β)	M_3 (β)	M_4 (β)	M_5 (β)
Control variables					
Gender	−0.039*	−0.043*	0.004	−0.020	0.049**
Grade	−0.027	−0.030	−0.025	−0.033*	0.033*
Region	−0.005	−0.006	−0.036*	−0.001	−0.027
Family monthly income	0.023	0.022	0.042*	0.012	0.054**
Leadership experience	−0.115**	−0.114**	−0.092**	−0.183**	−0.249**
Predictor variable					
Mobile phone addiction		−0.080**	−0.112**	−0.033*	−0.018
F	11.938**	13.788**	14.312**	22.667**	41.658**
R^2	0.017**	0.021**	0.022**.	0.036*	0.065
ΔR^2	0.015**	0.023**	0.024**	0.037*	0.067

M_1: control variables, including gender, grade, region, family monthly income, and leadership experience. M_2: explains the influence of mobile phone addiction on learning dedication. M_3: explains the influence of mobile phone addiction on learning performance. M_4: explains the influence of mobile phone addiction on relationship facilitation. M_5: explains the influence of mobile phone addiction on objective achievement.
**P < 0.05, **P < 0.01, Pearson Correlation is significant at the 0.01 level (2-tailed).*

TABLE 4 | Influence of academic procrastination on academic achievement.

Variables	M_6 (β)	Academic achievement			
		M_7 (β)	M_8 (β)	M_9 (β)	M_{10} (β)
Control variables					
Gender	−0.039*	−0.044**	0.003	−0.023	0.046**
Grade	−0.027	−0.023	−0.015	−0.029	0.036*
Region	−0.005	−0.005	−0.035*	−0.001	−0.027
Family monthly income	0.023	0.024	0.044**	0.012	0.054**
Leadership experience	−0.0115**	−0.102**	−0.073**	−0.173**	−0.240**
Predictor variable					
Academic procrastination		−0.220**	−0.322**	−0.171**	−0.154**
F	11.938**	40.628**	75.775**	40.919**	57.715**
R^2	0.017**	0.063**	0.113**	0.064**	0.088**
ΔR^2	0.015**	0.065**	0.115**	0.065**	0.090**

M_6: control variables, including gender, grade, region, family monthly income, and leadership experience. M_7: explains the influence of academic procrastination on learning dedication. M_8: explains the influence of academic procrastination on learning performance. M_9: explains the influence of academic procrastination on relationship facilitation. M_{10}: explains the influence of academic procrastination on objective achievement.
**P < 0.05, **P < 0.01, Pearson Correlation is significant at the 0.01 level (2-tailed).*

Impact of Academic Procrastination on Academic Achievement

Our results also confirm that academic procrastination has a significant negative influence on academic achievement. This is consistent with the findings of previous studies (Steel and Ones, 2002; Karatas, 2015). Procrastination is a negative defense mechanism that is characterized by escaping or postponing learning tasks (Hoare, 1986). During the process of studying, procrastination may lead to academic failure, and chronic procrastination can cause negative emotions such as tiredness, anxiety, guilt, among others (Ferrari, 2010). Therefore, once medical students show signs of procrastination, it may directly, passively impact their learning dedication and learning performance. However, procrastinators suffer from persistent anxiety about completing tasks, which can lead to other negative emotional reactions; thus, relationship facilitation is affected to some extent (Ferrari et al., 2009). Consequently, educators and teachers should focus on the negative effects of medical students' academic procrastination.

Implications for Medical Education

Instructors should consider their students' demographic factors in addressing mobile phone addiction and academic procrastination among medical students, and accordingly suggest interventions such as cognitive appraisals. Cognitive appraisals can provide insight into medical students' mobile phone addiction and academic procrastination and can be used by students and educators alike (Ann et al., 2019). Instructors can also guide medical students to learn and practice reducing their academic procrastination, and have regular face-to-face conversations with students who are addicted to their mobile phones (Yanting et al., 2018).

Limitations

There are several limitations in this study. First, the participants were from four medical schools in the same Chinese province, which may limit the generalizability of this study to other regions. Additionally, we used several scales that were developed for use among Western cohorts, requiring additional academic attention in the Chinese context. Finally, this cross-sectional study reveals the relationship between mobile phone addiction, academic procrastination, and academic achievement at one point, but does not explain the causal relationship between the variables.

CONCLUSION

This study revealed that the problems of mobile phone addiction and academic procrastination are prevalent among Chinese medical students, and these negatively influences their academic achievement. Based on these results, we offer guidance for reducing the negative effects of mobile phone addiction and academic procrastination on academic achievement. Future studies are required to identify the factors associated with mobile phone addiction and academic procrastination.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

D-PC, S-EZ, and JT contributed to conception and design of the study. J-MX and S-EZ organized the database. Q-LL, C-XZ,

and H-CG performed the statistical analysis. J-MX, J-YZ, and JT wrote the first draft of the manuscript. L-BY, L-YZ, and RG wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Predictive Effect of Internet Addiction and Academic Values on Satisfaction With Academic Performance Among High School Students in Mainland China

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Academic performance occupies an important role in adolescent development. It reflects adolescents' cognitive ability and also shapes their academic and career paths. Students who are satisfied with their school performance tend to show higher self-esteem, confidence, and motivation. Previous research has suggested that students' problem behaviors, such as Internet Addiction (IA), and academic values, including intrinsic and utility values, could predict satisfaction with academic performance. However, the influence of IA and academic values has not been thoroughly explored in Chinese contexts where the pressure for academic success is heavy. This study examined the relationships between IA, academic values (intrinsic and utility value), and satisfaction with academic performance using two waves of data collected from secondary school students in four cities in mainland China. The matched sample included a total of 2,648 Grade 7 or 8 students (57.1% were boys with a mean age of 13.1 years at Wave 1). Participants completed the same questionnaire containing validated measures at both waves with a 1-year interval. In line with the hypotheses, multiple regression analyses showed that Wave 1 IA was a significant negative predictor of Wave 2 intrinsic value, utility value, and satisfaction with academic performance and their changes. Results of mediation analyses revealed that only intrinsic value, but not utility value, positively predicted satisfaction with academic performance. Structural equation modeling (SEM) analyses also showed similar findings. Two observations are concluded from the present findings: IA impaired students' intrinsic value, utility value, and perceived satisfaction with academic performance; two aspects of academic values demonstrated different influences on satisfaction with academic performance. These findings provide implications for the promotion of academic satisfaction experienced by students and the prevention of negative effects of IA.

Keywords: internet addiction, academic value, satisfaction with academic performance, high school students, mainland China

INTRODUCTION

The Internet has significantly changed people's lives nowadays. Despite the profound benefits of the Internet, the public is aware of the negative influence of its overuse of misuse on health and well-being. One common problem is Internet addiction (IA), which refers to one's inability to control Internet use that consequently causes social, psychological, academic, and work difficulties in life (Chou and Hsiao, 2000). IA has drawn growing concerns of the public and professionals worldwide.

Among different age groups, adolescents are considered more vulnerable to IA as their cognitive ability, self-control, and coping strategies are not fully developed (Long et al., 2018). Many studies have revealed that adolescents have a higher tendency to develop addictive behaviors such as playing online games or using social media in comparison to adults (Long et al., 2018). As the Internet penetration rate has dramatically increased nowadays, more than 80% of the adolescent population in the United Kingdom, United States, and Asia can access the Internet (Cerniglia et al., 2017). According to a national report, around 940 million Chinese people were Internet users, and among them were 172 million children and adolescents (China Internet Network Information Center, 2020). Research has revealed a relatively high prevalence of IA among Chinese adolescents. Shek et al. (2008) conducted research with 6,121 Chinese primary and high school students in Hong Kong, revealing that around 20% of the respondents met the criteria for IA based on two assessment measures. The study of Tan et al. (2016) involving 1,772 high school students in southern China also showed that around 17.2% of participants demonstrating problematic Internet use.

Many studies have documented the negative impact of IA on different aspects of adolescent development, such as sleeping quality (Tan et al., 2016), mental health (Ko et al., 2012), subjective well-being (Allen and Anderson, 2018), social development (Cerniglia et al., 2017), emotional development (Truzoli et al., 2020), and interpersonal relationship (Zeng et al., 2021). For adolescents, IA is particularly associated with low levels of school performance. Empirical evidence showed that students with IA experience more academic failure than their counterparts (Nemati and Matlabi, 2017). For example, students' online gambling habits were positively related to low levels of school achievements and less prosocial behaviors (Floros et al., 2015). Online pornography watching also impaired adolescents' academic performance as it reduces their interest, concentration, and involvement in academic activities (Beyens et al., 2015). Similar results were found among Chinese adolescents. For example, a longitudinal study examined the relationship between Internet behavior and students' academic development based on a sample of 9,949 Chinese students revealed that IA could lead to lower academic achievement, dropout, and absenteeism (Anthony et al., 2021). Another study evaluating IA and negative emotions also reported that IA negatively influenced academic problems by undermining students' mental and psychological health (Bu et al., 2021). The study of Bai et al. (2020) based on 1,794 adolescents from low-income families in China revealed that IA was linked to depression and detrimental to students' academic performance.

In Chinese schools, students are evaluated publicly by peers and teachers in terms of whether their behavioral and academic performance reaches school standards, which largely influences students' psychological health and adjustment (Chen et al., 2012). Undoubtedly, academic performance is considered the most important standard in Chinese school context. Researchers have adopted different approaches to assess academic performance. Primarily, test scores are considered an objective indicator of academic performance and have been often used in previous studies. Although the use of test scores is helpful to suggest education improvement and school accountability, researchers have questioned whether test scores reflect the stable status of individual students' overall development (Goldhaber and Özek, 2019). An alternative is to use subjective indicators, such as perceived performance level, which reflects one's overall subjective evaluation of normative performance level compared to peers (Saw et al., 2016). Researchers have pointed out the importance of subjective perceptions of one's academic performance for its close association with students' psychological adjustment (Haraldsen et al., 2020). Researchers also argued that satisfaction with perceived academic performance as an element of school adjustment provides a better indication of one's appraisal of academic achievement in schools (Shek, 2002). Research has shown that dissatisfaction with one's academic performance constitutes developmental problems for adolescents, particularly when the failure occurs repetitively (Enns et al., 2001; Lee et al., 2016). As the present study was interested in the roles of perceived academic values and motivation, we used satisfaction with academic performance as the indicator.

Scientific studies have been conducted to unravel the mechanisms of the negative impacts of IA on academic performance among adolescents. Earlier research has focused on the distraction and divergence behaviors in learning among students with IA, which often directly lead to a decline in school performance. Besides, anxiety and depression have been found to mediate the adverse effect of IA on academic performance (Ko et al., 2012; Bai et al., 2020; Bu et al., 2021). Recent evidence suggests that IA may also interrupt students' psychological learning process and create problems in academic values and motivation (Reed and Reay, 2015; Truzoli et al., 2020). For example, problematic Internet use was found to exert a negative effect on academic motivation, learning productivity, and psychosocial status, which have negative effects on academic performance (Truzoli et al., 2020).

Academic motivation includes intrinsic value and utility value (Eccles, 1983; Neel and Fuligni, 2013). Intrinsic value involves a sense of satisfaction rooted in the study or learning procedure itself, while utility value refers to students' sense of the instrumental value of the school courses (such as getting higher grades or material rewards) rather than finding the courses interesting. Ryan and Deci (2000) also categorized motivation into intrinsic motivation and extrinsic motivation. Intrinsic motivation refers to an individuals' aspiration for doing something from the inner heart, while extrinsic motivation defines the concept of getting rewards from outside to stimulate someone to behave (Benabou and Tirole, 2003).

Previous studies have found that IA may impair intrinsic value, as studying is often not as attractive as surfing the Internet

(Hanus and Fox, 2015; Reed and Reay, 2015). The various attractive and interesting sensory stimulations derived from the Internet could undermine students' learning interest, self-control, and self-efficacy in learning. Wang et al. (2021) argued that problematic use of short-form video applications was associated with a sole focus on immediate hedonic rewards and a lack of understanding of future harmful consequences. The research of Anthony et al. (2021) found a close relationship between IA and a lack of interest in school learning. A study conducted with Chinese students also revealed the mediating role of intrinsic motivation in the positive relationship between social media use and academic performance (Malik et al., 2020). Previous studies have mainly focused on the negative influence of IA and intrinsic value but paid less attention to the relationships between IA and utility value. Theoretically speaking, IA could also undermine utility value or extrinsic motivation as the intensive reinforcement and reward schedules in Internet activities (e.g., online games) provide instant extrinsic rewards to adolescents (Truzoli et al., 2020), while students may not necessarily receive instant extrinsic rewards (e.g., high grades or praise) even if they study hard.

Although IA has been commonly considered a risk factor for academic values and performance, how the two types of academic values are associated with performance are less conclusive. Theoretically speaking, intrinsic value promotes academic performance through positive and active engagement in learning with enjoyment, autonomy, deep learning, task arrangement, and time spending in learning (Vansteenkiste et al., 2005; Froiland and Oros, 2014; Liu et al., 2020). Intrinsic value is considered to have a relatively long-term effect on academic performance because it reinforces students' self-concepts and values, which are vital for students to maintain healthy psychological status and deal with academic failures (Cheo, 2017). On the contrary, utility value is constrained by the existence of external rewards and thus believed to have an instant but short-term positive effect on academic performance. In other words, once external rewards are terminated, utility value may become ineffective in stimulating adolescents' continuous efforts into their study.

However, empirical evidence supporting the distinctive effects of the two types of values has been equivocal. For example, the study of Baker (2004) on university students found no significant relationships between intrinsic or extrinsic motivation and academic achievement. Some studies revealed that both intrinsic and utility value were positively linked to school performance (Afzal et al., 2010). Some other studies revealed differential effects of intrinsic and utility value on academic outcomes (Moneta and Siu, 2002). For example, a longitudinal study conducted with 13,799 Chinese high school students revealed the different effects of intrinsic and utility value on academic performance. Students with high levels of intrinsic value were more attentive, focused on learning interests, arranged flexible learning strategies, and spent more time learning to improve their academic performance (Liu et al., 2020). It was argued that utility value might undermine the academic performance of students with high intrinsic value because utility value made students feel of being controlled, which damaged ones' intrinsic values (Wang and Guthrie, 2004; Liu et al., 2020). Similarly, Kuvaas et al. (2017) found that intrinsic value was positively associated with better performance, while extrinsic motivation showed a modest negative effect on performance. These inconclusive findings call for further exploration on how academic values might be differently related to adolescent development.

This study aimed to fill some research gaps. First, this study explored the effects of IA on perceived satisfaction of academic performance and the mediating roles of both intrinsic and utility values. This helps reveal the underlying mechanism of the influence of IA on academic performance and clarify the function of two types of academic values, which would fill the above-mentioned theoretical gaps. Second, most existing studies on adolescent IA and academic outcomes have been conducted with Western samples, hence calling for devoting more efforts to these issues in non-Western societies, particularly in Chinese contexts (Shek et al., 2008; Shek and Yu, 2016). As academic excellence is highly emphasized in Chinese societies, academic motivation may be perceived differently. In fact, both intrinsic and utility values are emphasized in traditional Chinese culture. Regarding intrinsic value, Confucian stated that "wasn't it a pleasure to learn and practice often?" ("xue er shi xi zhi, bu. yi yue hu?") in the Analects of Confucius, highlighting the satisfaction of learning, practical application, and self-improvement (Waley, 2005). As to utility value, the Chinese saying, "one who excels in the study can follow an official career" ("xue er you ze shi"), emphasizes the benefits of academic excellence in future career development. In contemporary Chines societies, "an official career" may no longer be the ultimate goal of studying. However, the value of education still receives great recognition among the public despite the development of ideology and philosophy in China (Wang and Ross, 2010). At the national level, China's Education Modernization 2035 plan sets the direction for developing the education sector to strengthen its overall capacity and international influence and makes China a powerhouse of education, human resources, and talents. At the family and individual levels, parents and students believe that "knowledge changes fate" and thus highly emphasize academic success (Xiang, 2018). Third, as most studies have not collected longitudinal data, it is difficult to establish the causal relationships between IA and academic performance. In particular, although longitudinal studies have examined the antecedents of IA (e.g., Yu and Shek, 2013), limited research has examined the longitudinal prediction of IA on adolescent developmental outcomes in Chinese adolescents. This research aims to understand the relationship between IA and academic performance and examine the mediating role of academic motivation (intrinsic and utility values) in this relationship using two waves of data.

RESEARCH HYPOTHESES

Based on the literature, we proposed the following hypotheses for each research question.

Research Question 1 (RQ1)

What are the concurrent and longitudinal relationships between IA and academic motivation? Based on the previous findings (Truzoli et al., 2020), we proposed that IA would be negatively

associated with intrinsic value concurrently (Hypothesis 1a) and longitudinally (Hypothesis 1b). Besides, with reference to the existing literature (Ryan and Deci, 2000; Truzoli et al., 2020), we expected negative concurrent and longitudinal relationships between IA and utility value (Hypotheses 1c,d, respectively).

Research Question 2 (RQ2)

What are the concurrent and longitudinal relationships between IA and satisfaction with academic performance? In line with studies conducted with Chinese students (Anthony et al., 2021), we proposed that IA would be negatively related to satisfaction with academic performance concurrently (Hypothesis 2a) and longitudinally (Hypothesis 2b).

Research Question 3 (RQ3)

What are the concurrent and longitudinal relationships between academic motivation and satisfaction with academic performance? In line with previous research (Anthony et al., 2021), we proposed that intrinsic value would be positively linked to satisfaction with academic performance concurrently (Hypothesis 3a) and longitudinally (Hypothesis 3b). Similarly, utility value would also show positive associations with satisfaction with academic performance concurrently (Hypothesis 3c) and over time (Hypothesis 3d).

Research Question 4 (RQ4)

Does academic motivation mediate the relationship between IA and satisfaction with academic performance? According to previous studies suggesting the mediating role of academic motivation (Malik et al., 2020), we hypothesized that intrinsic value and utility value would mediate the impact of IA on satisfaction with academic performance (Hypotheses 4a,b, respectively).

MATERIALS AND METHODS

Participants and Procedure

The data of this study were derived from a project examining adolescent adjustment and development in mainland China. The participants were recruited from four junior high schools in three provinces. Two waves of data were collected at the beginning of the school year of 2016/2017 (Wave 1) and 1 year later (Wave 2). A survey questionnaire was administered to students during school hours. Students were informed of the research aims, data collection, and the principles that the data collected will be anonymous, confidential, and only used for academic purposes. We obtained written consent from students, their parents, teachers, and school heads before data collection. This study has been reviewed and granted ethical approval by the authors' university.

In total, 3,010 students completed the questionnaire at Wave 1. Among them, 1,362 were in Grade 7, and 1,648 were in Grade 8. The data at Wave 2 were collected from 2,648 students, including 1,305 Grade 8 students and 1,343 Grade 9 students. The matched sample consisted of 2,648 students (Boys = 1,513; Girls = 1,109) with a mean age of 13.12 years at Wave 1. The attrition rates were 4.2 and 18.5% for Grade 7 and Grade 8 students, respectively, which were more favorable compared with studies reported in longitudinal studies with adolescents (Epstein and Botvin, 2000). Results of attrition analysis revealed non-significant differences between students in the matched sample ($n = 2,648$) and the dropouts ($N = 362$) in terms of age, IA, intrinsic and utility values, and satisfaction with academic performance in both grades.

Measures

Internet Addiction

The Chinese version of the Internet Addiction Scale developed by Young (1998) was adopted to evaluate participants' IA symptoms. This scale has been used and validated in previous studies and showed good psychometric properties (Shek et al., 2008; Yu and Shek, 2013; Chi et al., 2020). It includes 10 items assessing different IA symptoms, such as "Have you lied to family members, teachers, social workers, or others to conceal the extent of involvement with the Internet?" Participants indicated whether they exhibited each of the symptoms in the past 12 months on a dichotomous scale (i.e., yes/no). The total score equals the counts of "yes" answers to 10 questions. The values of Cronbach's α of IA were 0.77 at Wave 1 and 0.80 at Wave 2.

Academic Values

Students' academic values were measured *via* two aspects, including intrinsic value and utility value (Eccles, 1983; Neel and Fuligni, 2013). This scale has been validated in the Chinese context (Guo et al., 2017). Intrinsic value depicts how students perceive schoolwork as interesting and how much they like schoolwork in general. It includes two items: "In general, I find working on schoolwork is…" (1 = "very boring" and 5 = "very interesting") and "How much do you like working on schoolwork?" (1 = "a little" and 5 = "a lot"). On the other hand, the utility value describes the perceived usefulness of schoolwork through three items: "Right now, how useful do you find things you learn in school to be in your everyday life," "In the future, how useful do you think the things you have learned in school will be in your everyday life?" and "How useful do you think the things you have learned in school will be for what you want to be after you graduate" on a five-point Likert scale (1 = "not useful at all" and 5 = "very useful"). The Cronbach's α estimates for the two scales ranged between 0.87 and 0.91 at the two waves, suggesting good internal consistency of the scales in this study.

Satisfaction With Academic Performance

Satisfaction with academic performance was measured by a single item, "I am satisfied with my academic performance as compared to my classmates," on a six-point reporting scale ("1 = strongly disagree"; "6 = strongly agree"). This item was developed by authors based on literature (Education and

Manpower Bureau, 2003) and has been used in previous studies (Shek, 2002).

Data Analysis

We first conducted descriptive analyses. **Table 1** summarizes the means, SDs, and correlations among variables. Hierarchical multiple regression analyses were conducted to examine the concurrent and longitudinal relationships between research variables (RQ1, RQ2, and RQ3). This approach has been commonly adopted in the field (Zhou et al., 2020; Dou and Shek, 2021). Particularly, we examined the longitudinal effects of IA at Wave 1 on academic outcomes at Wave 2 with the corresponding outcomes at Wave 1 controlled. By controlling the influence of the initial levels of academic outcomes, this method suggests the effect of the predictor variables on the dependent variables over time.

For RQ4, we first analyzed the mediational role of intrinsic and utility value through a series of regression models using PROCESS macro in SPSS (Hayes, 2017). We calculated bias-corrected (BC) bootstrap 95% CIs using 2,000 re-samplings in the mediation analyses (Hayes, 2017). We first examined the mediating effects of intrinsic and utility values in two models separately, and then simultaneously added them to one model. This conservative method is helpful to explore the relationships between research variables in line with research questions and also suggest potential interactions. Besides, we used Structural Equation Modeling (SEM) to test the complete hypothesized model *via* Lavaan package in R software (Rosseel, 2012). SEM models can accommodate latent variables, multiple predictors, and outcomes, which allow a comprehensive analysis of the relationships between research variables. Multiple indices were used to indicate model goodness of fit, including Comparative Fit Index ("CFI"), Tucker-Lewis Index ("TLI"), Root Mean Square Error of Approximation ("RMSEA"), and Standardized Root Mean Square Residual ("SRMR"). Based on Hu and Bentler (1999) and Kline (2015), the cutoff criteria should be above 0.90 for CFI and TFI values, and lower than 0.08 for RMSEA and SRMR values.

RESULTS

Descriptive Results and Correlations

Table 1 shows the means, SDs, and correlations for IA, intrinsic value, utility value, and satisfaction with school performance over the two time points. The correlations between the research variables were significant and in line with the hypotheses. IA was negatively associated with intrinsic and utility value concurrently and longitudinally (r ranged between −0.20 and −0.30, $ps < 0.001$), and was negatively correlated with satisfaction with academic performance at each wave (rs ranged between −0.09 and −0.17, $ps < 0.001$). Both intrinsic and utility values were positively correlated with satisfaction with academic performance at two waves (rs ranged between 0.127 and 0.232, $ps < 0.001$).

Predictive Effects of IA on Academic Values

Results of hierarchical multiple regression analyses revealed significant concurrent negative effects of IA on intrinsic value (Wave 1: $b = -0.30$, $p < 0.001$, Cohen's $f^2 = 0.096$; Wave 2: $b = -0.27$, $p < 0.001$, Cohen's $f^2 = 0.080$, see **Table 2**) and utility value (Wave 1: $b = -0.28$, $p < 0.001$, and Cohen's $f^2 = 0.079$; Wave 2: $b = -0.21$, $p < 0.001$, and Cohen's $f^2 = 0.046$, see **Table 3**) at each wave after controlling gender, age, and family intactness. As to the longitudinal effect, Wave 1 IA had significant longitudinal effects on Wave 2 intrinsic value ($b = -0.21$, $p < 0.001$, and Cohen's $f^2 = 0.042$, see **Table 4**) and Wave 2 utility value ($b = -0.28$, $p < 0.001$, and Cohen's $f^2 = 0.079$, see **Table 5**). Additionally, after controlling Wave 1 intrinsic and utility values, IA at Wave 1 significantly predicted a decrease in both academic values over time (b was −0.09 and −0.21, $ps < 0.001$, and Cohen's f^2 was 0.007 and 0.046 for intrinsic and utility value, respectively, see **Tables 4, 5**). Hypotheses 1a, 1b, 1c, and 1d were supported.

Predictive Effects of IA on Satisfaction With Academic Performance

Results of multiple regression analyses demonstrated that IA had a significantly negative influence on satisfaction with academic performance at each wave (b was −0.15 and −0.18, $ps < 0.001$, and Cohen's f^2 was 0.022 and 0.034 for Wave 1 and 2, respectively, see **Table 6**). In addition, IA showed significant and negative prediction on Wave 2 satisfaction with academic performance ($b = -0.11$, $p < 0.001$, and Cohen's $f^2 = 0.011$, see **Table 6**). After controlling Wave 1 satisfaction with academic performance, IA significantly predicted a decrease in satisfaction with academic performance ($b = -0.07$, $p < 0.001$, and Cohen's $f^2 = 0.004$, see **Table 6**). Hypotheses 2a and 2b were supported.

Predictive Effects of Academic Values on Satisfaction With Academic Performance

Results of multiple regression analyses revealed that intrinsic value and utility value positively predicted each wave's satisfaction with academic performance (b ranged between 0.15 and 0.23, $ps < 0.001$, Cohen's f^2 ranged from 0.022 to 0.057, see **Table 6**). Results also showed a longitudinal prediction of intrinsic value and utility value on satisfaction with performance ($b = 0.20$ and 0.14, $ps < 0.001$, and Cohen's $f^2 = 0.039$ and 0.019 for intrinsic and utility value, respectively, see **Table 7**). Moreover, both intrinsic and utility values predicted an increase in Wave 2 satisfaction with academic performance when Wave 1 satisfaction was controlled ($b = 0.15$ and 0.10, $ps < 0.001$, and Cohen's $f^2 = 0.020$ and 0.010 for intrinsic and utility value, respectively, see **Table 7**). Results supported Hypotheses 3a, 3b, 3c, and 3d.

Mediating Roles of Academic Values

Results of mediation analyses *via* PROCESS are summarized in **Table 8**. When intrinsic and utility values were examined in two separate models, results revealed significant mediating effects of both intrinsic value (see Model 1a in **Table 8**) and utility value (see Model 1b in **Table 8**). When they were added to the model simultaneously, results showed that IA

TABLE 1 | Descriptive and correlational analyses.

Measures	Mean	*SD*	Correlations									
			1	2	3	4	5	6	7	8	9	10
Age	13.124	0.809										
Gender[a]	–	–	−0.081***									
Family intactness[b]	–	–	0.019	0.009								
W1 IA	2.308	2.344	0.088***	−0.168***	0.081***							
W2 IA	2.300	2.434	0.057**	−0.097***	0.051**	0.451***						
W1 Intrinsic value	3.386	1.356	−0.094***	0.012	−0.066***	−0.304***	−0.217***					
W2 Intrinsic value	3.292	1.304	−0.050**	−0.010	−0.042*	−0.200***	−0.269***	0.411***				
W1 Utility value	4.145	0.988	−0.097***	0.039*	−0.080***	−0.288***	−0.184***	0.514***	0.275***			
W2 Utility value	3.929	1.036	−0.073***	0.008	−0.052**	−0.181***	−0.215***	0.337***	0.625***	0.388***		
W1 Academic performance satisfaction	3.781	1.483	−0.092***	−0.101***	−0.042*	−0.139***	−0.088***	0.226***	0.131***	0.154***	0.127***	
W2 Academic performance satisfaction	3.967	1.484	−0.066***	−0.126***	−0.028	−0.087***	−0.172***	0.199***	0.232***	0.138***	0.166***	0.269***

[a]*1 = boy, 2 = girl.*

[b]*1 = intact, 2 = non-intact; W1 = Wave 1; W2 = Wave 2; and IA = Internet addiction.*

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

at Wave 1 negatively predicted intrinsic value and utility value at Wave 2. However, only intrinsic value, not utility value, positively predicted satisfaction with academic performance, suggesting the potential mediating effect of intrinsic value only (see Model 2 in **Table 8**). The indirect effect of IA on academic performance *via* intrinsic value was significant ($b = -0.03$, $p < 0.001$, see Model 2 in **Table 8**). The mediating effect of utility value was not significant (see Model 2 in **Table 8**).

We further developed a SEM model to comprehensively understand the relationships between variables under investigation (see **Figure 1**). The SEM model included IA at Wave 1 and satisfaction with academic performance at Wave 2 as observed variables, and intrinsic and utility values at Wave 2 as latent variable. The SEM model showed adequate model fit ($\chi^2 = 47.243$, $df = 9$, CFI = 0.996, TFI = 0.990, NNFI = 0.990, RMSEA = 0.040, and SRMR = 0.011; Kline, 2015). **Figure 1** shows the standardized coefficients in this model. IA at Wave 1 significantly and negatively predicted Wave 2 intrinsic value ($\beta = -0.09$, $p < 0.001$), utility value ($\beta = -0.08$, $p < 0.001$), but not satisfaction with academic performance ($p = 0.064$). Wave 2 intrinsic value, but not utility value, demonstrated a significant and positive prediction on academic performance ($\beta = 0.33$, $p < 0.001$). Results of SEM were in line with the PROCESS findings, which supported Hypothesis 4a but rejected Hypothesis 4b.

DISCUSSION

In this study, we examined the predictive effect of IA on satisfaction with academic performance, with academic values hypothesized as mediators. With reference to the research gaps in the literature, this study has several strengths. First, instead of focusing on objective academic performance indexed by test scores, we adopted students' satisfaction with academic performance, an indication of students' appraisal of overall academic achievement, to better understand the research questions concerning students' psychological motivation and values. Second, this study examined two potential mechanisms through which having IA symptoms potentially predict students' satisfaction with academic performance through intrinsic and/or utility value. Third, a short-term longitudinal design was used to understand the predictive effects of IA on satisfaction with academic performance. Fourth, we employed a relatively large sample to enhance the generalizability of the findings. Fifth, as very few studies in this field have been conducted in the Chinese context, this study contributes to the understanding of the negative influence of IA on academic performance and the underlying mechanisms in an educational system that highly emphasizes academic success. Finally, analyses based on both multiple regression and SEM were used to address research questions in a comprehensive manner.

Findings based on multiple regression analyses generally support the proposed hypotheses, which are consistent with the existing literature. First, IA negatively predicted satisfaction with academic performance and its change over

TABLE 2 | Cross-sectional regression analyses for intrinsic value.

Model	Predictors	Intrinsic value (Wave 1)					Intrinsic value (Wave 2)				
		β	*t*	Cohen's f^2	R^2 change	*F* change	*β*	*t*	Cohen's f^2	R^2 change	*F* change
1	Age	−0.09	−4.77***	0.009	0.012	10.52***	−0.05	−2.42*	0.002	0.004	3.77*
	Gender[a]	0.00	0.21	0.000			−0.01	−0.68	0.000		
	Family intactness[b]	−0.05	−2.78**	0.003			−0.04	−2.22*	0.002		
2	IA	−0.30	−15.98***	0.096	0.088	255.35***	−0.27	−14.52***	0.080	0.074	210.75***

In model 2, control variables were statistically controlled. IA at Wave 1 and Wave 2 were included as predictors to predict academic performance at Wave 1 and Wave 2, respectively. [a]*1 = boy, 2 = girl.*
[b]*1 = intact, 2 = non-intact. IA = Internet Addiction.*
$^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

TABLE 3 | Cross-sectional regression analyses for utility value.

Model	Predictors	Utility value (Wave 1)					Utility value (Wave 2)				
		β	*t*	Cohen's f^2	R^2 change	*F* change	*β*	*t*	Cohen's f^2	R^2 change	*F* change
1	Age	−0.09	−4.65***	0.008	0.016	14.57***	−0.07	−3.43***	0.005	0.007	6.14***
	Gender[a]	0.03	1.66	0.001			0.00	0.11	0.000		
	Family intactness[b]	−0.08	−4.1***	0.006			−0.05	−2.44*	0.002		
2	IA	−0.28	−14.54***	0.079	0.074	211.49***	−0.21	−11.07***	0.046	0.044	122.46***

In model 2, control variables were statistically controlled. IA at Wave 1 and Wave 2 were included as predictors to predict academic performance at Wave 1 and Wave 2, respectively. [a]*1 = boy, 2 = girl.*
[b]*1 = intact, 2 = non-intact. IA = Internet Addiction.*
$^*p < 0.05$; $^{***}p < 0.001$.

TABLE 4 | Longitudinal regression analyses for intrinsic value.

Model	Predictors	Intrinsic value (Wave 2)					Intrinsic value (Wave 2)				
		β	*t*	Cohen's f^2	R^2 change	*F* change	*β*	*t*	Cohen's f^2	R^2 change	*F* change
1	Age	−0.047	−2.42*	0.002	0.004	3.77*	−0.009	−0.48	0.000	0.170	540.66***
	Gender[a]	−0.013	−0.68	0.000			−0.015	−0.84	0.000		
	Family intactness[b]	−0.043	−2.22*	0.002			−0.021	−1.17	0.000		
	W1 intrinsic value						0.415	23.25***	0.206		·
2	W1 IA	−0.21	−10.51***	0.042	0.040	110.54***	−0.09	−4.61***	0.007	0.007	21.22***

In model 2, control variables were statistically controlled. [a]*1 = boy, 2 = girl.*
[b]*1 = intact, 2 = non-intact. W1 = Wave 1. IA = Internet addiction.*
$^*p < 0.05$; $^{***}p < 0.001$.

TABLE 5 | Longitudinal regression analyses for utility value.

Model	Predictors	Utility value (Wave 2)					Utility value (Wave 2)				
		β	*t*	Cohen's f^2	R^2 change	*F* change	*β*	*t*	Cohen's f^2	R^2 change	*F* change
1	Age	−0.067	−3.43***	0.004	0.007	6.14***	−0.032	−1.77	0.001	0.148	458.77***
	Gender[a]	0.002	0.11	0.000			−0.010	−0.57	0.000		
	Family intactness[b]	−0.048	−2.44*	0.002			−0.017	−0.93	0.000		
	W1 utility value						0.388	21.42***	0.174		·
2	W1 IA	−0.17	−8.92***	0.030	0.029	79.5***	−0.07	−3.82***	0.005	0.005	14.6***

In model 2, control variables were statistically controlled. [a]*1 = boy, 2 = girl.*
[b]*1 = intact, 2 = non-intact. W1 = Wave 1. IA = Internet addiction.*
$^*p < 0.05$; $^{***}p < 0.001$.

TABLE 6 | Cross-sectional regression analyses for academic performance.

Model	Predictors	Academic performance satisfaction (Wave 1)					Academic performance satisfaction (Wave 2)				
		β	*t*	Cohen's f^2	R^2 change	*F* change	*β*	*t*	Cohen's f^2	R^2 change	*F* change
1	Age	−0.10	−5.13***	0.010	0.022	18.93***	−0.08	−4.00***	0.006	0.023	20.08***
	Gender[a]	−0.11	−5.55***	0.012			−0.13	−6.79***	0.018		
	Family intactness[b]	−0.03	−1.73	0.001			−0.03	−1.35	0.001		
2	IA	−0.15	−7.64***	0.022	0.022	58.41***	−0.18	−9.48***	0.034	0.033	89.78***
	Intrinsic value	0.22	11.45***	0.050	0.048	131.04***	0.23	12.21***	0.057	0.054	149.11***
	Utility value	0.15	7.67***	0.022	0.022	58.87***	0.17	8.56***	0.028	0.027	73.2***

In model 2, control variables were statistically controlled. Predictors at Wave 1 and Wave 2 were included as predictors to predict academic performance at Wave 1 and Wave 2, respectively. [a]*1 = boy, 2 = girl.*

[b]*1 = intact, 2 = non-intact. IA = Internet Addiction.*

***$p < 0.001$.

TABLE 7 | Longitudinal regression analyses for academic performance.

Model	Predictors	Academic performance satisfaction (Wave 2)					Academic performance satisfaction (Wave 2)				
		β	*t*	Cohen's f^2	R^2 change	*F* change	*β*	*t*	Cohen's f^2	R^2 change	*F* change
1	Age	−0.076	−3.85***	0.006	0.023	20.12***	−0.050	−2.62**	0.002	0.063	173.07***
	Gender[a]	−0.135	−6.86***	0.019			−0.107	−5.55***	0.011		
	Family intactness[b]	−0.027	−1.35	0.001			−0.017	−0.91	0.000		
	W1 academic performance satisfaction						0.253	13.16***	0.067		·
2	IA	−0.11	−5.31***	0.011	0.011	28.24***	−0.07	−3.40***	0.004	0.004	11.54***
	Intrinsic value	0.20	10.14***	0.039	0.038	102.9***	0.15	7.53***	0.020	0.020	56.64***
	Utility value	0.14	7.07***	0.019	0.019	49.98***	0.10	5.37***	0.010	0.010	28.84***

In model 2, control variables were statistically controlled. [a]*1 = boy, 2 = girl.*

[b]*1 = intact, 2 = non-intact. IA = Internet addiction.*

**$p < 0.01$; ***$p < 0.001$.

time. The findings support previous evidence suggesting negative associations between IA and academic performance (Nemati and Matlabi, 2017; Anthony et al., 2021; Bu et al., 2021). Second, IA positively predicted both intrinsic and utility values and the changes over time. These findings are also in line with previous studies revealing negative influences of problem Internet use on students' learning motivation (Truzoli et al., 2020; Anthony et al., 2021). Third, results of multiple regression showed that both intrinsic and utility values positively predicted satisfaction with academic performance and its change over time. Although some previous studies have emphasized the downside of utility value on adolescent development, the results of the present study corroborate previous evidence highlighting the positive influence of both intrinsic and utility values (Afzal et al., 2010). As mentioned earlier, Chinese cultures acknowledge both intrinsic and utility values of study. Although the education system in China has been criticized for the examination orientation, it is still perceived as the most accessible and fair approach for disadvantaged students to beat the odds and seek academic access (Wang and Ross, 2010). For these students, schooling means much more than individual interests or satisfaction but "a future of comfort and dignity, a family responsibility and collective investment, and a path toward individual freedom and actualization" (Xiang, 2018, p. 81). These beliefs reflect instrumental value but are also rooted in spirits of hard-working and persistence that are vital for academic success. Finally, when both intrinsic and utility values were included in the mediation models, only intrinsic value, but not utility value, served as a mediator in the relationship between IA and satisfaction with academic performance. Results based on multiple regression and SEM are consistent, which generate triangulated findings for the study. The results are consistent with the widely held belief that intrinsic and utility values are distinct constructs and have different associations with adolescents' maladjustment and psychological well-being (Moneta and Siu, 2002). Students demonstrating more IA symptoms tended to regard school work as boring and consequently felt less satisfied with their academic performance, which is in agreement with previous findings (Liu et al., 2020). Additionally, the mediating effect of utility value was not significant when intrinsic value was taken into account. One explanation is that utility value may include different subtypes depending on how one internalizes the extrinsic goals as a personal pursuit.

TABLE 8 | Longitudinal mediating effect analyses of intrinsic value and utility value at Wave 2 (the mediators) for the effect of IA at Wave 1 on academic performance satisfaction at Wave 2.

Regression models summary	Model 1a			Model 1b		
	Intrinsic value			Utility value		
	β	*SE*	*t*	*β*	*SE*	*t*
Total effect of IV on DV	−0.05	0.01	−4.43***	−0.05	0.01	−4.43***
IV to Mediator	−0.11	0.01	−10.48***	−0.08	0.01	−9.47***
Mediator to DV	0.25	0.02	11.46***	0.22	0.03	7.90***
Direct effect of IV on DV	−0.03	0.01	−2.16*	−0.04	0.01	−2.98*
Mediating effect	**Point estimate**	**Bootstrapping (BC 95% CI)**		**Point estimate**	**Bootstrapping (BC 95% CI)**	
		Lower	**Upper**		**Lower**	**Upper**
	−0.04***	−0.06	−0.03	−0.00	−0.01	0.00
	Model 2 (intrinsic and utility values as mediators)					
Regression models summary	**Intrinsic value**			**Utility value**		
	β	*SE*	*t*	*β*	*SE*	*t*
Total effect of IV on DV	−0.09	0.01	−4.43***	−0.09	0.01	−4.43***
IV to Mediator	−0.20	0.01	−10.48***	−0.18	0.01	−9.47***
Mediator to DV	0.20	0.03	8.30***	0.03	0.03	1.27
Direct effect of IV on DV	−0.04	0.01	−2.07*	−0.04	0.01	−2.07*
Mediating effect	**Point estimate**	**Bootstrapping (BC 95% CI)**		**Point estimate**	**Bootstrapping (BC 95% CI)**	
		Lower	**Upper**		**Lower**	**Upper**
	−0.03***	−0.03	−0.02	−0.00	−0.01	0.00

*Model 1a and Model 1b examined the mediating effects of intrinsic and utility values separately. In Model 2, intrinsic value and utility value were simultaneously added to the model as mediators. BC, bias corrected; CI, confidence interval. *p < 0.05; ***p < 0.001.*

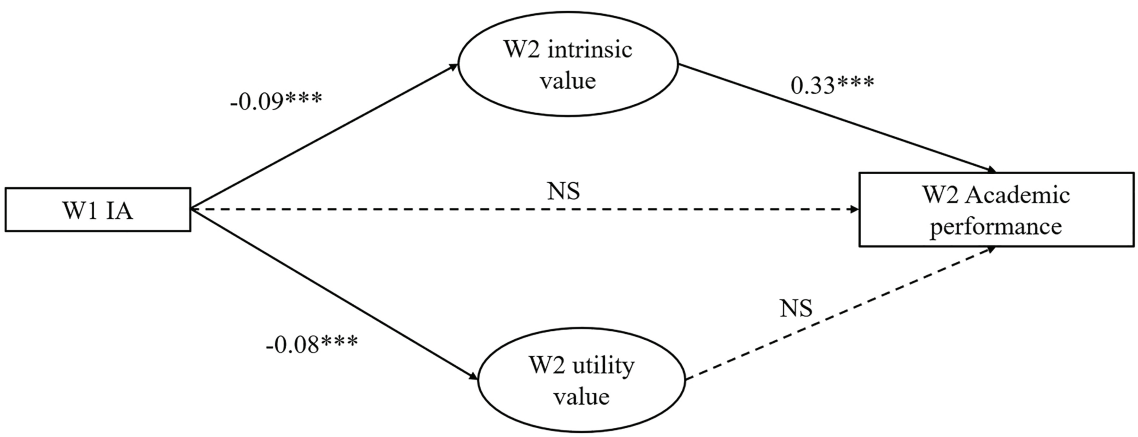

FIGURE 1 | Results of Structural equation modeling (SEM) model. ***$p < 0.001$.

If students regard the striving for performance excellence as a personal commitment, it reflects high levels of autonomy and self-determination (Ryan and Deci, 2000). As results of the correlational analysis revealed a significant positive association between intrinsic and utility value, students may accept the utility of schooling and endorse the external goals. This finding echoes the idea that intrinsic value has an immediate effect on study performance, while ulitity value contributes to performance through its close association with intrinsic motivation (Wang and Guthrie, 2004). We should also investigate the linkages between the two types of academic value in future studies.

There are several theoretical implications of the present findings. First, the study suggests that the negative effects of IA on academic values and satisfaction with academic performance concurrently and over time, which strengthens the theoretical proposition that IA has longitudinal adverse effects on academic outcomes (Zhang et al., 2018). Second, the results underscore the importance of academic values, particularly intrinsic value, in mediating the influence of IA on satisfaction with academic performance. Students possessing high levels of intrinsic value perceive learning as exploratory, playful, and curiosity driven. According to Self-determination Theory (Ryan and Deci, 2000), intrinsic value serves as "a natural wellspring of learning." However, many online activities, including short videos, social media networks, and online games, have been designed or presented to be mentally stimulating to give users high levels and continual enjoyment (King and Delfabbro, 2018). Students' basic psychological needs for competence, autonomy, and relatedness may be better satisfied by Internet use rather than by traditional learning activities, which may lead to a decrease in their engagement in school work and an increase in Internet use (Salmela-Aro et al., 2017; Zhang et al., 2018). As existing research has paid much attention to the direct relationship between the Internet and academic performance, our results highlight the importance of examining how psychological factors mediate the relationship between adolescent problem behaviors and their development and well-being in the long run.

The finding has practical implications for teachers and social workers to help adolescents and their parents understand the negative consequences of IA in undermining academic values (i.e., meaning of study) and academic performance. Given that many teaching and learning activities are online nowadays, adolescents and parents commonly hold the belief that Internet is an indispensable part of life, and thus it cannot be addictive and the "prolonged" use of IA is not problematic. Instead, adolescents should be aware of the potential dark side of Internet use, such as the adverse effects of IA on academic values and perceived school performance (Salmela-Aro et al., 2017). Furthermore, to promote satisfaction with academic performance, we need to cultivate the meaning of studying in students. In school practices, it is trendy for teachers to adopt various pedagogical strategies to spark students' intrinsic value and cultivate active learners. Utility value, on the contrary, is often regarded as ineffective or even detrimental in adolescent development and is often associated with unhealthy teaching or parenting styles, such as excessive involvement (Rivers et al., 2012). As Benabou and Tirole argued, "external incentives are weak reinforcers in the short run, and negative reinforcers in the long run" (2003, p. 489). However, our results did not reveal any negative associations between utility value and intrinsic value or academic performance. As suggested by Lin et al. (2003), we believe it is important that teachers and parents need not eliminate all perceived utility values for high performance, especially when students accepting utility value of schooling based on a sense of commitment and self-determination.

There are several limitations of the study. First, because only two waves of data were collected, the findings are based on a short-term longitudinal study. As such, more time points should be added in future studies. Second, the scale of academic values only included a few items for the two types of values. As suggested by Ryan and Deci (2000), it is meaningful to explore different subtypes of extrinsic motivation based on the perceived locus of causality. We recommend that more items and subtypes of utility value should be examined in future studies. Third, the present study only adopted a subjective indicator of academic performance. We believe satisfaction with performance better reflects adolescents' self-evaluation on schooling and is closely associated with their psychological well-being. Although satisfaction with academic performance is closely correlated with GPA (Bradley, 2006), it would be helpful to include test scores and/or teacher-rated performance in future studies. Fourth, this study mainly focused on academic values as mediators. Other important factors, such as academic stress, could be taken into account in future studies (Baker, 2004). Finally, only self-report data were collected, which may lead to common-method variance bias. Future studies should use multiple informants' reports to assess adolescent IA symptoms and academic performance.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Subjects Ethics Subcommittee at The Hong Kong Polytechnic University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

DS designed the research project and contributed to all the steps of the work. DD conducted data analyses, prepared the first draft, and revised the manuscript based on the comments and editing provided by DS. All authors contributed to the article and approved the submitted version.

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The Influence of Different Learning Strategies on Pupils' Learning Motivation: Is Augmented Reality Multimedia Learning Consistent With Traditional Text Learning?

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How to reduce pupils' burden and improve learning efficiency? Research shows that non-intelligence factors and learning strategies are the key factors in the effective learning process, and external intervention can play a greater role in these two aspects. The purpose of this study is to explore the effects of different learning strategies on learning motivation under the presentation of augmented reality (AR) multimedia or traditional text learning. Sixty third-grade pupils in Hebei Province were selected, and 2 (learning materials: AR materials and text materials) × 3 (learning strategies: restudying strategies, retrieval practicing strategies, and self-generated drawing strategies) between-subjects design was adopted. The dependent variable is learning motivation, which includes three dimensions: surface motivation, deep motivation and achievement motivation. The results showed that (1) Learning strategies had a significant impact on deep motivation. The deep motivation aroused by retrieval practicing strategies was significantly higher than that aroused by restudying strategies and self-generated drawing strategies. (2) The interaction between learning materials and learning strategies was marginally significant. When learning with AR materials, the achievement motivation of pupils in the restudying strategy group was higher (marginal significant) than that in the retrieval practicing strategy group. Retrieval practicing strategies have positive significance in cultivating deep motivation. The combination of different learning modes and learning strategies will impact achievement motivation.

Keywords: AR multimedia learning, text learning, learning strategy, learning motivation, self-generated drawing strategies

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INTRODUCTION

In recent years, how to reduce pupils' burden and improve learning efficiency has become a key issue in quality education. Previous studies have confirmed that the psychological structure of efficient learning includes five main internal factors: selective attention, metacognition, learning strategies, nonintellectual factors and implicit cognition (Shen and Bai, 2006). Studies have shown that non-intelligence factors are the driving force of efficient learning, while learning

strategies provide guarantee for efficient learning process. Improving the level of both will improve students' learning efficiency. At the same time, external intervention can play a greater role in these two aspects (Shen and Bai, 2006). Lu (2007) also proposed that scientific learning methods, appropriate use of learning strategies and fun in learning are the three basic characteristics of students' efficient learning. In other words, studying how to combine specific material content with learning strategies to promote students' learning motivation is an important topic in efficient learning. Previous studies have proven that learning strategies, teaching environment and learning motivation affect the learning effect and interact with each other.

The psychological state of children in primary school is at a critical stage of development. In late childhood, children's thinking transitions from concrete image to abstract logical thinking. At this time, children's internal language is also developing, but it cannot be as perfect as adults, and still has great concrete image. There is a critical age in the transition stage, approximately 9–11 years old, when dialectical thinking begins to emerge. The second or third grade is the key period for the development of pupils' written language. Before that, the written language level lags behind the oral language level, while the written language gradually shows advantages after the fourth grade. As for children's learning motivation, generally speaking, the lower the grade, the more specific their learning motivation is. With the growth of grade, their learning interest has gradually shifted from external activities, such as games, to internal learning content (Lin, 2009). However, this change is not necessarily formed naturally. According to the viewpoint of evolutionary psychology, children's natural interest lies in exploring the environment and social interpersonal relationships, which conflicts with the motivation to master learning ability. In other words, the development of students' learning motivation in the critical period of development needs external forces, such as family and school education, to guide and intervene (Wang and Tan, 2014).

Stimulating and maintaining learning motivation is a teaching focus in primary school. Motivation is the internal driving force to stimulate individual action and guide it to a certain goal. Therefore, learning motivation can be defined as the internal motivation for students to learn spontaneously, which is a key factor affecting students' academic performance (Lin et al., 2003; Steinmayr and Spinath, 2009). Biggs (1987) divided learning motivation into three dimensions: surface motivation (SM), deep motivation (DM), and achievement motivation (AM). Surface motivation refers to the motivation to learn due to surface material stimuli, such as rewards. Students with high surface motivation usually take coping with exams or classroom tests as their learning goals. Deep motivation refers to the motivation to learn due to deeper non-material stimuli, such as mastering knowledge and acquiring skills, which originates from the real interest in the learned content. Achievement motivation refers to an individual's drive to achieve goals and achieve success (Zhang and Yang, 1999; Jia et al., 2012). The impact of learning motivation on learning performance is significant. Learning motivation drives students to conduct learning activities. The motivation pointing results of different dimensions are different; that is, there are differences in learning objectives, so the efforts and actions are not consistent (Zhang and Shen, 2005).

Learning strategies are also an important dimension affecting learning efficiency. There are many types of learning strategies, and the most commonly used strategies in the classroom are restudying strategies and retrieval practicing strategies. Tests are a form of retrieval practicing strategy. In daily learning activities, students consciously use restudying strategies for learning, but by adding retrieval practice between learning and a final test, students' learning effect is significantly better than pure repetition learning (Roediger and Karpicke, 2006; Karpicke and Roediger, 2008). Retrieval practicing strategies are helpful to maintain long-term memory so as to improve the learning effect. In recent years, the self-generated drawing strategy with high popularity has to be mentioned. The self-generated drawing strategy refers to students expressing what they have learned through drawing when learning content without pictures, that is, learning content visualization. The key points of the self-generated drawing strategy are self-generation and drawing representation. According to the Generative Theory of Drawing Construction (GTDC), this process requires students to carry out some constructive activities. In this process, learners will select, organize and integrate materials, and self-monitoring and regulation will also be activated, so that learners can more deeply understand the text content and help master knowledge (van Meter and Garner, 2005; Wang et al., 2019).

With the development of science and technology, multimedia technology is also being updated and iteratively applied to learning activities. The new learning method based on AR enhancement technology has good interaction and brings learners a completely different experience from the traditional learning method. The basic characteristics of AR technology mainly include three points: the integration of virtual and real environment, real-time interaction and 3D registration. Augmented reality (AR) can make users experience a strong sense of authenticity and presence. In educational psychology, the impact of the application of AR technology on teachers' instructional design and students' cognitive strategies is an important direction of scientific research (Zhao et al., 2014; Zhou et al., 2015). AR (augmented reality) technology can realize the transformation of students' knowledge from abstract to concrete, display the text content in a concrete and realistic way, make the text content easier to understand and enhance interest, and compensate for the shortcomings of traditional learning methods (Liu and Chen, 2019). The benefits of applying augmented reality technology to teaching activities have been studied in recent years. Students learn through AR materials, and the visualization effect generated by 3D model greatly enhances students' understanding and perception of the learned abstract concepts. In addition, the presence and interactivity brought by AR materials make students feel like they are on the scene, which can improve students' sense of existence and concentration (Cai et al., 2016).

According to previous studies, learning motivation, learning strategies, and the types of learning materials can affect the

FIGURE 1 | The front and back of augmented reality (AR) cognitive card.

FIGURE 2 | Augmented reality video presentation.

learning effect; and previous studies have stated that there is a certain correlation between learning strategies and learning motivation. The two promote each other. Students with strong learning motivation will use more meta learning strategies, and the use of learning strategies will also enhance students' learning motivation (Sun and Meng, 2021). However, research on the relationship between the three is still relatively rare. Therefore, this study is expected to explore the influence of different types of learning modes and learning strategies on learning motivation, and use the experimental method to study whether the three learning strategies of restudying, retrieval practicing, and self-generated drawing have different effects on pupils' learning motivation under the presentation of two different learning materials of AR multimedia and traditional text. The possible reasons for the existence of different effects also will be discussed.

METHODS

Participants

Sixty pupils in grade 3 were recruited by cluster random sampling from one public primary school in Hebei Province, China. The gender ratio was balanced (27 girls and 33 boys). The age range was 8–11 years old (two pupils aged 8, 38 pupils aged 9, 19 pupils aged 10, one pupil aged 11), and the average age was 9.32 years old (SD = 0.57). All subjects were native speakers of Chinese and had normal vision or corrected vision. They had not participated in similar experiments before and voluntarily participated in this study.

Materials

Vocabulary Test Questions

The 10 English words used in the experiment were compiled into vocabulary test questions. The subjects were asked to review whether they had learned the corresponding English words according to the Chinese words provided, score the words they had not learned "×" and tick "√" and write the English spelling of the words they had learned. In order to ensure that the subjects had the same initial level of learning, those pupils who could write English spelling by dictation were eliminated.

Augmented Reality Materials

Ten AR cognitive cards, the front and back of which are shown in **Figure 1**, were selected. Each card corresponds to a type of animal. The animal was scanned with AR software, and the screen presented a color 3D image of the corresponding animal equipped with an English teaching voice, thus making full use of the interactivity of AR technology. In the experiment, the AR cognitive card was scanned and made into an AR video presentation. The video content includes 3D dynamic animal images, Chinese and English words and English teaching pronunciations (as shown in **Figure 2**).

Text Materials

The participants used the text materials made by the researchers and followed the teaching textbooks. The learning content was the same 10 Chinese and English words as with the AR materials and was presented in the form of text, including 2D static animal images and Chinese and English words. In order to simulate traditional text learning conditions, pronunciation is not taught.

Pupils' Learning Motivation Questionnaire

This questionnaire was revised by Jia et al. (2012), and the original questionnaire was adapted from the Learning Process Questionnaire of Biggs (1987). The content includes three motivation dimensions: surface type, deep type, and achievement type. This questionnaire consists of 16 questions and uses four-point scoring. The revised questionnaire has good reliability and validity, the correlation coefficient between each subscale is low, and the correlation coefficient with the total scale is high, which represents good structural validity.

Display Equipment

A 15.6-inch laptop with the screen resolution set to 1920 × 1080 was used.

Design

A 2 (learning materials: AR materials and text materials) × 3 (learning strategies: restudying strategies, retrieval practicing strategies, and self-generated drawing strategies) between-subjects design was adopted, and the dependent variable was learning motivation.

Procedure

Firstly, the subjects were randomly divided into six groups, text restudying group, text retrieval practicing group, text drawing group, AR restudying group, AR retrieval practicing group and AR drawing group, so as to ensure the randomness of the learning materials and learning strategies used, with 10 people in each group. All subjects were screened using vocabulary test questions. In order to ensure the same initial level, subjects who could dictate any English word were excluded.

Secondly, in the learning stage, the subjects in each group learned the corresponding materials first, the text group learned according to the distributed text materials, and the AR group learned according to the AR video materials for 80 s. After learning, the text repetition group and AR repetition group repeated learning, that is, they repeated the learned content twice for 80 s each time. The text extraction group and AR extraction group randomly extracted the learned content. That is, Chinese clue words were presented in the text or screen; the subjects were asked to recall the corresponding English words, such as "Peacock -?"; and each word was addressed for 16 s. The text drawing group and the AR drawing group conducted self-generated drawing. That is, the text prompts were combined with the materials learned above to generate corresponding images in the mind and those images were drawn. An example is the following: "A dragon is a mythical animal and can spit fire. Its body is like a lion and its head is like a horse. Its two huge wings are like bats." The subjects drew by themselves according to the requirements, and the time was 160 s.

Finally, all subjects completed the pupils' learning motivation questionnaire according to the same guidance. The questionnaire includes three dimensions, surface motivation, deep motivation and achievement motivation; and collected learners' learning motivation level data under different conditions. In the measurement results, the total scores of all items are the indicators to measure the overall level of learning motivation, and the total scores of each dimension are the indicators to measure the level of different sub-types of learning motivation.

Data Processing

The experimental data were processed and analyzed using SPSS 26.0. For the abnormal data, the box chart is used to filter the abnormal values, and the group average value is used for replacement processing. When processing the data, firstly, the learning motivation under different learning modes is described and statistically analyzed. Secondly, multivariate analysis of variance was used to test the main effects of learning materials and learning strategies on learning motivation and their interaction effects.

RESULTS

The learning motivation of grade 3 pupils when using different learning materials and learning strategies was described and counted. The specific results were shown in **Tables 1, 2**.

Taking learning materials and learning strategies as independent variables and deep motivation as dependent variables, multivariate analysis of variance was carried out. The results showed that the main effect of learning strategies was significant [$F(2, 54) = 8.313$, $p < 0.01$, $\eta_p^2 = 0.235$]. Furthermore, pupils' deep motivation using retrieval practicing strategies ($M = 28.95$, SD = 2.35) was the highest, which was significantly higher than when using restudying strategies ($M = 26.20$, SD = 3.21), $p < 0.01$, and self-generated drawing strategies ($M = 25.10$, SD = 3.77), $p < 0.001$.

TABLE 1 | Descriptive statistics of learning motivation under different learning materials.

	AR ($M \pm SD$)	Text ($M \pm SD$)	t	d
Surface motivation	8.27 ± 1.87	7.37 ± 2.30	1.66	0.429
Deep motivation	26.13 ± 3.79	27.37 ± 3.15	−1.37	−0.356
Achievement motivation	12.70 ± 3.42	12.30 ± 3.64	0.44	0.113
Total learning motivation	47.10 ± 6.77	47.03 ± 6.45	0.04	0.011

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Taking learning materials and learning strategies as independent variables and achievement motivation as dependent variables, multivariate analysis of variance was carried out. The results showed that the interaction between learning materials and learning strategies was marginally significant [$F(2, 54) = 2.916$, $0.05 < p < 0.10$, $\eta_p^2 = 0.097$]. The simple effect analysis (**Figure 3**) showed that when learning with AR materials, the students' achievement motivation in the restudying strategy group ($M = 14.10$, SD = 3.76) was higher than (marginal significant) that in the retrieval practicing strategy group ($M = 11.40$, SD = 2.88).

DISCUSSION

Significance of Learning Strategies for Cultivating Pupils' Deep Motivation

The use of learning strategies is closely related to students' learning motivation (Zhang and Guo, 2001; Zhou et al., 2005). Compared with restudying strategies, retrieval practicing strategies have obvious advantages in promoting meaningful learning. They can trigger the deep processing of learning materials and encourage students to form the goal orientation of mastering knowledge and skills (Ma et al., 2014). Deep processing strategies can effectively improve pupils' perceived ease of use of learning content. That is, deep processing strategies affect students' cognition of learning ease, reduce their learning frustration, make them think actively and explore actively, and have a good effect on cultivating deep motivation (Zhang and Yang, 1999; Liu et al., 2015). The deep motivation of self-generated drawing strategy in text material learning is higher than that in AR material. According to cognitive load theory, the increase of cognitive load will hinder the individual information processing process, and the size of internal cognitive load (ICL) is related to the complexity of the material itself.

TABLE 2 | Descriptive statistics of learning motivation under different learning strategies.

	Restudying strategies ($M \pm SD$)	Retrieval practicing strategies ($M \pm SD$)	Self-generated drawing strategies ($M \pm SD$)	F	η^2
Surface motivation	7.45 ± 2.06	8.15 ± 1.87	7.85 ± 2.46	0.537	0.018
Deep motivation	26.20 ± 3.21	28.95 ± 2.35	25.10 ± 3.77	7.866**	0.216
Achievement motivation	12.45 ± 3.98	12.35 ± 3.34	12.70 ± 3.33	0.051	0.002
Total learning motivation	46.10 ± 6.50	49.45 ± 5.86	45.65 ± 6.92	2.079	0.068

*$p<0.05$, **$p<0.01$, ***$p<0.001$.

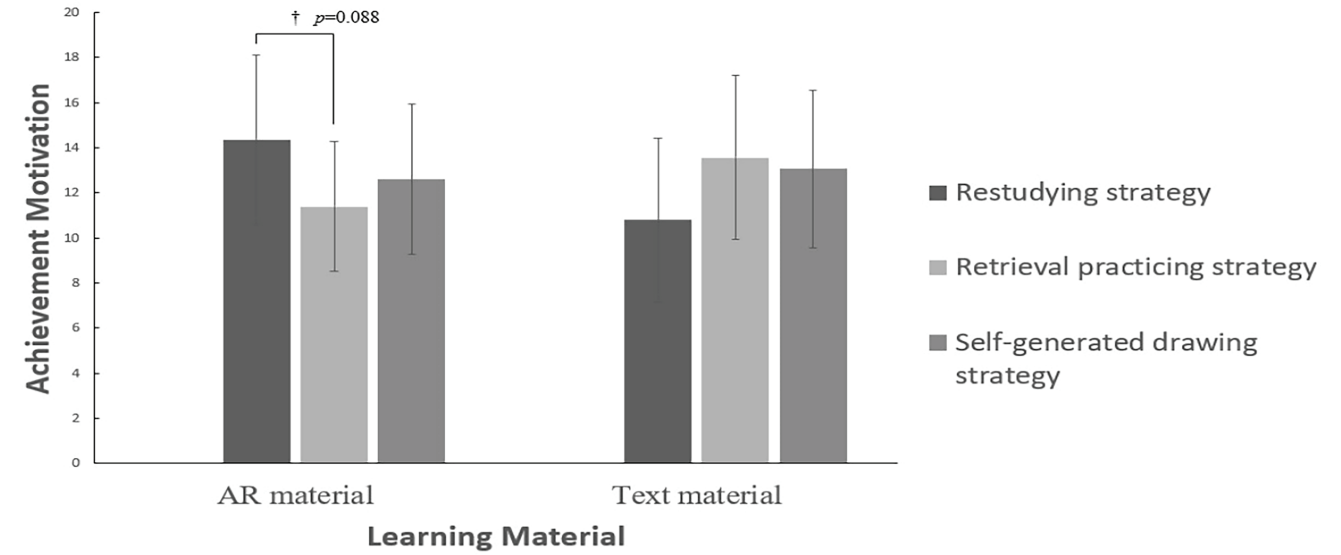

FIGURE 3 | Achievement motivation under different learning conditions. *$p<0.05$, **$p<0.01$, ***$p<0.001$, †$0.05<p<0.10$.

Self-generated drawing is mainly a process in which individuals form psychological images by word processing, and draw them. Compared with the plane images presented by text materials, the processing complexity of 3D dynamic images presented by AR materials increases, and its ICL also increases, which may reduce students' learning efficiency and further lead to the reduction of deep motivation (Ding and Luo, 2009; Sweller et al., 2011). Cao et al. (2005) also pointed out that the correct rate of working memory resource strategy used by grade 3 primary school students will decrease significantly with the increase of cognitive load difficulty. Therefore, the disadvantages of the application of AR technology in education also need to be considered. The learning strategies discussed in this study are mainly based on visual presentation. Previous studies on multimedia learning pointed out that learning strategies from the perspective of hearing will also affect learners' learning process and results. Xiong et al. (2018) proved through experiments that when presenting multimedia learning materials, reducing the pitch by 0.5 ERB can effectively induce learners' positive emotions. Mayer (2009) also proposed that compared with a single visual channel material, the presentation of audio-visual dual channel materials in multimedia learning is conducive to learners' memory and transfer, that is, to produce a Modality Effect. Are the research results in the field of multimedia learning consistent with those in the field of AR learning? Future research can further explore the impact of learning strategies on children's learning motivation in AR learning based on multi-sensory channels such as hearing and touch.

The Combination of Different Learning Modes and Learning Strategies Leads to a Change in Pupils' Achievement Motivation

As can be seen from **Figure 3**, when learning with text materials, students' achievement motivation of using extraction practice strategy is higher than that of repeated learning strategy. Perhaps because the sample size does not reach the ideal level, the significance of this trend can not be verified, which needs to be tested by expanding the sample in follow-up research. According to the theory of achievement motivation, when the probability of success is equal, the attraction of goals is the main factor affecting individual achievement motivation (Jia and Liu, 2011; Anderman, 2020). When learning with text materials, compared with retrieval practicing strategies, restudying strategies are more boring, consumes pupils' passion for learning and may reduce pupils' achievement

motivation. AR materials are presented in 3D. Although the materials appear repeatedly during learning, pupils can still maintain a high degree of attention. However, the presentation time of 3D animation in the retrieval practicing strategy is short, and the interest cannot be sustained, so pupils' achievement motivation is relatively low. Among the students who adopt restudying strategies, the achievement motivation when using AR materials is higher than that when using text materials, which also proves that presenting learning materials in the form of AR video can effectively stimulate students' achievement motivation and then help to improve their academic performance (Schüler et al., 2021).

Therefore, in order to cultivate pupils' positive learning motivation in primary school, teachers need to guide pupils to adopt diversified learning strategies to transform different learning contents of different disciplines. For the learning materials that need to be understood and explored, the effect of using retrieval practicing strategies will be more prominent. Finally, the application of AR multimedia technology in the field of education can process boring text materials and present them in the form of animation images, which is helpful to improve pupils' achievement motivation.

CONCLUSION

(1) Retrieval practicing strategies have positive significance in cultivating deep motivation. (2) The combination of different learning modes and learning strategies will impact achievement motivation.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the academic and ethics committee of school of education in Hebei University. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

XZ: conceived the study. XZ, ML, and YL: carried out the study and wrote the paper. All authors contributed to the article and approved the submitted version.

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Influencing Factors of International Students' Anxiety Under Online Learning During the COVID-19 Pandemic: A Cross-Sectional Study of 1,090 Chinese International Students

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Objective: We conducted the following cross-sectional study to comprehensively assess the anxiety among Chinese international students who studied online during the COVID-19 pandemic and its influencing factors.

Methods: Questionnaires were distributed through "Sojump," and a total of 1,090 valid questionnaires were collected. The questionnaire was divided into two parts: general situation and anxiety assessment of students. The former used a self-made questionnaire, and the international general GAD-7 scale was used to measure anxiety. Chi-square test was used to analyze the differences between groups, and logistic regression analysis was performed for the factors with differences.

Results: Anxiety was found in 707 (64.9%) of 1,090 international students. Chi-square test and multivariate Logistic regression analysis showed that the incidence of anxiety was higher in the group under 22 years of age than in the group over 22 years of age (68% vs. 61%, $p = 0.015$; OR = 1.186, 95% CI 1.045–1.347, $p = 0.008$); International students living in big cities had a higher incidence of anxiety than those living in rural areas (67% vs. 60%, $p = 0.022$; OR = 1.419, 95%CI 1.038–1.859, $p = 0.011$); international students who socialized 3 times or less monthly had a higher incidence of anxiety than those who socialized more than 3 times per month (68% vs. 58%, $p = 0.003$; OR = 1.52, 95%CI 1.160–1.992, $p = 0.002$); international students who expected purely online teaching had a higher incidence of anxiety than those who expected purely offline teaching or dual-track teaching (72% vs. 64%, $p = 0.037$; OR = 1.525, 95%CI 1.069–2.177, $p = 0.02$); international students with a subjective score of online learning experience of 6 or less had a higher incidence of anxiety than those with subjective scores of more than 6 (70% vs. 60%,

$p = 0.001$, OR = 1.25, 95%CI 1.099–1.422, $p = 0.001$). However, gender, emotional status, BMI, major of study, vaccination status, and degree type had no significant difference in the incidence of anxiety among international students who studied online during the COVID-19 pandemic.

Conclusion: During COVID-19, international students who were younger, came from big cities, had low social frequency, expected purely online teaching, and had poor experience of online classes were risk factors for anxiety during online classes.

Keywords: international students, anxiety, COVID-19, online learning, public health emergency, mental health, online survey, cross-sectional study

INTRODUCTION

In January 2020, the World Health Organization listed COVID-19 as a public health emergency of international concern (Yue et al., 2020). As of 2 August 2021, COVID-19 has rapidly spread to 208 countries and territories, making it a global pandemic with over 200 million infections and over 4 million deaths worldwide. Studies have shown that COVID-19 has caused a psychological crisis in the public that urgently needs to be addressed (Choi et al., 2020; Dong and Bouey, 2020; Gao et al., 2020; Gómez-Salgado et al., 2020; Huang and Zhao, 2020; Wang et al., 2020; Yang et al., 2020). The COVID-19 pandemic has triggered a psychological crisis among the public because of the increased prevalence of mental illness, including anxiety and depression (Asmundson and Taylor, 2020; González-Sanguino et al., 2020; Kola, 2020; Ozamiz-Etxebarria et al., 2020; Ahn et al., 2021). The public's positive psychological response to COVID-19 has played a crucial role in reducing anxiety. Positive thoughts and attitudes can help individuals cope with stressors (Görgen et al., 2014). A recent study found that the hope helps prevent anxiety (Mirhosseini et al., 2020). The theory of rational emotive behavioral therapy suggests that rational beliefs can relieve anxiety and other symptoms of mental distress (David et al., 2018; Eseadi, 2019). In addition, cognitive-behavioral models of health anxiety suggest that negative emotions and misunderstanding of health-related stimuli may increase the chance of developing anxiety (Gautreau et al., 2015; Hagger et al., 2017; Schäfer et al., 2017). Therefore, promoting positive psychological response, initiating emotional regulation, and positive cognition of health-related information, such as maintaining a positive attitude and rationality, is necessary for the public to better cope with stress (Grecucci et al., 2015). It is worth noting that the psychological impact of COVID-19 on students is significant. Previous studies have also shown that after the government blockaded the city for a week, the rating of anxiety and depression among students increased significantly and reached a stable state in the second week but remained at a poor level (Jin and Fung, 2021). Two months after online learning, the anxiety and depression among students still increased significantly (Magson et al., 2021). So, after implementing online courses for a year, what is the students' psychological state? However, no relevant literature has been reported so far.

International students, primarily college students, are a huge and leading group for world cultural and academic exchanges. According to the Ministry of Education, PRC, there were 700,000 Chinese students studying abroad in 2019. With the increasing demand for academic qualifications in society, international students have increased yearly. The mental health of this particular group has attracted more and more attention (Wang et al., 2015).

To avoid infection or implement border blockade policies, many schools worldwide have transferred traditional offline teaching to online. The outbreak of COVID-19 has also forced many Chinese international students to stay in China for online learning. When the teaching mode changed from the expected foreign campus to the computer at home, such large-scale online teaching came as suddenly as COVID-19, international students were significantly affected both physically and mentally. Therefore, as a particular group, the anxiety and its influencing factors of international students under online learning during the COVID-19 pandemic are worthy of our attention. However, for example, previous studies have not focused on issues of mental health among international students or the context of online learning among international students during the COVID-19 pandemic. To better understand the anxiety among international students under online learning and its influencing factors during the COVID-19 pandemic, we conducted a cross-sectional study on the anxiety and its influencing factors of international students.

The main objective of this study was to assess anxiety and its influencing factors in a sample of 1,090 Chinese international students who studied online during the outbreak of COVD-19. In this study, A standardized mental health measure (GAD-7) was used to assess acute anxiety symptoms. Our study found that age, cities of residence, the frequency of socialization, expected teaching mode, and subjective experience of online learning influenced the anxiety of international students.

MATERIALS AND METHODS

Research Object and Procedures

To investigate the anxiety among international students who studied online during the COVD-19 pandemic, we adopted a

Abbreviations: GAD-7, Generalized Anxiety Disorder 7-item; OR, Odds ratio.

cross-sectional study design and questionnaires through the "Sojump," an Internet-based questionnaire application in mainland China. We distributed questionnaires on the platform of 15 WeChat international student groups with a total of about 15*500 = 7,500 people. This survey adopted the principle of voluntary participation, and 1,101 questionnaires were collected. 11 questionnaires were invalid for interfering with common sense problems, and 0 were excluded within 2 min. A total of 1,090 valid questionnaires were collected, and the recovery rate was 99%. The WeChat group of international students was established spontaneously by Chinese international students to facilitate communication in all aspects of study and life abroad. The person in charge of this survey is in charge of the WeChat group mentioned above. During the outbreak of COVID-19, we distributed questionnaires in the name of the person in charge to understand the psychological conditions of the students during online learning.

The survey was conducted from August 15 to 25, 2021, during which we obtained a sufficient sample size in accordance with previous related studies (Hu et al., 2007; Kamangar and Islami, 2013; Zhang et al., 2017; Liu et al., 2020). The questionnaire consisted of two parts: the internationally recognized Chinese Version of the Generalized Anxiety Disorder Scale (GAD-7) and the self-designed general situation of international Students who studied online due to the outbreak of the COVID-19 pandemic. It takes about 3–5 min to complete the questionnaire. The inclusion criteria for participating in this study were: international students who have taken online courses for a certain period, have Chinese reading and writing ability, can use smartphones to complete the questionnaire, and were willing to participate. Exclusion criteria were any treatment for mental illness, any history of drug dependence, and any diagnosis of illness or injury that might prevent them from completing the questionnaire independently.

The questionnaire was submitted after the participants had answered all the questions. Only data from the complete questionnaires were analyzed.

Moral Statement

The study was carried out by the Declaration of Helsinki (1989). This study was approved by the Ethics Committee of Xiangya Hospital of Central South University. In the process of informed consent in the preamble of the questionnaire, we left the contact information of the project team members for the respondents. If the international students need professional psychological consultation, they can contact us through our contact information.

Demographics and the General Situation of International Students Who Studied Online During the COVID-19 Pandemic

Demographic characteristics of participants were collected in this study, including gender, age, emotional status, BMI, city of residence, the location of the school they attended, major of study, vaccination status, and degree type. During the COVID-19 pandemic, the general situation of international students who studied online included advantages and disadvantages of online learning, time difference, average daily study duration, average daily sleep duration, the frequency of physical exercise, the frequency of socialization, primary ways to relieve stress, measures to deal with infection risk, expected teaching modes in coming semesters, concerns about COVID-19 infection, and subjective ratings of the online learning experience. The significant advantages and disadvantages of online learning, the primary ways to relieve stress, and the primary measures to deal with the risk of infection were multiple-choice questions. Participants chose at least one of these multiple choices and could choose up to five. The subjective score of online learning experience during the COVID-19 pandemic was 10 points, with 0 points for completely dissatisfied and 10 points for completely satisfied.

Measurement of Anxiety

Gad-7 is one of the most reliable measures of generalized anxiety disorder. Anxiety-related psychological problems were assessed on the Likert-4 scale, with options ranging from "totally uncertain = 0," "a few days =1," "more than half the time = 2," and "almost every day =3" on a scale of 0 to 21. The threshold of anxiety was set to higher than 5 based on the Gad-7 score (Ahn et al., 2021; Park et al., 2021; Yoo et al., 2021).

Statistical Analysis

SPSS software (version 23.0) used to perform all statistical analysis. The Chi-square test was used to analyze the difference in anxiety degree among groups. Anxiety was assessed using a binary variable (anxiety or non-anxiety, measured on the GAD-7 scale). The variables included in multivariate logistic regression analysis included age, city of residence in China, subjective experience score of online learning, the frequency of socialization, and expected teaching method, all of which were two variables. When the two-tail p-value was less than 0.05, the result was considered to be statistically significant.

RESULTS

Demographic Characteristics and Prevalence of Anxiety Among International Students Who Studied Online During the COVID-19 Pandemic

Our study found anxiety in 707 (64.9%) of 1,090 international students. 1,101 international students participated in the survey, of which 1,090 were valid questionnaires with an effective rate of 99.0%. *The general situation of international students and their opinions toward online learning are shown in* **Table 1**. Students from schools in Europe and Hong Kong, Macao, and Taiwan accounted for 37.8 and 27.1%, respectively, while those from schools in Oceania accounted for less than 10%(6.3%). The top three majors chosen by international students were economics and finance, management, and engineering, accounting for 21, 15, and 12%, respectively. History, agriculture, and military science were the least popular, accounting for less

TABLE 1 | General situation of 1,090 Chinese international students who studied online during the COVID-19 pandemic.

Variables	Frequency	Chi-square	*p*-value
The location of schools			
North America	151(13.9)	1945.68	0
Europe	412(37.8)		
Asia	163(15)		
Oceania	69(6.3)		
Hong Kong, Macao and Taiwan	295(27.1)		
Major of study			
Philosophy	13(0.01)	702.04	0
Economics and finance	230(0.21)		
Law	39(0.04)		
Pedagogy	122(0.11)		
Literature	123(0.11)		
History	12(0.01)		
Science	101(0.09)		
Engineering	133(0.12)		
Agronomy	10(0.01)		
Medicine	61(0.06)		
Management	166(0.15)		
Art	79(0.07)		
Military science	1(0)		
Advantages of online learning			
Saving living and commuting expenses	747(0.69)	1369.86	0
Saving commuting time	751(0.69)		
Effectively reduce the risk of COVID-19 infection	872(0.8)		
No extra time needed to get used to the new environment	387(0.36)		
No social fear	329(0.3)		
Online courses can be played repeatedly for easy understanding and review	582(0.53)		
Online courses are fast paced and more efficient	130(0.12)		
Translation software/plug-ins can be used to solve the language barrier	296(0.27)		
Online courses may have higher grades	101(0.09)		
Disadvantages of online learning			
Time difference can easily lead to a chaotic daily routine	337(0.31)	918.7	0
The Difficulty of concentration	744(0.68)		
Poor network connection	557(0.51)		
Unable to interact with teachers immediately	552(0.51)		
Inconvenience to exchange ideas with classmates	560(0.51)		
The lack of campus atmosphere of studying abroad	768(0.7)		
Lack of social interaction	312(0.29)		
Inconvenience for scientific research	189(0.17)		
The trouble of Preparing for exams	129(0.12)		
The ways to relieve stress			
Chatting with friends online	719(0.66)		
Watching TV series& movies	841(0.77)		
Shopping and dining out	539(0.49)		
Doing physical exercise	480(0.44)		
Playing video games	377(0.35)		
Massage	125(0.11)		
Watching ASMR videos	96(0.09)		
Primary measures to address the risk of COVID-19 infection			
Vaccination	894(0.82)	1922.38	0
Wearing a mask	971(0.89)		
Washing your hands regularly	806(0.74)		
Keeping Social distance	832(0.76)		
Avoid visiting crowded places	772(0.71)		
Gap year/delay until the epidemic stabilizes	190(0.17)		
Drop out of school	33(0.03)		
Transfer to another schools in areas where the epidemic is stable	83(0.08)		

than 1%. The top three advantages of online learning were effectively reducing the risk of COVID-19 infection, saving living and commuting expenses, and saving commuting time, with a cumulative selection rate of 80, 69, and 69%, respectively. The two significant disadvantages of online learning were the difficulty of concentration and the lack of campus atmosphere

of studying abroad. The cumulative selection rate was 70 and 68%, respectively. In addition, primary ways for international students to release pressure were watching TV series & movies (77%) and chatting with friends online (66%), followed by dining out & shopping (49%) and physical exercise (44%). The primary measures for these international students to deal with the risk of infection were wearing masks (89%), getting vaccinated (82%), maintaining social distance (76%), washing hands frequently (74%), and reducing the times of visiting crowded places (71%), while only 11% of them chose to drop out (3%) or transfer to another school (8%).

Factors Influencing the Anxiety Among International Students Who Studied Online During the COVD-19 Pandemic

Students with GAD-7 scores higher than or equal to 5 were defined as the anxiety group, and the Chi-square test was used to analyze the influencing factors of anxiety among the international students who studied online due to the outbreak of COVD-19. The results are shown in **Table 2**. Among the international students who studied online, the incidence of anxiety was 68%(383/561) among the international students under the age of 22, compared with 61%(324/529) among those higher or equal to the age of 22. There was a statistical significance between the two groups (Chi-square = 5.893, $p = 0.015$). Among the international students who studied online, 67%(500/745) of those students living in first-tier and provincial capital cities and Hong Kong, Macao, and Taiwan *(hereinafter referred to as big cities)* felt anxious. In comparison, 60%(207/345) of international students living outside first-tier and provincial capital cities and in rural areas *(hereinafter referred to as small cities and rural areas)* felt anxious. There was a statistical significance between the two groups (Chi-square = 5.236, $p = 0.02$). Among the international students who studied online, 68%(512/756) of them who socialized three times or less monthly felt anxious about online learning, compared with 58%(195/334) of students who socialized three times or more monthly. There was a statistical significance between the two groups (Chi-square = 8.87, $p = 0.003$). Among the international students who studied online, the incidence of anxiety among those who wished for purely offline teaching or dual-track online and offline teaching was 64%(567/907), compared with 72%(131/183) among those who wished purely online teaching. There was a statistical significance between the two groups (Chi-square = 4.361, $p = 0.037$). Among the international students who studied online, 70%(341/484) students with a subjective score of online learning experience during the COVID-19 pandemic of 6 or less felt anxious, while 60%(366/696) of them with a subjective score of more than 6 felt anxious. There was a statistical significance between the two groups (Chi-square = 11.945, $p = 0.001$). However, gender, emotional status, BMI, vaccination or not, degree type, time difference, daily study duration, daily sleep duration, and frequency of physical exercise had no significant difference in the incidence of anxiety among international students who studied online.

Logistic Analysis of Factors Influencing the Incidence of Anxiety Among International Students Who Studied Online During the COVID-19 Pandemic

Our study combined age, the resident city in China, the frequency of socialization, expected teaching methods, and subjective experience score of online courses to construct a multi-factor Logistic regression equation (**Table 3**). We found that international students under the age of 22 were at increased risk of anxiety compared with those higher or equal to the age of 22, and the difference was statistically significant (OR = 1.186, 95%CI 1.045–1.347, $p = 0.008$). Compared with international students in small cities and rural areas, the students living in big cities were at increased risk of anxiety, and the difference was statistically significant (OR = 1.419, 95%CI 1.038–1.859, $p = 0.01$). Compared with the international students with a subjective score of online learning experience during the COVID-19 pandemic higher than 6, students with a subjective score less than or equal to 6 were at increased risk of anxiety, and the difference was statistically significant (OR = 1.25, 95%CI 1.099–1.422, $p = 0.001$). Compared with the international students who socialized more than three times a month, those who socialized less than three times per month were at increased risk of anxiety, and the difference was statistically significant (OR = 1.52, 95%CI 1.160–1.992, $p = 0.002$). Compared with the international students who wished for purely offline or online and offline dual-track teaching in coming semesters, those who wished for purely online teaching were at increased risk of anxiety, and the difference was statistically significant (OR = 1.525, 95%CI 1.069–2.177, $p = 0.02$).

DISCUSSION

With the development of globalization and increasingly fierce competition in society, international students are increasing year by year. As a result, the mental health of this unique group is also attracting more and more attention. Previous studies have suggested that international students in higher education are prone to mental health problems, such as depression and anxiety (Wang et al., 2015). At the same time, international students are the vulnerable group with apparent mental health problems, which indicates that the research on international students' mental health is rapidly expanding and developing toward a new research direction (Han et al., 2013; Wang et al., 2015). We observed that 707 out of 1,090 Chinese international students participating in the study felt anxious, accounting for 64.86%. The prevalence of these international students significantly exceeds the post-pandemic incidence of anxiety among the general population (31.9%; Salari et al., 2020). Apparently, the prevalence of anxiety among these international students was twice that of the general population. Since universities in many countries have been forced to switch from offline to online teaching due to the high contagiousness of COVID-19, international students were forced to return to their home countries for online study. The mode of online

TABLE 2 | Analysis of influencing factors on the incidence of anxiety during online courses for international students.

	Non-anxiety n (%)	Anxiety n (%)	Total	Chi-square	*p*-value
Gender					
Male	95(0.37)	160(0.63)	255	0.665	0.48
Female	288(0.34)	547(0.66)	835		
Age					
≥22 years old	178(0.32)	383(0.68)	561	5.893	0.02
<22 years old	205(0.39)	324(0.61)	529		
Relationship status					
Single	256(0.34)	500(0.66)	756	1.760	0.19
Non-single	127(0.38)	207(0.62)	334		
BMI					
Low	103(0.31)	230(0.69)	333	3.734	0.16
Medium	242(0.37)	411(0.63)	653		
Height	38(0.37)	66(0.63)	104		
City of residence in China					
Big cities	245(0.33)	500(0.67)	745	5.236	0.02
Small cities and rural areas	138(0.4)	207(0.6)	345		
COVID-19 vaccination status					
Completed vaccination	306(0.35)	572(0.65)	878	0.162	0.69
Incomplete vaccination	77(0.36)	135(0.64)	212		
Degree type					
Undergraduate and below	166(0.34)	318(0.66)	484	0.270	0.60
Postgraduate and above	217(0.36)	389(0.64)	606		
Time difference in online courses					
With time difference	121(0.33)	250(0.67)	371	1.571	0.20
Without time difference	262(0.36)	457(0.64)	719		
The average daily study duration					
≤5 h	236(0.35)	430(0.65)	666	0.067	0.80
>5 h	147(0.35)	277(0.65)	424		
The average daily sleep duration					
≤6 h	54(0.33)	111(0.67)	165	3.391	0.18
6–8 h	221(0.34)	432(0.66)	653		
>8 h	108(0.4)	164(0.6)	272		
Frequency of physical exercise					
No physical exercise	98(0.32)	210(0.68)	308		
1–2 times weekly	178(0.37)	308(0.63)	486	2.094	0.35
>3 times weekly	107(0.36)	189(0.64)	296		
Frequency of socialization (e.g., shopping, eating, and going to the movies)					
≤3 times monthly	244(0.32)	512(0.68)	756	8.870	0.00
>3 times monthly	139(0.42)	195(0.58)	334		
The expected teaching mode in coming semesters (2021 fall & 2022 spring)					
Pure *offline* teaching/*online and offline dual-track* teaching	331(0.36)	576(0.64)	907	4.361	0.04
Pure *online* teaching	52(0.28)	131(0.72)	183		
The concerns about the risk after forcing mandatory on-campus teaching					
Worry	341(0.34)	652(0.66)	993	3.112	0.08
No worry	42(0.43)	55(0.57)	97		
Subjective score of the experience of online learning during the COVID-19 pandemic (from 1 to 10)					
≤6	143(0.3)	341(0.7)	484	11.945	0.00
>6	240(0.4)	366(0.6)	606		

teaching can be a challenge for many international students. This survey was conducted 1 year after the outbreak of COVID-19 in China, mainly to understand the situation of international students from China after 1 year of online learning and the influencing factors of anxiety.

Our research showed that international students from schools in Europe (37.8%) and Hong Kong, Macao, and Taiwan (27.1%) accounted for the majority, while those from schools in Oceania accounted for less than 10% (6.3%). From the perspective of the regions chosen by international students, fewer international students chose schools in Oceania. Their choices may be affected by the border blockade policies of Oceanian countries, such as Australia and New Zealand. As a result, many international students can only study online in China for a long time and therefore do not consider Oceania as their first choice. In addition, our results showed that the proportion of international students who chose to study in Asia (Hong Kong, Macau, Taiwan, and other parts of Asia) was as high as 42.1%. It is not hard to see that Asia has become one of the new education centers, attracting more international students. According to our results, the top

TABLE 3 | Logistic regression analysis of the incidence of anxiety during online courses for international students.

	B	Wald	*p*-value	OR-value	95% confidence	
		Chi-square value			Interval	
Age						
≥22 years of age*	0.171	6.931	0.008	1.186	1.045	1.347
<22 years of age						
City of residence						
Small cities and rural areas*	0.35	6.449	0.01	1.419	1.083	1.859
Big cities						
Subjective score of the online learning (from 1 to 10)						
>6*	0.223	11.52	0.001	1.25	1.099	1.422
≤6						
Frequency of socialization						
>3 times monthly*	0.419	9.204	0.002	1.52	1.16	1.992
≤3 times monthly						
The expected teaching mode in coming semesters						
Offline teaching or *online* and *offline* dual-track teaching*	0.422	5.414	0.02	1.525	1.069	2.177
Pure *online* teaching						

**Is the control group.*

three majors chosen by international students were economics, management, and engineering, accounting for 21, 15, and 12%, respectively. History, agriculture, and military sciences, by contrast, accounted for less than 1%. The distribution of majors chosen by international students is relatively consistent with the popular majors chosen by Chinese college students (Wu et al., 2021).

The top three advantages of online learning were effectively reducing the risk of COVID-19 infection, saving living and commuting expenses, and saving commuting time, with the cumulative selection rate of 80, 69, and 69%, respectively. Online learning, where students are primarily at home, can effectively reduce the probability of COVID-19 infection by avoiding gatherings (Wu et al., 2021). At the same time, since the price of necessities in Europe and the United States is much higher than that in mainland China, students can save a lot expenses. The two most significant disadvantages of online learning were the difficulty of concentration and the lack of campus atmosphere of studying abroad, with a cumulative selection rate of 70 and 68%, respectively. It can be seen that online courses without face-to-face supervision by teachers and the atmosphere of studying together with other students is likely to cause distraction in class, which is consistent with the research of Mukhtar et al. (2020). This is why online learning places higher demands on self-discipline of students. At the same time, online learning, as the scope of activity for international students is mainly at home, international students who were unable to experience campus life have become the regret of those who studied online during the COVID-19 pandemic.

Nevertheless, international students can make up for this by interacting with their peers in China. Gradually, with the control of COVID-19 and the resumption of offline classes, It is believed that these international students taking online courses during the COVID-19 pandemic will cherish campus life more after returning to campus. Therefore, in the long run, short-term online learning may play a positive role in promoting international students to experience the campus culture and atmosphere.

Watching TV series & movies and chatting with friends accounted for 77 and 66%, respectively. However, the proportion of dining out & shopping and physical exercise was only 49 and 44%, respectively. According to our study, international students tended to choose leisure activities that can be completed at home and on the Internet, such as watching TV series and movies and chatting with friends online, while those that need to be completed outdoors, such as dining out and shopping and physical exercise were relatively low. On the one hand, affected by the COVID-19, students may purposely avoid gathering. On the other hand, most students may like to stay alone. With the COVID-19 pandemic under control, students can subjectively increase some recreational ways to interact with others.

The top five measures to deal with risk of COVID-19 infection were wearing a mask, getting vaccinated, maintaining social distance, washing hands frequently, and reducing visits to crowded places (89, 82, 76, 74, and 71%, respectively). It is not hard to see that more than a year after the outbreak of COVID-19, with the exception of vaccination, other anti-epidemic measures were consistent with the measures taken at the beginning of the COVID-19 outbreak (Liguori and Winkler, 2020). At the same time, the results of this study are consistent with the results of another study on Chinese college students (Shen et al., 2021). Combining the two studies, it can be concluded that Chinese college students, whether studying in China or abroad, have high support and compliance for non-drug intervention (NPI) prevention.

Our research (**Table 2**) showed that age, geography, the frequency of socialization, expected teaching methods, and subjective experience of online learning were influencing factors for international students' anxiety. These related factors were also the core of this study, which can provide part of the basis

for colleges and universities to quickly screen international students with a high risk of anxiety. Colleges and universities can carry out early intervention for students with risk through health promotion and psychological education so that the limited psychological consultation resources can reach the students who are most likely to benefit and then reduce the occurrence of anxiety among international students (Gladstone et al., 2021).

Age Factors

Our findings suggested that age was strongly associated with positive psychological responses. The prevalence of anxiety was higher among the international students under the age of 22 (68%) than those higher or equal to the age of 22 (61%), suggesting that younger age may be a risk factor for anxiety among these international students who studied online during the COVID-19 pandemic. Our result is consistent with previous studies showing that younger age is a risk factor for anxiety (Brenes, 2006; Guo et al., 2016; Xiong et al., 2020). Compared with older students, young international students have less social cognition and future prediction because young international students tend to have less social practice and experience. With lower self-regulation and psychological resilience, the younger group tends to be worried about the uncertain future and negative academic impact of online teaching in the context of COVID-19, such as the acceptance of online courses by future employers. Conversely, due to their rich social experience and cognition, international students in the older group have stronger psychological endurance. As a result, they are less worried about negative impacts. Therefore, schools should pay more attention to young international students or carry out psychological counseling to relieve the anxiety of younger international students.

Geographical Factors

Our study also found that geographical factors were an influencing factor for anxiety. Previous studies have pointed to a higher prevalence of anxiety disorders in the urban area of China (7.6%) than in rural China (4.66%; Guo et al., 2016). Our result is also in line with the high incidence of anxiety disorders in cities during the COVID-19 pandemic (Ren et al., 2020). Living in big cities was a risk factor for anxiety for international students who studied online during the COVID-19 pandemic. In addition, according to our survey data, most of these international students (745/1090) came from big cities, which is also related to the developed economy, high education level, and active thinking. This phenomenon reflects that the distribution of educational resources in China is relatively concentrated in big cities. International students from big cities live in more developed regions, where talent concentration leads to greater competition, thus increasing risk factors for anxiety.

Moreover, the cost of living in big cities, such as housing prices, is higher than in relatively small cities and rural areas, which may also increase the stress of international students. Faced with the pressure from fierce competition and high living costs, these international students who studied online in big cities may worry about the lack of competitiveness caused by online learning or other factors, thus increasing the risk of anxiety. Therefore, schools and health professionals should pay more attention to the mental health of international students from big cities.

The Frequency of Socialization

In this study, the frequency with which international students socialized with others (such as shopping and dining out and watching movies) 3 times or less a month was a risk factor for anxiety. Among international students who studied online during the COVID-19 pandemic, the lower frequency of socializing outside to some extent reduces the space and channels for releasing stress, thus increasing the perception of stress, anxiety, and other negative emotions. For these international students, instead of staying in one environment for a long time, going out and socializing with friends to get outside support is an effective way to relieve and vent stress. Previous studies have suggested that social support may reduce genetic and environmental vulnerability and imbue resilience to stress through its effects on the hypothalamic–pituitary–adrenal cortex (HPA) system, the norepinephrine system, and the central oxytocin pathway, so social support is essential for maintaining physical and mental health (Ozbay et al., 2007). Conversely, those international students with low frequency of socialization, lack of social support, and long-term exposure to the same environment cannot relieve the stress from online learning, thus increasing anxiety. Compared with the frequency of socialization, the difference in daily sleep duration, the frequency of physical exercise, and daily study duration was not significantly correlated with anxiety. Our result also suggested that the improving lifestyles, including sleep duration, physical exercise, and study duration, was not as effective as increasing the frequency of socialization in reducing anxiety. Our study is partially consistent with a Malaysian study of Malaysian university students (Mohamad et al., 2021). Our research suggested that active participation in social activities can reduce anxiety in students. The difference is that local studies in Malaysia have shown that sleep quality and BMI were the influencing factors of anxiety. In contrast, in our study, there was no correlation between sleep and BMI and anxiety among international students. On the one hand, this may be due to sample selection bias. On the other hand, it also indicated that increasing social frequency could be more significant for international students in alleviating anxiety than for local students. Therefore, international students should increase the frequency of social activities as possible, instead of staying in the same environment every day, to relieve anxiety.

Expected Teaching Mode

In this study, the expectation that the teaching mode of the coming semesters (2021 fall & 2022 Spring) would be purely online was a risk factor for anxiety of these international students. Notably, students expecting purely online teaching were more anxious, suggesting that the main factor causing anxiety among these students is not the online learning themselves but the risk of COVID-19 infection brought by face-to-face classes. Compared with those who expected pure face-to-face teaching and online and offline dual-track teaching, international students who expected purely online teaching may be more worried about their health risks caused by the COVID-19 pandemic due to some reasons, such as poor physical fitness

or other psychological problems. That is because online classes, compared with offline courses, provide a platform for international students to avoid the risk of infection. In the coming semesters, many schools have announced the resumption and mandatory offline classes, which may increase the anxiety of these students. Therefore, the school had better make special teaching arrangements, such as online and offline dual-track teaching, for those who cannot participate in offline teaching for various reasons rather than forcing completely face-to-face teaching to relieve their anxiety.

Subjective Experience of Online Learning

In this study, poor subjective experience of online learning (rating the subjective experience of online courses less than 6 out of 10) was a risk factor for anxiety of these international students. Among the international students who studied online during the COVID-19 pandemic, some were upset due to various inconveniences from online classes, such as poor Internet connection and the inability to interact with instructors immediately. These international students may be anxious about their grades or the recognition of their qualifications gained through online teaching by future employers due to poor experiences of online learning. In contrast, international students who rated the experience of online learning higher than 6—those who were more adaptable to online learning—were less likely to experience anxiety. Moreover, there may be a correlation between psychological stress, coping style, adaptability, and mental health (Zimmermann et al., 2012; Zhou et al., 2017). International students with pessimism or anxiety are also more likely to experience poor online teaching.

On the contrary, students with solid adaptability tend to have a better experience of online learning. Our result is also consistent with previous studies that whether students adapt to online courses significantly affects anxiety (Zhao et al., 2021). In addition, people with positive coping styles have better mental health than those with negative coping styles (Wu et al., 2020). Students with high psychological resilience can better understand the meaning of positive coping styles, thus effectively overcoming difficulties in adversity (Hartley, 2011). Therefore, schools should continue to upgrade the facilities for online learning and take other measures to improve the online teaching experience. At the same time, schools can also increase communication with students, genuinely understand the factors that affect students' online teaching experience and make appropriate corrections. While improving students' experience of online courses, it is also possible to improve students' learning efficiency, enthusiasm, academic performance, and mental health. During the COVID-19 pandemic, students with anxiety should also seek outside support during online study, such as reaching out to instructors or seeking psychological counseling (Ozbay et al., 2007).

LIMITATIONS

Some limitations should be acknowledged. Firstly, data were collected through online questionnaires on social platforms, leading to information bias and misclassification. Participants may not have provided accurate information, either included in the study or quickly completed the survey. Therefore, it is necessary to clean and filter the collected questionnaires, check the consistency and logicality of the answers, and adjust invalid and missing values. Due to the international students who participated in this study from the Internet, they did not complete it face-to-face. Secondly, due to the groups to which the questionnaire was collected, the number of international students in each region was not evenly distributed, hence affecting the overall results.

CONCLUSION

In conclusion, younger age, living in big cities, low frequency of socialization, the expectation of purely online teaching, and poor subjective experience of online courses were the risk factors for anxiety of these international students who studied online during the COVID-19 pandemic. To minimize the negative impacts of these risk factors of international students who studied online requires the joint efforts of the school and students. The school should provide psychological assistance to the corresponding groups in time and continuously upgrade the facilities to provide a better experience for online learning. At the same time, students should socialize and communicate more with their friends, trying to get more external support to relieve anxiety and stress.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Medical Ethics Committee, Xiangya Hospital, Central South University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JK, YT, and ZW were responsible for the study design. YT was responsible for collecting the data. YT and JK were responsible for the explanation of the data, data analysis, and drafting the manuscript. XQ, YL, LP, YG, SL, JD, QT, JW, XP, JL, and MS were responsible for the revision of the manuscript. All authors contributed to the article and approved the submitted version.

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ORIGINAL RESEARCH
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Improving the Behavioral Intention of Continuous Online Learning Among Learners in Higher Education During COVID-19

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The COVID-19 pandemic caused colleges and universities to rely heavily on online learning to continue knowledge dissemination to learners. This study used the second-generation model of unified theory of acceptance and use of technology (UTAUT2) to comprehensively analyze the mediating effects of *self-efficacy*, which affects learners' effective use of online tools for learning, and *capability of metacognition and self-regulation*, which can independently adjust learning progress into the UTAUT2 model, on the learner's willingness to continue online learning [i.e., their behavioral intention (BI)] by constructing a UTAUT2-based e-learning model. This study administered questionnaires to undergraduates in universities in East China to collect data. The effects of performance expectancy, effort expectancy (EE), social influence (SI), and facilitating conditions (FCs), hedonic motivation (HM), price value (PV), and habits on BI (directly or through mediators) were analyzed through data analysis and structural equation modeling, and the UTAUT2-based e-learning model was accordingly modified. The results indicated that the self-efficacy enhanced the effects of EE, SI, FCs, HM, and PV on learners' BI; that metacognition and self-regulation (MS) capabilities enhanced the effects of EE on learners' BI; and that habits had a direct and strong effect on BI. This study also provided some suggestions to enhance higher education learners' willingness to continue online learning, such as improving social recognition and support, careful design of teaching content, easy-to-use technology, financial support. These results and suggestions may guide colleges and universities in conducting, continuing, or enhancing online education, particularly as the pandemic continues.

Keywords: COVID-19, UTAUT2, online education, capability of metacognition and self-regulation, self-efficacy

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INTRODUCTION

During the COVID-19 pandemic that commenced in 2020, online learning helped overcome the social distancing restrictions to ensure that educational activities at all levels and types of schools could proceed. Colleges and universities have been required to exploit the advantages of online learning and promote the integration of online and offline teaching (Zhong and Nan, 2021). The strict supervision of education departments can partly guarantee the quality of the course content and teaching implementation. Nevertheless, many challenges remain, such as low satisfaction

with online learning, low participation, low readiness for online learning, low attention input, and poor completion rates (Li Y.Y. et al., 2020; Li Y. et al., 2020; Wan et al., 2020; Li et al., 2021). Some scholars have argued that external and objective aspects, such as teachers' learning ability and teacher support, should be improved to enhance the learning outcomes of online teaching (Jia et al., 2021; Jing et al., 2021). However, irrespective of the optimization of external objective conditions, learners' willingness to accept online learning and their internal psychological willingness to continue online learning constitute the core internal drive that determines learning outcomes (Clay et al., 2008).

The unified theory of acceptance and use of technology (UTAUT) can be used to predict the learner's behavioral intention (BI) (Liu et al., 2007). The second-generation model of UTAUT (UTAUT2) has the highest explanatory power for the acceptance and continuous use of individual technology among the existing models (Venkatesh et al., 2012). Mittal et al. (2021) extended the UTAUT which can highlight the determinants of the adoption of online teaching during COVID-19 with three new constructs, namely facilitative leadership, regulatory support and project team capability. This study extended the UTAUT2 by incorporating self-efficacy (SE), which affects learners' effective use of online tools for learning, and the capability of metacognition and self-regulation (MS), which can independently influence learning progress, as mediating variables. This extended model is called the UTAUT2-based e-learning model.

Tandon et al. (2021) identified the facilitators and inhibitors for the adoption of e-learning for the undergraduate students by structural equation modeling (SEM), found that all the identified facilitators emerged significant except social influence (SI) and price value (PV), and technology risk emerged insignificant while all other inhibitors had significant impact on BI to adopt e-learning. Several researchers from different countries have explore the effectiveness and learners' perceptions of online learning in higher education during COVID-19 (Al-Karaki et al., 2021; Packmohr and Brink, 2021; Peimani and Kamalipour, 2021; Ranjan et al., 2021). The purpose of this study is to validate the UTAUT2-based e-learning model to comprehensively explore learners' intention to continue online learning during COVID-19 in China, which is different from the previous studies. This study used questionnaires to collect data and a structural equation model (SEM) to verify the results and make suggestions for improving the learners' willingness to continue online learning.

OVERVIEW OF UTAUT2

Development From Unified Theory of Acceptance and Use of Technology to UTAUT2

Venkatesh et al. (2003) comprehensively analyzed eight models and extracted four independent variables—performance expectancy (PE), effort expectancy (EE), SI, and facilitating conditions (FCs)—to predict the BI and user behavior of users' continuous use of certain technologies, thereby forming the UTAUT. Studies have explored various fields of technological application using diverse approaches, such as single model, model expansion, model combination, and model integration (Zhang et al., 2018). A meta-analysis of 161 studies published from 2007 to 2016, revealed that the four independent variables of the UTAUT had moderate or even low effect values on BI and user behavior (Han, 2017). Venkatesh et al. (2012), who first proposed the UTAUT, added three independent variables to construct the UTAUT2 model: hedonic motivation (HM), PV, and habits (**Figure 1**). Compared with the UTAUT, the explanatory power of BI increased from 56 to 74% and user behavior increased from 40 to 52% in UTAUT2, which is the highest among the existing models (Wong et al., 2013).

Related Studies on Unified Theory of Acceptance and Use of Technology and UTAUT2

The UTAUT can predict BI in ordinary individuals and in learners (Liu et al., 2007; Yang et al., 2014). **Table 1** provides a summary of related studies that employed the UTAUT model to predict BI of continued use for a technology or product.

Most studies have explored learners' BI for using a technology or product based on the UTAUT model, but few have used the UTAUT2 model. Furthermore, multiple studies have integrated other influencing factors associated with learners, such as SE, metacognition, and self-regulation. Online learning relies on various synchronous and asynchronous teaching technology tools to achieve time and space flexibility. Teachers must provide a learning space for independent learning and meet the needs of learners for personalized learning. Therefore, the effect of online learning is largely dependent on the learners' SE related to using technology tools and their ability for self-regulation.

RESEARCH DESIGN

Model Reconstruction

Rodgers et al. (2002) verified the beneficial effect of SE on BI by using confirmatory factor analysis. Shiau and Chau (2016) employed a multimodel comparison approach and revealed that SE positively affected the BI of learners using cloud-computing classrooms. In addition, students have high SE and MS capabilities when learning online (Yuan, 2014). Chen and Hwang (2019) demonstrated that college students' willingness to use networks was indirectly influenced by MS capabilities.

Therefore, this study selected the UTAUT2 model, which has high explanatory power, and included SE and MS as the two mediating variables to explore their mediating effect on BI—that is, willingness of college learners to continue online learning. Considering that user behavior in the UTAUT2 model can be reflected by BI (Yang, 2016), this study considered BI as the independent variable. **Figure 2** presents the reconstructed UTAUT2-based e-learning model.

In the UTAUT2-based e-learning model, the independent variables affecting the willingness of college learners to continue

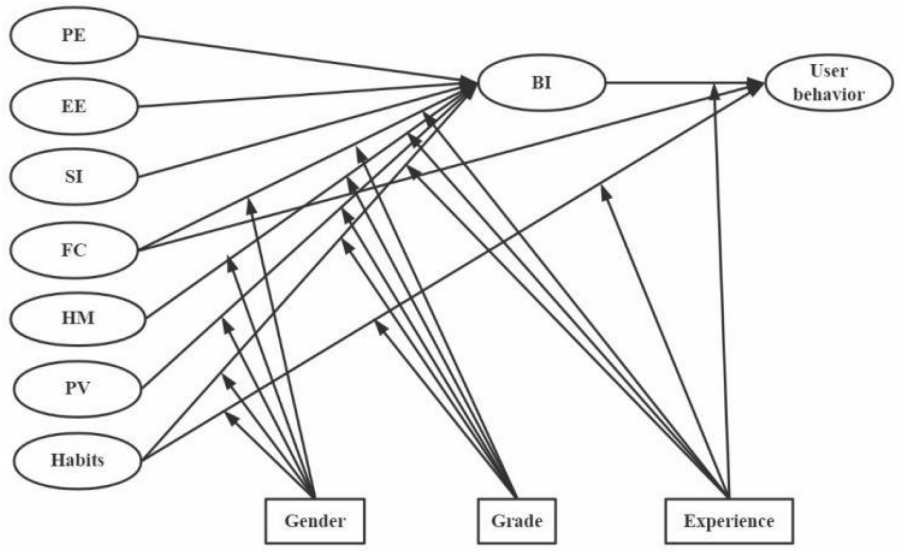

FIGURE 1 | The UTAUT2 model.

online learning were PE, EE, SI, FC, HM, PV, and habits; the mediating variables were SE and MS; and the relevant variables were gender, year of study, and experience.

Behavioral intention in this study was used to refer to the learners' willingness to continue online learning both during subsequent routine learning or emergency situations when they must remain at home after online learning during the pandemic period.

Performance expectancy refers to an individual's expectation that using a given technology would help improve their performance. In this study, PE was used to refer to the expectation of learners that online learning would improve their academic performance. The more the online learning meets their expectations, the stronger their BI is.

Effort expectancy refers to the difficulty of mastering a technology. In this study, EE was used to refer to the difficulty learners experience in mastering the use of online learning. When learners feel that technical problems in online learning can be addressed in a simple and rapid manner, BI is enhanced.

Social influence reflects the impact of others' beliefs or the external environment on an individual's willingness or behavior. In this study, SI was used to refer to the view of the learner's social group regarding the learner's online learning; if external factors are positive regarding the learner's choice to learn online, BI is enhanced.

Facilitating condition refers to the degree of support that individuals believe they receive in terms of organization and technological systems for their use of new technologies. In this study, FC was used to refer to the ability of learners to obtain guidance on objective conditions, such as resources, technologies, and tools, used to support their online learning. The stronger the perceived guidance and support is, the higher the BI is.

Hedonic motivation refers to the individual using technology that stimulates their intrinsic motivation to improve BI. In this study, HM refers to the extent to which learners experience enjoyment during online learning. The more enjoyment they experience while learning, the stronger their BI is.

Price value refers to the trade-off between benefits and sacrifices. The stronger the BI is, the lower the monetary cost is for online learning and the greater the learning gain is.

Habits reflect the degree of automation of individual behavior. In this study, learners' repeated engagement in online learning behavior or the cultivation of habits related to online learning has a positive impact on BI.

Self-efficacy refers to the degree of confidence that individuals have in their skills to complete a certain task, which is a non-intellectual factor. In this study, the higher the SE is, the stronger learners' interest and motivation in online learning is for achieving learning goals, thus leading to higher BI.

MS refers to individuals' subjective judgment of their cognitive activity and ability to acquire knowledge and skills and clarify their learning paths during online learning to improve their BI.

Hypotheses

On the basis of the existing UTAUT2 model and related studies, this study proposed the following hypotheses:

H1: The UTAUT2-based e-learning model would explain the learners' willingness to continue their online learning, and the factors would have significant effects on the dependent variable (BI).

H2: The effects of the independent variables on the dependent variable (BI) would be enhanced through the mediating effect of SE.

H3: The effects of the independent variables on the dependent variable (BI) would be enhanced through the mediating effect of MS.

TABLE 1 | Related studies.

References	Technology or product	Influencing factor
Wong et al., 2013	Interactive electronic whiteboard	PE, EE, SI, FC, and applicability of the UTAUT model
Yang et al., 2014	E-learning	PE, EE, SI, FC, and information technology adoption
Wang and Mao, 2016	MOOC	PE, EE, SI, and FC
Yang, 2016	MOOC	Intrinsic motivation, basic psychological demand factors (perceptual autonomy, perceptual ability, perceptual relationship), MOOC design factors (content quality, autonomy, social interaction), extrinsic motivation (perceptual usefulness), satisfaction, and expectation confirmation
Shiau and Chau, 2016	Cloud-computing classroom	Attitude, compatibility, SE, quality of cloud service, perceived behavioral control, perceived ease of use, perceived interest, perceived usefulness, result presentation, subjective specification, quality of applied service, and visibility
Raja Yusof et al., 2017	Real-time visualization system using radio-frequency identification	PE, EE, SI, and FC
Chen and Hwang, 2019	Online learning behavior	Metacognition and self-regulation, motivational self-regulation, PE, EE, and SI
He and Zhang, 2019	College students' English mobile learning	PE, EE, SI, and FC
Zeng, 2019	Mobile language learning	PE, EE, SI, FC, HM, PV, habits, experience, year of study, and major

Tools

The questionnaire (49 items) was divided into three parts: the first part (6 items) investigated the relevant variables of learners, namely gender, experience, year of study, and dependent variable BI; the second part (23 items) investigated seven independent variables in the UTAUT2 model (Venkatesh et al., 2012; Zeng, 2019); and the third part investigated learners' SE (8 items) and MS (12 items), with questions adapted from the motivated strategies for learning questionnaire developed by Pintrich et al. (1993). All items except those related to the relevant variables (gender, experience, and year of study) were measured using a 5-point Likert scale. All statistical analyses were conducted using SPSS v21.0 and SPSS AMOS for Windows v21.0 (IBM, Armonk, NY, United States).

DATA ANALYSIS AND RESULTS

Participant Information

Because of the widespread suspension of in-person classes in the universities in East China, online teaching has been extensively promoted. Therefore, questionnaires were issued to 45 universities in East China from September to December 2020 through various channels. The inclusion criteria were undergraduate students (freshmen, sophomores, juniors, or seniors) aged 19–22 years; 566 valid questionnaires were retrieved (response rate: 89.8%).

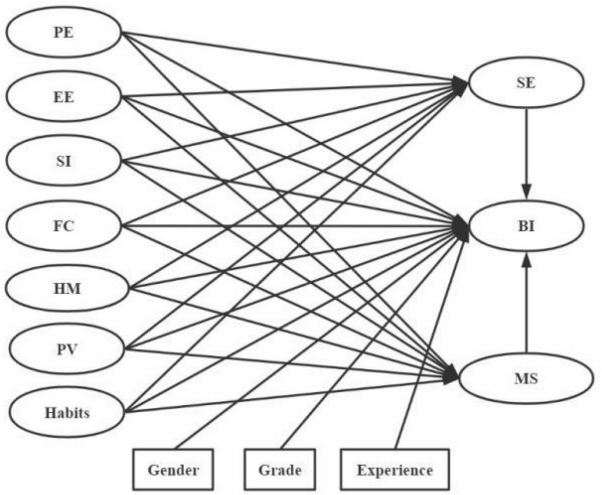

FIGURE 2 | UTAUT2-based e-learning model.

Of them, 227 (40.1%) were from male learners and 339 (59.9%) from female learners. In terms of year of study, the distribution was comprehensive, with 173 freshmen (30.6%), 168 sophomores (29.7%), 179 juniors (31.6%), and 46 seniors (8.1%) responding to the questionnaire. The majors were widely distributed, including philosophy, economics, law, education, literature, science, engineering, agriculture, medicine, management, art, and historiography. Overall, the research sample was evenly distributed in terms of gender, year of study, and major; the sample can thus represent average university learners in East China.

Difference and Correlation

Analysis of Relevant Variables for Gender, Year of Study, and Experience

The Cronbach's alpha of variables in the questionnaire were shown as **Table 2**, which were all above 0.7, implying high confidence. The Kaiser–Meier–Olkin measure of sampling adequacy was 0.935, which is greater than 0.70, and the results of the Bartlett's test of sphericity was $p < 0.01$, indicating the favorable validity (Clark and Watson, 2019).

Differences in BI of different genders and learning experience were tested with an independent samples *t*-test. Significant difference were observed in BI to continue online learning among male and female learners ($p = 0.000 < 0.01$), and whether learners had experience with online learning resulted in significant differences in BI ($p = 0.002 < 0.01$; **Table 3**). ANOVA was used to examine the difference between the 4 years of study;

TABLE 2 | Reliability statistics.

Variables	Cronbach's alpha
PE	0.877
EE	0.899
SI	0.896
FC	0.918
HM	0.851
PV	0.896
Habits	0.853
BI	0.864
SE	0.929
MS	0.900

no significant difference in BI was observed between the different years of study ($p > 0.05$).

Correlations Between Variables

Correlation refers to an association between two elements that cannot be explained directly (Liang et al., 2016). The results of the correlations between the variables in the UTAUT2-based e-learning model are presented in **Table 4**.

Correlation analysis revealed that PE, EE, SI, FC, HM, PV, habits, SE, and MS all had significant positive correlations with BI. Therefore, a multivariate analysis of these variables was performed using an SEM.

Model Inspection and Modification

Structural equation modeling is a key multivariate analysis tool; in structural equation modeling, the covariance matrix of variables is used to analyze correlation (Cheng, 2006). This study applied the maximum likelihood method to implement estimates of the relevant parameters of the UTATU2-based e-learning model (**Figure 3**).

Model Fit

Fitness indices are typically used to evaluate the appropriateness of an SEM. The model exhibits a favorable fit when $2/df$ is <3, root mean square error of approximation is <0.08, and fitness indices such as the goodness of fit index, adjusted goodness of fit index, normed fit index, incremental fit index, and comparative fit index are >0.9 (values of 0.8–0.9 are considered acceptable). According to the results in **Table 5**, this model exhibited a favorable fit.

Inspection of SEM

Under the influence of the relevant variables (gender, experience, and year of study), EE, SI, HM, PV, and habits had significant positive effects on BI, whereas PE and FC had no significant effect on BI (**Table 6**).

Mediating Effect

In addition to the effect of the seven variables in the UTAUT2 model on BI, SE and MS also have significant positive effects on BI. To assess the mediating effect of these two variables on BI, this study used the bootstrap method; **Table 7** presents the 14 paths.

Regarding SE's mediating effect, except for the EE–SE–BI and habits–SE–BI paths ($p > 0.05$), the interval range in other mediating paths did not contain 0 ($p < 0.05$), thus indicating the existence of a mediating path. In addition, the estimate value of 0.035 indicates that SE had the largest mediating effect on the association between SI and BI.

Regarding MS's mediating effect, except for the PE–MS–BI and PV–MS–BI paths ($p > 0.05$), the interval range in other

TABLE 3 | Independent samples *t*-test on BI for gender and experience.

	t	df	Sig. (two-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
						Lower	Upper
Gender	3.694	564	0.000	0.269	0.073	0.126	0.412
Experience	3.254	113.545	0.002	0.360	0.111	0.141	0.579

TABLE 4 | Correlations between variables.

	PE	EE	SI	FC	HM	PV	Habits	SE	MS	BI
PE	1									
EE	0.287**	1								
SI	0.447**	0.366**	1							
FC	0.433**	0.302**	0.565**	1						
HM	0.296**	0.306**	0.383**	0.321**	1					
PV	0.331**	0.308**	0.412**	0.344**	0.511**	1				
Habits	0.202**	0.219**	0.214**	0.246**	0.496**	0.504**	1			
SE	0.474**	0.396**	0.605**	0.564**	0.494**	0.544**	0.370**	1		
MS	0.192**	0.258**	0.315**	0.301**	0.295**	0.238**	0.251**	0.256**	1	
BI	0.361**	0.380**	0.480**	0.428**	0.510**	0.533**	0.473**	0.560**	0.335**	1

***Correlation is significant at the 0.01 level (two-tailed).*

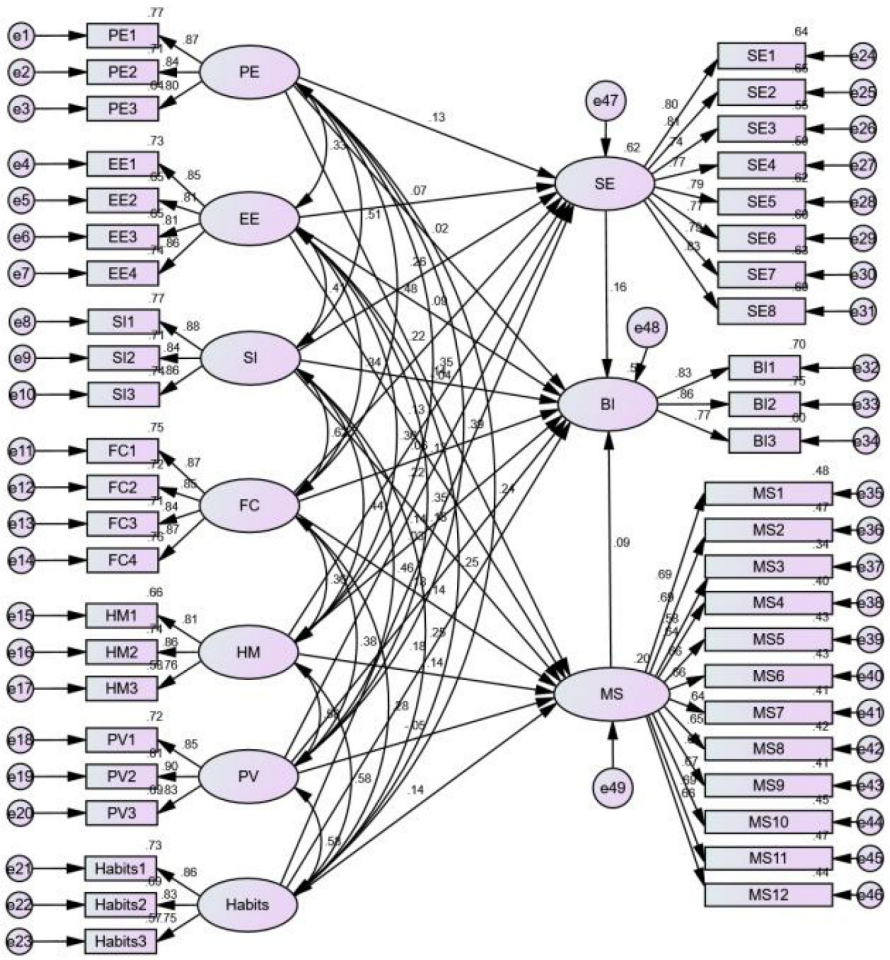

FIGURE 3 | SEM of UTAUT2-based e-learning.

mediating paths did not contain 0 ($p < 0.05$), thus indicating the existence of a mediating path. In addition, the estimate value of 0.015 indicates that MS had the largest mediating effect on the association between SI and BI.

Model Modification

Some paths in the null hypothesis model were false. EE, SI, HM, PV, and habits in the UTAUT2-based e-learning model had significant positive effects on BI, verifying the paths of EE → BI, SI → BI, HM → BI, PV → BI, and habits → BI in the null hypothesis. PE and FC had no significant effect on BI, rejecting the paths of PE → BI and CF → BI. SE had a mediating effect in the association of PE, SI, FC, H M, and PV with BI, rejecting the paths of EE → SE → BI and habits → SE → BI in the null hypothesis. MS had a mediating effect in the association of EE, SI, FC, HM, and habits with BI, rejecting the paths of PE → MS → BI and PV → MS → BI in the null hypothesis.

Thus, first modifications were applied to the null hypothesis model (i.e., the UTAUT2-based e-learning model; **Figure 2**), and the path coefficient of each existing path is marked on the relevant lines in **Figure 4A**. The effects of the independent variables on the dependent variable had up to three branches. For example, the path coefficients of SI directly affecting BI was 0.098, of SI affecting BI through SE was 0.283, and of SI affecting BI through MS was 0.104. In comparison, SI had the greatest effect on BI through the mediation of SE. Similarly, EE had the greatest effect on BI through the mediation of MS, FC through the mediation of SE, HM through the mediation of SE, and PV through the mediation of SE; habits had the greatest effect on BI directly. The secondary modification to the model is presented in **Figure 4B**

DISCUSSION AND SUGGESTIONS

Attach Great Importance to the Educational Status of Online Learning and the Independent Initiative of Learners

The study results revealed that PE and FC in the UTAUT2 model had no effect on the learners' willingness to continue

TABLE 5 | Model fit.

Model	CMIN/df	GFI	AGFI	NFIDelta1	IFIDelta2	TLIRho2	CFI	RMSEA
Default model	1.702	0.887	0.872	0.895	0.954	0.949	0.953	0.035
Saturated model		1.000		1.000	1.000		1.000	
Independence model	14.894	0.185	0.151	0.000	0.000	0.000	0.000	0.157

online learning (BI), but the mediating effect of SE enhanced the significant effects of PE and FC on BI. The effectiveness of online learning should not be judged merely according to improvements in learning performance. The performance output of higher education is long-term work; colleges and universities should reexamine the function of online learning and focus on cultivating students' core qualities related to their personal and social development. Packmohr and Brink (2021) found that students during the pandemic were more critical of the effects on their learning success, and this could cause great pressure on learners making low PE. Thus PE had no significant effect on learners' BI.

TABLE 6 | Inspection of SEM.

Hypothetical relationship			Unstandardized		Standardized	Label
			Estimate	*p*	Estimate	
SE	→	BI	0.106	0.026	0.132	True
MS	→	BI	0.102	0.014	0.096	True
PE	→	BI	**0.029**	**0.489**	**0.031**	**False**
EE	→	BI	0.070	0.019	0.094	True
SI	→	BI	0.098	0.016	0.135	True
FC	→	BI	**0.039**	**0.246**	0.057	**False**
HM	→	BI	0.140	0.009	0.141	True
PV	→	BI	0.168	***	0.188	True
Habits	→	BI	0.188	***	0.184	True

*Bold terms and values refer that p > 0.05 and there is no significant difference. ***p < 0.001.*

TABLE 7 | Mediating effects of study variables.

Parameter (standardized)	Estimate	Lower	Upper	*p*
PE–SE–BI	0.017	0.001	0.048	0.038
EE–SE–BI	**0.010**	**0.000**	**0.032**	**0.054**
SI–SE–BI	0.035	0.001	0.084	0.044
FC–SE–BI	0.029	0.002	0.068	0.037
HM–SE–BI	0.017	0.002	0.049	0.032
PV–SE–BI	0.029	0.002	0.072	0.042
Habits–SE–BI	**0.004**	**−0.007**	**0.027**	**0.350**
PE–MS–BI	**−0.003**	**−0.019**	**0.006**	**0.390**
EE–MS–BI	0.011	0.002	0.031	0.012
SI–MS–BI	0.015	0.002	0.040	0.012
FC–MS–BI	0.014	0.002	0.034	0.011
HM–MS–BI	0.013	0.001	0.037	0.021
PV–MS–BI	**−0.004**	**−0.024**	**0.008**	**0.383**
Habits–MS–BI	0.013	0.002	0.039	0.020

Bold terms and values refer that p > 0.05 and there is no significant difference.

The result that FC in the UTAUT2 model had no effect on the learners' willingness to continue online learning is consistent with Tandon et al. (2021), they found that technology risk as an inhibitor emerged insignificant. However, Al-Karaki et al. (2021) believed that technical needs were related to students' satisfaction and success in distance learning, absence of the proper infrastructure would hinder the operation especially in courses with hands-on components. This is related to the applicability of the model, which was originally applied in the commercial field, mainly to predict users' acceptance of new technologies (Venkatesh et al., 2003). Online learning is not a new concept, although various new technologies such as artificial intelligence and mixed reality are being studied by researchers and introduced in the educational field as online learning technology continues to evolve, the technical equipment that supports students in online learning is actually exceedingly simple from the perspective of knowledge dissemination. Thus FC had no significant effect on learners' BI. Online learning supports the bring your own device concept and diversified forms of knowledge dissemination and enables functions such as asynchronous distribution of resources and assignments; thus, online teaching can be realized in colleges and universities. For learners, online learning is easy to master without instructional materials, particularly for younger generation of learners who are digital natives.

Online learning cannot replace in-person teaching in colleges and universities, while during the COVID-19 it is a very good alternative solution to face-to-face approach (Al-Karaki et al., 2021). Improving academic performance is not the original intention of online learning, and advanced and expensive technical equipment cannot maintain learning enthusiasm over extended periods (Chen, 2021). The core of online learning is the careful design of teaching content, which front-line teachers are encouraged to explore scientifically and logically and to conduct on-demand teaching on the basis of learners' existing knowledge, enabling learners to leverage their strengths in online learning. In other words, when learners' SE is enhanced, PE and FC have a substantial effect on BI.

Lower Barriers to Learn Online and Stimulate Learners' Learning Motivation

As expected, EE, SI, HM, PV, and habits had a direct effect on BI, which were contrary to the results of Tandon et al. (2021), which showed that SI and PV did not emerge significant. Moreover, the significant effect of EE on BI was enhanced through the mediating effect of MS, and the effect of SI, HM, and PV on BI was enhanced through the mediation of SE. However, the

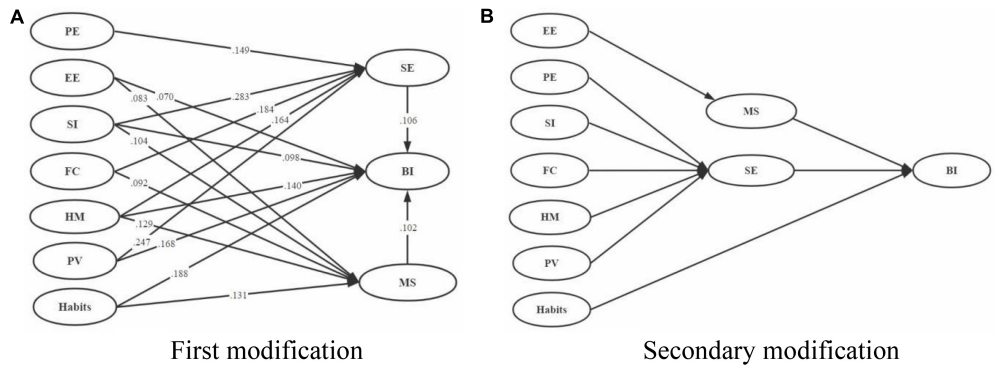

FIGURE 4 | Modification of the UTAUT2-based e-learning model. **(A)** First modification. **(B)** Secondary modification.

effect of habits on BI remained very strong without the mediation of SE and MS.

During the pandemic period, some educational institutions encouraged teachers to use popular teaching tools, including some commonly used social software (e.g., QQ and WeChat) to ensure learning could proceed. In addition, network communication companies have been cooperating with universities to reduce the costs associated with online learning, and each online learning platform also provides full technical support to ensure successful learning progress. Therefore, learners can engage in online learning without changing their habits, investing additional effort (EE), or incurring high costs (PV); this is vital because lower barriers would increase learners' BI to continue online learning. Before the pandemic, massive open online courses (MOOCs) were already changing people's traditional view of online teaching (SI), for online learning becoming students' preference that made the amalgamation of knowledge, human force (teacher) and technological force (Ranjan et al., 2021). Online learning is no longer the traditional form of non-formal education but a teaching form in which high-quality teaching resources are shared. Learners regard online learning as more enjoyable (HM) than face-to-face learning, thereby stimulating their learning motivation, which directly affects their BI.

Meanwhile, this study considered the added factors' mediating effect, that was the effect of EE on BI was higher under the mediating effect of MS than when EE affected BI directly. This result indicates that online learning through familiar technology enables learners to expend less effort and focus more on how to regulate themselves to adapt to the online learning process. The enhanced learning experience does not increase their cognitive load, thus promoting their willingness to continue online learning. Similarly, the effects of SI, HM, and PV on BI were enhanced through the mediating effect of SE. This result indicates that when the value of online learning is recognized by society, learners spend less on experiencing a pleasant online learning process and believe that they have adequate social support, learning energy, and financial means to complete online learning. Thus, learners' SE is improved, learning motivation is stimulated, and they are more willing to continue online learning in the future.

Stimulate Positive Public Opinion and Improve the Social Recognition of Online Learning

The results revealed that compared with the other independent variables, the mediating value of SE and MS on the effect of SI on BI was the largest (0.035 and 0.015, respectively). SI refers to the view of social groups around individuals on the learners' online learning. The external approach of learning drive involves effectively changing the learners' motivation from "teachers want you to learn" to "you yourself want to learn" (Wang et al., 2020).

The teaching content in college and university courses is closely linked to students' future employment. Therefore, higher education can be regarded as an economic behavior. To improve the quality of curriculum implementation, some studies have highlighted the necessity of enhancing the social and cultural environment of campuses (Chen and Miao, 2020). For positive public opinion regarding online learning, the public's beliefs, attitudes, and emotions regarding online learning should be improved (Xu and Zhang, 2008). General social recognition directly affects the training quality and employment rate of part-time postgraduates (Li X. et al., 2020).

Similarly, a positive attitude of the general public toward online learning can effectively improve the learners' BI. If society in general and elders in the family in particular recognize online learning as a formal type of learning, learners are more likely to realize their learning potential; this can be achieved by considering their capability of completing the complex tasks of online learning, improving their SE, or making an effort to regulate cognitive strategies to adapt to the progress of online learning to gain the praise of their elders (Cook and Ausubel, 1970). Therefore, compared with other independent variables, SI results in a greater increase in confidence related to online learning and expectation of future use of online learning through the mediating effects of SE and MS.

CONCLUSION

This study used a literature review and questionnaire survey and modified the UTAUT2 model to form the UTAUT2 e-learning

model to integrate the two mediating variables, SE and MS. By investigating the first round of online learning for undergraduates during the COVID-19 pandemic, the direct and mediating factors affecting learners' willingness to continue online learning (BI) were analyzed through data analysis and structural equation modeling; on the basis of the results, the UTAUT2-based e-learning model was modified.

The results indicated that SE enhanced the effects of EE, SI, FC, HM, and PV on learners' BI; that MS enhanced the effects of EE on learners' BI; and that habits have a direct and strong effect on BI. This study also provided some suggestions to enhance higher education learners' BI to continue online learning, which can serve as reference for colleges and universities to conduct, continue, or enhance online education, particularly as the pandemic continues.

This study had certain limitations. The UTAUT2 e-learning model was developed from the UTATU2 model, the discussion could only compared with the studies regarded to UTATU2 model. Meanwhile, the real thoughts of learners might be different with what examined in the questionnaire, thus more participants are needed to test the validity and accuracy of the UTAUT2 e-learning model. Future research can add different variables which may effect the learning willingness and behavior as mediating factors or dependent variables to innovate the model.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

WX and Z-YS designed and carried out the research and conducted the data analysis and summary. S-JL and J-CC issued the questionnaires, conducted the research, and participated in the data analysis. All authors contributed to the article and approved the submitted version.

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Fear and Challenges of Nursing Students Being in Hospital for Clinical Posting During the COVID-19 Pandemic: An Exploratory Survey

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Background: The world is facing unprecedented challenges in the face of a global pandemic (COVID-19). The institutions resumed nursing students' clinical experiences as an earlier part of their curriculum, which was transitioned to a virtually delivered format due to global disaster. Therefore, working through this pandemic in hospital posting is challenging and fearful for nursing students. The aim of this study was to measure the fear of COVID-19 and the challenges faced by nursing students when posted in hospitals during the COVID-19 pandemic.

Methods: A web-based exploratory survey was conducted on 185 participants from March 2021 to April 2021. Participants were selected through a web-based survey (Google form) by non-probability purposive sampling technique. The Fear of COVID-19 Scale and self-structured questionnaires with the Likert-type scale were used to measure the fear of COVID-19 and the challenges faced by nursing students when posted in hospitals during the COVID-19 pandemic, respectively. Descriptive and inferential statistics were used for the analysis of data with IBM SPSS version 27.

Results: A significant number (61.1%) of participants had moderate fear of COVID-19 infection, one-third of them (28.1%) had mild fear, and very few participants (10.8%) had an extreme fear of COVID-19 infection. The majority of participants (64.9%) faced moderate challenges, 27% faced high challenges, and very few study participants (8.1%) did not face any challenges when posted in the hospital during the COVID-19 pandemic. The fear due to COVID-19 is not associated with demographic variables, but the challenges faced due to COVID-19 are significantly associated with demographic variables, such as the age, batch, and duration of clinical posting (p-value = 0.01).

Conclusion: Study data indicated that respondents reported fear of COVID-19 infection and also experienced a variety of challenges in hospital posting during the COVID-19 pandemic.

Keywords: challenges, clinical posting, COVID-19 pandemic, fear, hospital, nursing students

INTRODUCTION

The nationwide coronavirus (COVID-19) pandemic and the ensuing lockdown have forced schools and institutions across India to temporarily shut down to prevent the spread of the virus. This unprecedented move had created a big gap in the education system despite the central and state governments doing their best to provide support for e-learning and online education. The crisis in the world scenario, caused by COVID-19, has demanded prompt changes in the way of teaching in institutions. Several institutions in the country started online education to help students to continue their education from home (Dewart et al., 2020).

Consequently, the pandemic has elicited significant distractions in the implementation of programs across educational institutions, and the most affected are the students (De Los Santos et al., 2021). The disruption of education for nursing students had been unanticipated by the students (Aslan and Pekince, 2021). In addition, nursing students also retracted from a clinical practicum in March 2020, specifically because of the possibility that a nursing student, who was an asymptomatic or mildly symptomatic carrier of COVID-19, could return to their community and spread the infection further. If nursing students were exposed to COVID-19 in a clinical environment, they put not only their health at risk but also the health of their families (Dewart et al., 2020). Lira et al. (2020) performed a reflection analysis using a theoretical approach in which they explored the challenges and perspectives of nursing education in times of the COVID-19 pandemic. Long-standing problems have arisen as a result of the pandemic, and the processes of acceleration, change, and paralysis have marked education in these times (Lira et al., 2020). De Los Santos et al. (2021) conducted a cross-sectional study on fear of COVID-19, poor quality of sleep, irritability, and intention to quit school among nursing students. According to the results of the report, first-year nursing students are the most fearful of the group.

Fear of COVID-19 is linked to high irritability, poor sleep quality, and a desire to drop out of nursing school. As we all know, the COVID-19 vaccination drive is currently taking place across the world. In addition, the institutions restored nursing students' clinical experiences as an earlier part of their curriculum, which was transitioned to a virtually delivered format due to the global disaster, the COVID-19 pandemic. Thus, working through this pandemic in hospital clinical posting is challenging and fearful for nursing students because of the fear of contracting the disease and the risk of transmitting it.

Nursing students, without a doubt, become familiar with quickly adjusting, routing through areas, and moving promptly from one challenge to the next. Working through a pandemic has changed all aspects of the general population's lives as well as of nursing students.

Hence, this study was conducted to assess the fear of COVID-19 and the challenges faced by nursing students being in hospital for clinical posting during the COVID-19 epoch.

TABLE 1 | Frequency and percentage distribution of demographic variables.

Variables	Frequency (%)
Age	
≤ 20 Years	65 (35.1)
≥ 21 Years	120 (64.9)
Batch	
Fresher (1st Year)	45 (24.3)
Intermediate (2nd and 3rd Year)	96 (51.9)
Interns (4th Year)	44 (23.8)
Religion	
Hindu	181 (97.8)
Others (Muslim/Sikh)	04 (2.20)
Did you ever had history of COVID-19 infection?	
Yes	18 (9.70)
No	167 (90.3)
Did any of your family member had COVID-19 infection?	
Yes	10 (5.4)
No	175 (94.6)
Duration of clinical posting during COVID-19 pandemic	
≤ 2 Week	132 (71.40)
≥ 3 Week	53 (28.60)

N = 185.

MATERIALS AND METHODS

Research Design

A web exploratory survey was conducted to find out the fear and challenges of nursing students being in hospital for clinical posting during the COVID-19 pandemic.

Setting and Data Collection

The study was conducted among undergraduate nursing students in March 2021 in western Rajasthan, India. The study aimed to measure the fear of COVID-19 and challenges faced by nursing students when posted in hospitals during the COVID-19 pandemic. The survey link was forwarded to participants *via* WhatsApp. The researcher followed up on the status of data collection a week after the survey link was delivered.

Participants

The sample size was estimated by using Slovin's formula: $n = N/(1 + Ne^2)$, where n is the number of samples, N is the population size (total students: 255), and e is the margin of error of 5%, with 95% CI, and the minimum estimated sample size needed is 154. After considering the withdrawn participants, 20% of preliminary participants, approximately 185 subjects, were enrolled in the study. The students were recruited *via* a non-probability purposive sampling technique following the inclusion criteria, where only undergraduate students who have consented to participate were included in the study. A survey link (Google form) was shared and circulated among participants *via* a WhatsApp group to facilitate data collection. Duplication of data was restricted since one student can submit the response through only one e-mail ID.

TABLE 2 | Participants' fear related to COVID-19.

Fear of COVID-19 Items	Strongly disagree Freq. (%)	Disagree Freq. (%)	Neutral Freq. (%)	Agree Freq. (%)	Strongly agree Freq. (%)
I am afraid of coronavirus-19	12 (6.49)	39 (21.09)	40 (21.62)	80 (43.25)	14 (7.57)
It makes me uncomfortable to think about coronavirus-19	16 (8.65)	46 (24.87)	50 (27.02)	67 (36.21)	06 (3.25)
My hands become cold and clammy when I think about coronavirus-19	34 (18.38)	80 (43.25)	35 (18.91)	33 (17.84)	03 (1.63)
I am afraid of losing my life because of coronavirus-19	29 (15.68)	66 (35.68)	39 (21.08)	42 (22.70)	09 (4.87)
When I watch news and stories about Corona Virus, I become nervous or anxious	15 (8.10)	44 (23.79)	42 (22.70)	73 (39.45)	11 (5.95)
I cannot sleep because I'm worried about getting COVID-19	52 (28.10)	92 (49.73)	27 (14.60)	13 (7.03)	01 (0.55)
My heart races or palpitates when I think about getting COVID-19	41 (22.17)	77 (41.63)	33 (17.84)	31 (16.76)	03 (1.63)
Mean (SD) of total score: Fear of COVID-19	**18.78 (5.58)**				
Level of fear related to COVID-19	**Mild fear score (7–15)**	**Moderate fear score (16–25)**		**Extreme fear score (26–35)**	
	52 (28.1)	113 (61.1)		20 (10.8)	

N = 185.

TABLE 3 | Participants' challenges faced due to COVID-19.

Challenges faced due to COVID-19 statements	Never Freq. (%)	Sometimes Freq. (%)	Always Freq. (%)
Problem in carrying out assessment and care of patients because of constant fear of infection	32 (17.3)	102 (55.1)	51 (27.6)
Difficulty in continue handling of personal protective equipment (PPE)	10 (5.4)	37 (20.0)	138 (74.6)
Hindrance in interaction and communication because of facemask/PPE	15 (8.1)	107 (57.8)	63 (34.1)
Skin irritation/problem because of frequent use of hand rub and hand washing	32 (17.3)	106 (57.3)	47 (25.4)
Issues in handling of patients' records and clinical assignments due to fear of contracting infection	31 (16.8)	105 (56.8)	49 (26.5)
Dealing with continue stress, fear and mental exhaustion due to COVID-19 pandemic	67 (36.2)	91 (49.2)	27 (14.6)
Ineffective clinical skill learning due to fear of COVID- 19 infection and limited clinical exposure	27 (14.6)	109 (58.9)	49 (26.5)
Lack of effective clinical supervision by teachers due to fear of contracting infection	83 (44.9)	79 (42.7)	23 (12.4)
Difficulty in completing clinical assignments like case study, case presentation and nursing care plan	16 (8.6)	62 (33.5)	107 (57.8)
Problem in counseling patients and family due to fear of infection	32 (17.3)	104 (56.2)	49 (26.5)
Mean (SD) of total score: Challenges faced due to COVID-19	**21.39 (3.6)**		
Level of challenges faced due to COVID-19	**Low challenges score (10–16)**	**Moderate challenges score (17–23)**	**High challenges score (24–30)**
	15 (8.1)	120 (64.9)	50 (27.0)

N = 185.

Data Collection Instruments

Three questionnaires section were used to assess the main variables of the study.

Part I: Demographic Variables

The first questionnaire includes 6 items related to the demographic variables of the respondents: age, batch, religion, history of COVID-19 infection, family history of COVID-19 infection, and duration of clinical posting in the pandemic.

Part II

The fear of COVID-19 was assessed using the Fear of COVID-19 Scale by Ahorsu et al. (2020). The participants indicated their level of agreement with the statements. It has a list of seven items on a five-item Likert-type scale. Answers included "strongly disagree," "disagree," "neutral," "agree," and "strongly agree." The minimum score possible for each question is 1, while the maximum is 5. A total score could be calculated by adding up each item's score (ranging from 7 to 35). The scale has composite reliability of 0.88, which indicates good reliability in measuring the fear construct.

Part III

The third section intended to measure the challenges faced by nursing students when posted in hospitals during the COVID-19 pandemic. The tool was prepared after conducting

TABLE 4 | Independent *t*-test and ANOVA for association of fear and challenges due to COVID-19 with demographic variables among participants.

Demographic characteristics	Fear of COVID-19			Challenges faced due to COVID-19		
	Mean ± SD	*t*-value/*F*-value	*p*-value	Mean ± SD	*t*-value/*F*-value	*p*-value
Age						
≤20 Years	18.32 ± 4.37	0.921	0.35	20.46 ± 3.77	**2.255***	**0.01***
≥21 Years	19.04 ± 6.14			21.90 ± 3.42		
Batch						
Fresher (1st Year)	18.04 ± 4.25	1.25	0.28	20.08 ± 3.63	**4.34***	**0.01***
Intermediate (2nd and 3rd Year)	18.64 ± 6.05			21.65 ± 3.72		
Interns (4th Year)	19.86 ± 5.65			22.15 ± 2.98		
Religion						
Hindu	18.82 ± 5.63	1.414	0.22	21.38 ± 3.62	0.386	0.72
Others (Muslim/Sikh)	17.25 ± 2.06			22.00 ± 3.16		
Did you ever had history of COVID-19 infection?						
Yes	18.87 ± 5.67	0.742	0.46	21.38 ± 3.68	0.162	0.87
No	18.00 ± 4.63			21.50 ± 2.81		
Did any of your family member had COVID-19 infection?						
Yes	18.74 ± 5.50	0.377	0.71	21.41 ± 3.62	0.383	0.71
No	19.60 ± 7.07			21.00 ± 3.33		
Duration of clinical posting during COVID-19 pandemic						
≤2 Week	18.43 ± 5.42	1.329	0.18	20.97 ± 3.56	**2.532***	**0.01***
≥3 Week	19.67 ± 5.90			22.43 ± 3.52		

N = 185.
**Significant ($p < 0.05$).*

three focussed group discussions (FGD) of 15–20 min with undergraduate students of different batches. This scale was validated by experts and found to be 80% reliable with Cronbach's α = 0.81. The content validity ratio (CVR) for the scale was 0.89, showing an acceptable level of internal consistency of the scale. It has a list of 10 items on a three-item Likert-type scale. Answers included "always," "sometimes," and "never." The minimum score possible for each question is 1, and the maximum is 3. A total score could be calculated by adding up each item's score (ranging from 10 to 30). The higher the scores interpreted, the higher the challenges faced by nursing students. The score given for the "always" response will be 3, the "sometimes" response will be 2, and the "never" response will be 1. The total score could be calculated by adding up each score (ranging from 10 to 30).

Data Analysis

SPSS version 27, IBM Corp., Armonk, NY, United States was used to aid in the analysis of the variables. The data were analyzed using both descriptive and inferential statistics. Frequency and percentage were calculated for demographic variables, fear, and challenges. Mean and standard deviation was considered for the assessment of fear and challenges due to COVID-19 in all domains. The normality of the data was checked with the help of Kolmogorov-Smirnov. It was found that data are normally distributed. An independent *t*-test and ANOVA tests were used to find the association of demographic variables with fear and challenges due to COVID-19 among participants. The data significance was set to less than 0.05.

RESULTS

Table 1 displays the demographic variables of study participants. A total of 185 participants participated in the study. A majority of the participants [120 (64.9%)] were aged more than 21 years, and one-third of them [65 (35.1%)] were aged less than 20 years. The maximum numbers of participants [96 (51.9%)] were from the Intermediate level (second year and third year) and around half of the study participants [45 (24.3%) and 44 (23.8%)] were freshman (first year) and interns (fourth Year), respectively. In regard to religion, the maximum number of participants were Hindu [181 (97.8%)] and only few participants [4 (2.2%)] were from other religions (Muslim/Sikh). The maximum number of participants [167 (90.3%)] had no history of COVID-19 infection and only few participants [18 (9.7%)] had a history of infection with COVID-19. The maximum number of participants' [175 (94.6%)] family members had no COVID-19 infection and only a few participants' [10 (5.4%)] family members had COVID-19 infection. The of study participants, 132 (71.4%), had 2 weeks of clinical posting during the COVID-19 pandemic and less than half of the participants, 53 (28.6%), had 3 weeks of clinical posting during the COVID-19 pandemic.

Table 2 depicts the fear of participants related to COVID-19; more than half [113 (61.1%)] of the study participants have a moderate fear of COVID-19 infection, one-third of study participants [52 (28.1%)] have mild fear, and only a few participants [20 (10.8%)] have an extreme fear of COVID-19 infection. The mean score (*SD*) of fear of COVID-19 was 18.78 (5.58).

Table 3 presents the challenges faced by participants due to COVID-19, with the majority of study participants [120 (64.9%)] having faced moderate challenges due to the COVID-19 pandemic, one-third of them [50 (27%)] having faced high challenges, and few study participants [15 (8.1%)] having faced no challenges when posted in hospital due to the COVID-19 pandemic. The mean score (*SD*) of challenges faced due to COVID-19 was 21.39 (3.6).

Table 4 depicts the association of fear and challenges due to COVID-19 with demographic variables among the study participants, that is, age, batch, religion, history of infection with COVID-19, history of family member infection with COVID-19, duration of clinical posting during COVID-19 pandemic. It was found that fear due to COVID-19 is not significantly associated with these demographic variables, while age, batch, and duration of clinical posting were found to be significantly associated with the challenges faced due to COVID-19 (p-value = 0.01).

DISCUSSION

The primary purpose of this study was to find out the fear and challenges of nursing students being in hospital for clinical posting during the COVID-19 pandemic. In this study, we found that a significant number of study participants, 113 (61.1%), had moderate fear of COVID-19 infection, similar findings have been reported for other studies where it was determined that 68.1% of students were worried about being infected with COVID-19 (Aslan and Pekince, 2021).

Another consideration is the finding of Huang et al. (2020) who found that nurses at the frontline exhibit stronger anxiety, fear, sadness, and anger than nursing students. In one study, four predictors for the fear of the coronavirus, i.e., health anxiety, regular media use, social media use, and risks for loved ones, were reported, which are similar to the findings of the present study, and 84 (45.4%) participants of that study agreed to becoming nervous or anxious when they watched news and stories about COVID-19 (Mertens et al., 2020).

De Los Santos et al. (2021) revealed in their study results that there is a moderate to high fear of COVID-19 among students across all year levels. Notably, the first-year students displayed the greatest fear among the group (M = 21.47, SD = 6.49). It was also revealed that fear of COVID-19 negatively affects the students' sleep quality ($\beta = -0.124$, $p = 0.045$) (De Los Santos et al., 2021). In the present study, the majority of the study participants, 120 (64.9%), faced challenges due to the COVID-19 pandemic, which was replicated in a similar study, which found that longstanding challenges have emerged with the pandemic, and the processes of acceleration, change, and paralysis have marked education in these times (Lira et al., 2020).

The findings of the present study are also similar to a study conducted in China, which found that healthcare providers were challenged by working in a totally new context, exhaustion due to heavy workloads and protective gear, fear of becoming infected and infecting others, feeling powerless to handle patients' conditions, and managing relationships in this stressful situation (Liu et al., 2020).

Our study findings which explicate that increasingly watching news and stories about COVID-19 is related to fear of COVID-19 is replicated in a similar study in which they found that more media exposure is related to more fear (Van den Bulck and Custers, 2009; Garfin et al., 2020). Galehdar et al. (2020) revealed the fear and challenges of nursing students through their qualitative data analysis, that is, death anxiety, anxiety due to the nature of the disease, fear of infecting the family, distress about wastingtime, the emotional distress of delivering bad news, fear of being contaminated, the emergence of obsessive thoughts, the bad feeling of wearing personal protective equipment, which is similar to the finding of the current study, that is, 138 (74.6%) participant faced challenges due to difficulty in continue handling of personal protective equipment (PPE), and participants [84 (45.4%)] becoming nervous or anxious when they watch news and stories about COVID-19.

STUDY LIMITATIONS

This study has several limitations. Generalizability issues are also raised because of the limited sample of participants included. The study was limited to one institution. The study was limited only to female students, and data were collected after 2–4 weeks of clinical posting during the COVID-19 pandemic. Data were collected through a web survey.

RECOMMENDATIONS

Future researchers are encouraged to gather a bigger sample size to derive more generalized findings. A qualitative assessment of fear and challenges faced by nursing students during the COVID-19 pandemic and its implication on their mental health may be useful to augment and better describe their lived experience with the COVID-19 pandemic.

CONCLUSION

This study revealed that a significant number of nursing students had moderate fear and faced challenges due to the COVID-19 pandemic while being in hospital for clinical posting. The demographic variables such as age, batch, and duration of clinical posting were found to be significantly associated with the challenges faced due to COVID-19. COVID-19 is not going to end soon as per the existing scenario, so we require innovative stratagems or plans for nursing students in this critical time, where fear and challenges faced by students can be prevented.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Ethical Committee AIIMS Jodhpur. Undergraduate students and who have consented to participate were included in the study. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

NR considered and designed the study, conducted research, provided research materials, and collected and organized data. SS analyzed and interpreted data and did the final editing. NK wrote the initial and final draft of the manuscript and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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Effects of Water, Sanitation, and Hygiene on the School Absenteeism of Basic Level Students in the Government School of Nepal

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This study assesses the effect of improved water, sanitation, and hygiene (WASH) services on students' absenteeism in government basic schools for 10–19 years old in Nepal. This study applied an *ex post* facto research design on two groups of students: with and without improved school WASH services. This study showed that students in schools with improved WASH services were more likely to be regular in attendance (80%) compared to those without (58%), $p < 0.001$. There was an association between students' school absenteeism and student grades, $p < 0.05$. Moreover, the caste, religion, and grades of students were also associated with students' school absenteeism, $p < 0.001$. The analysis further showed that students with improved WASH were more likely to be regular [crude odds ratios (COR) = 0.353; 95% confidence interval (CI); 0.256–0.487, $p < 0.001$] than those without. This trend was maintained across all demographics. It was significant even after the inclusion of all sociodemographic characteristics and increased rapidly [adjusted odds ratio (AOR) = 0.508; 95% CI; 0.334–0.773, $p < 0.01$]. The Brahmin/Chhetri-Terai and the Dalit students were more likely to be absent (COR = 0.315; 95% CI; 0.153–0.648, $p < 0.01$ and AOR = 0.274; 95% CI; 0.139–0.542, $p < 0.001$, respectively) than Brahmin/Chhetri-Hill, Janajati, and other castes. This study underscores the importance of WASH services in schools in reducing students' school absenteeism. Access to WASH services is recommended with several awareness programs to reduce absenteeism and increase students' school regularity.

Keywords: effect, water, sanitation, hygiene, student, absenteeism, Nepal

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INTRODUCTION

Absenteeism is one of the major barriers to achieving quality education (Monse et al., 2013). Among school-age children, approximately 75% of all absences are attributed to illness (Kathleen, 2002). Marriage is the most common reason for girls in low- and middle-income countries for quitting school. Dropouts due to marriage range from the 5th to 10th grade, and married girls are 10 times more likely to quit school compared to unmarried girls (Sekine and Hodgkin, 2017). However, illness-related absences have been shown to lead to adverse educational and economic outcomes; for instance, a sick child may fall behind in his or her coursework and suffer academically

(Miller et al., 2008). As hands are a crucial mode of infectious disease transmission among school-going children, hand hygiene with water and soap is critical to reduce illness-related absences (Goldmann, 2021). Moreover, handwashing has been recognized as one of the most cost-effective health interventions to reduce the burden of disease (Bartram and Cairncross, 2010) and as the most effective process that is considered as the key measure to trim down the potential transmission of infection through contact with people and things (Sharma et al., 2022).

Information regarding absenteeism was defined and collected differently in several studies. Its duration was defined as the "number of days absent due to a single cause, with at most 2 days of attendance or a weekend between events and was recorded based on the number of absences due to infectious causes as reported by students, teachers, and parents" (Joshi and Amadi, 2013). The number of absences caused by illness per 100 studentweeks was recorded based on the number of illness-related absences as reported by parents and school records (Talaat et al., 2011) and the number of illness- and non-illness-related absences from both parents and teachers (Nandrupbus and Visitor, 2009). Overall, illness-related absenteeism among children constitutes about 75% of all school absences (Kathleen, 2002), which is largely attributed to respiratory and gastrointestinal infections (Lau et al., 2012).

Grant et al. (2015) concluded that one-third of female students missed at least 1 day of school during their menstrual period. Further, menstruation accounts for only a small proportion of all female absenteeism and does not create a gender gap in absenteeism. An impact study in Nyanza province, Western Kenya, by O'Reilly et al. (2008) concluded that the provision of safe drinking water, handwashing facilities, and hygiene education in primary schools reduced student absenteeism by 35%. A study in the USA by Guinan et al. (2002) showed a reduction in absenteeism following the implementation of the use of hand sanitizers, hygiene education, or a combination of these interventions. The baseline study in Kenya illustrated that fecal contamination of the school environment was high because many schools have few latrines, inadequate water supplies, poor quality of water sources, water storage in containers that permit hands to touch and contaminate the stored water, and a lack of handwashing facilities. The research further revealed that, in addition to impacting school attendance, the burden of diarrheal diseases and parasitic infections harms students' growth, nutritional status, physical activities, cognition, concentration, and school performance.

Several studies have been carried out to access school absenteeism caused by specific illnesses, such as the prevalence of diarrhea, acute respiratory infections (ARI), asthma, headache, and abdominal pain (Saps et al., 2009), and social and physical causes, such as social pressures, family responsibility, poverty, parental occupation, and physical and mental disability (Besculides et al., 2005; Uppal et al., 2010). However, research on the effect of water, sanitation, and hygiene (WASH) services in schools on students' absenteeism is scarce. Therefore, we undertook a causal-comparative study in schools to assess the effect of school-based WASH facilities on students' school absenteeism.

In this study, absenteeism accounts for at least a full day of absenteeism from school. It was not retained if students bunked or left school after half a day even after a class. Furthermore, according to the GoN Flash-I Report 2076 (2019–2020), the promotion rate to the lower basic level (1–5) was 90%, with 89.4% boys and 90.7% girls. The dropout rate was 3.6–4.1% for boys and 3.3% for girls. There was a slightly lower promotion and a slightly high dropout rate for boys compared to girls. Similarly, at the basic upper level (6–8), the promotion and dropout were 92.5% and 3.8%, respectively. A slight difference was noted: boys had a 91.9% and girls had a 93.1% promotion rate. Similarly, boys had a higher dropout rate of 4.1% compared to that of 3.3% for girls. Thus, girls had a higher promotion rate and lower dropout rates at the upper basic level than boys (MoE, 2019). In this context, research is oriented to examine the effect of WASH services on student absenteeism using *ex post* facto research.

MATERIALS AND METHODS

Research Design

This is quantitative research, which applied a nonexperimental *ex post* facto/causal-comparative research design. It was conducted between January and March 2021 in four basic Governmental schools in the Dhanusha and Chitwan districts of Nepal. Each district consists of two schools: one with improved WASH facilities and another without.

The study population constituted the total number of students n = 1,342 from four basic schools studying in grades 6–8 in two districts: Dhanusha and Chitwan of Nepal. The data were collected in person by administering paper-and-pencil survey questionnaires to the students in a single phase.

Sample Size and Sampling Techniques

The sample size was calculated using the standard statistical formula $S = \frac{z^2 \times p \times (1-p)}{e^2}$ for an infinite population (Sharma et al., 2021). So, the calculated sample size was 384; however, to make a more representative sample and minimize sampling errors (Sharma and Adhikari, 2022), the calculated sample size was multiplied by the design effect of two. Hence, the final sample size for this study was 768. These respondents were equally distributed in each stratum: improved and unimproved schools. The intent of this distribution was to obtain optimum results from a larger number of respondents. For the selection of schools, whether they are considered improved or unimproved WASH facilities, the researchers consulted closely with the Education Development Coordination Unit (EDCU) in the study area. In close consultation with the EDCU, we purposively selected two schools: one improved and another without improved WASH facilities from Janakpurdham sub-metropolitan city of Dhanusha and Ratnanagar municipality of Chitwan district in Nepal. Thereafter, it was verified through the researcher's self-observation based on the Joint Monitoring Program (JMP, 2018) guidelines (Sharma and Adhikari, 2022). Based on the JMP (2018) guidelines, schools are divided into two stratums: improved and without improved WASH facilities. Hence, four schools were purposively selected from the study area. The number of students

was proportionally calculated from each of the grades from 6 to 8 in the selected basic level schools through a stratified sampling method, while students were randomly selected.

Data Collection and Analysis

The researcher collected data using survey research tools from students through the face-to-face method. Absenteeism of at least 1 day was measured. The data were carefully checked, rechecked, coded, and analyzed by applying Statistical Package of Social Science (SPSS) version 25.00. Three types of analysis, viz., univariate, bivariate, and multivariate, were used in this study. The univariate analysis was performed to show the frequency and percentage of the respondents' participation in this study. The bivariate analysis was performed through the Chi-squared test to show the association between two variables (Sharma, 2020), and all variables were entered into the multivariate analysis to show the effect between more than two variables.

Ethical Consideration

Ethical approval was obtained from the Nepal Health Research Council (NHRC), Nepal and 8541-2020 PhD. Initially, written consent was obtained from school authorities like the school administration to conduct this study in the school. Initially, written consent was obtained from school authorities like school administration to conduct this study in the school. In addition, the researcher took written consent from all students over 18 years of age. For those under 18 years of age, assent/consent was received from the school head teacher as she/he is the legal guardian while students are at the school. No incentives, such as money or any goods, were offered to the students, and only those who agreed to be a part of this study voluntarily participated (Van Teijlingen and Hundley, 2001). Confidentiality was maintained by providing a unique code to each of the schools and students instead of their actual identity.

RESULTS

This section depicts students' school absenteeism by background characteristics. In addition, it examines whether there is an association between sociodemographic variables of the respondents; school WASH situations, age, sex, grade, caste, and religion with students' school absenteeism.

Sociodemographic Characteristics of Students

The total sample size of 768 consists of an equal number of students in two groups, i.e., 384 (50%) participated in schools with improved WASH facilities and an equal number participated from schools without improved WASH facilities. **Table 1** shows that the majority (82%) of students aged 10–14 (47%) were from improved school WASH facilities. The largest number of respondents were girls (53%) and 28% were from unimproved school WASH facilities. Respondents fairly equally represented grades six to eight. Brahmin/Chhetri-Hill (29%) and Brahmin/Chhetri-Terai (27%) castes had higher respondents than Dalit (19%), Janajati (16%), and other castes (9%). The improved school had a quarter of Brahmin/Chhetri-Hill and a few (2%) other caste respondents. The majority (20%) of Brahmin/Chhetri-Terai and a few (4%) Brahmin/Chhetri-Hill respondents were found in unimproved school WASH facilities. The majority (82%) were Hindus, fairly equally represented in the improved and unimproved school WASH facilities (**Table 1**). In this study, the non-Hindus consist of Buddhists, Christians, and Muslims.

School Absenteeism by Students' Background Characteristics

Table 2 showed that students in schools with improved WASH services were less likely to be absent (20%) than those in schools without improved school WASH services (42%, $p < 0.001$). One-third of respondents aged 15–19 years were found to be absent in the school while less than one-third of them (30%) between the ages of 10–14 years were found to be absent in the school, $p = 0.517$.

Overall, respondents were fairly equally represented from grades six to eight and there was an association between school grade and students' school absenteeism, $p < 0.05$. There was a strong association between the caste of the respondents and school absenteeism, $p < 0.001$. Next, the religion of the respondents had a statistical association with students' school absenteeism, $p < 0.01$.

Logistic Regression Analysis

Table 3 illustrates the prediction of students' school absenteeism based on sociodemographic characteristics through multilevel modeling. As shown in the first model, school WASH services had a statistically significant association with students' school absenteeism. The result depicts that students who came from schools with improved WASH services were more likely to be regular [crude odds ratios (COR) = 0.353; 95% confidence interval (CI); 0.256–0.487, $p < 0.001$] than those who came from schools without improved school WASH services. In the same way, students' regularity in terms of school attendance was significant even after the inclusion of all sociodemographic characteristics in model 2, and [adjusted odds ratio (AOR) = 0.508; 95% CI; 0.334–0.773, $p < 0.01$] it increased rapidly after the inclusion of sociodemographic covariates. Furthermore, in model 2, students with Brahmin/Chhetri-Terai (COR = 0.315; 95% CI; 0.153–0.648, $p < 0.01$) and Dalit identities (AOR = 0.274; 95% CI; 0.139–0.542, $p < 0.001$), respectively, were more likely to be absent in school than other castes, including Brahmin/Chhetri-Hill, Janajati, and other castes.

DISCUSSION

This study assesses the effects of school WASH services on basic level students' school absenteeism in urban Nepal. This study found that students' school absenteeism was higher in schools that did not have improved WASH services compared to those that had. The findings of this study were similar to those of a study in China, which showed that the school WASH

TABLE 1 | Sociodemographic characteristics of students.

Variables	School WASH facilities					
	Improved		Unimproved		Total	
	n = 384	%	*n* = 384	%	*n* = 768	100%
Age group						
10–14	360	46.9	273	35.5	633	82.4
15–19	24	3.1	111	14.5	135	17.6
Sex						
Boys	190	24.7	170	22.1	360	46.9
Girls	194	25.3	214	27.9	214	53.1
Grade/Class						
Grade six	183	23.8	49	6.4	232	30.2
Grade seven	117	15.2	135	17.6	252	32.8
Grade eight	84	10.9	200	26.0	284	37.0
Caste/Ethnicity						
Brahmin/Chhetri-Hill	190	24.7	34	4.4	224	29.2
Brahmin/Chhetri-Terai	54	7.0	152	19.8	206	26.8
Janajati	73	9.5	52	6.8	125	16.3
Dalit	49	6.4	95	12.4	144	18.8
Other castes	18	2.3	51	6.6	69	9.0
Religion						
Non-Hindu	73	9.5	65	8.5	138	18.0
Hindu	311	40.5	319	41.5	630	82.0
Total	384	50.0	384	50.0	768	100

TABLE 2 | School absenteeism by students' background characteristics.

		Absenteeism at school				Total		$\chi 2$	*P*
		Yes		No		*n*	%		
		n	%	*n*	%				
School WASH situation***	Improved	78	20.3	306	79.7	384	100.0	40.93	0.000
	Unimproved	160	41.7	224	58.3	384	100.0		
Age group	10–14	193	30.5	440	69.5	633	100.0	0.42	0.517
	15–19	45	33.3	90	66.7	135	100.0		
Sex	Boys	111	30.8	249	69.2	360	100.0	0.08	0.930
	Girls	127	31.1	281	68.9	408	100.0		
Grade of the student*	Grade 6	61	26.3	171	73.7	232	100.0	7.08	0.029
	Grade 7	73	29.0	179	71.0	252	100.0		
	Grade 8	104	36.6	180	63.4	284	100.0		
Ethnicity/Caste of the students***	Brahman/Chhetri-Hill	38	17.0	186	83.0	224	100.0	63.81	0.000
	Brahman/Chhetri-Terai	78	37.9	128	62.1	206	100.0		
	Janajati	21	16.8	104	83.2	125	100.0		
	Dalit	68	47.2	76	52.8	144	100.0		
	Other castes	33	47.8	36	52.2	69	100.0		
Religion of the students**	Hindu	199	31.6	431	68.4	630	100.0	16.1	0.001
	Budhhism	7	13.7	44	86.3	51	100.0		
	Muslim	21	51.2	20	48.8	41	100.0		
	Christianity	11	23.9	35	76.1	46	100.0		
Total		238	31.0	530	69.0	768	100.0		

****p < 0.001, **p < 0.01, and *p < 0.05.*

program reduced the number of missed school days by 54% per year and reduced absenteeism by 42% (Bowen et al., 2007). Another study in Philippines found that school WASH services reduced school absenteeism by 27% (Bella et al., 2008); in India, a sanitation program helped increase girls' enrolment by one-third and enhanced boys' and girls' academic performance

TABLE 3 | Adjusted odds ratios (AOR) from a multivariate logistic regression assessing school absence by students predicting the school's WASH services and other socio-demographic covariates.

Selected predictors	Model I			Model II		
	cOR	95% CI		aOR	95% CI	
School WASH services						
Without improved	1.00			1.00		
With improved	0.353***	0.256	0.487	0.508**	0.334	0.773
Age group						
10–14				1.00		
15–19				1.481	0.945	2.320
Sex of students						
Boys				1.00		
Girls				1.027	0.740	1.427
Class/Grade of students						
Six				1.00		
Seven				0.839	0.524	1.342
Eight				0.709	0.476	1.056
Caste/Ethnicity						
Brahmin/Chhetri-Hill				1.00		
Brahmin/Chhetri-Terai				0.315**	0.153	0.648
Janajati				0.689	0.359	1.323
Dalit				0.274***	0.139	0.542
Other castes				1.086	0.603	1.892
Religion						
Non-Hindu				1.00		
Hindu				1.068	0.603	1.892
Constant	0.722**			0.858		
Cox & Snell R^2	0.054			0.103		
2 Log likelihood	909.895			868.620		

****p < 0.001 and **p < 0.01. Non-Hindus consist of Buddhists, Christians, and Muslims.*

by 25% (United Nations Children's Fund Regional Office for South Asia, 2015). UNICEF highlighted a beneficial effect of hygiene intervention, significantly reducing absenteeism due to infectious causes during and after the intervention (United Nations Children's Fund, 2013).

Additionally, our analysis found that students' school grade, caste, and religion have a significant association with students' school absenteeism. Even among students in the same school WASH facilities, the prevalence of school absenteeism varies as a function of home environment, WASH handling behavior, food consumption behavior, family economic status, and individual and family perception toward the school and education in different caste and religion groups. Further, different interests of students and parents may have contributed to the low attendance rate. In support of the present study, Nandrup-bus and Visitor (2009) concluded that female students were more likely to be absent from school compared to male students in schools with inadequate WASH services. A systematic review by Joshi and Amadi (2013) concluded, in line with the present findings, that school-based WASH programs, especially hygiene facilities and hand hygiene instruction in the school, improved student attendance in public elementary schools during the flu season. Furthermore, the benefits of school WASH services were more pronounced for girl students. Consistent with the present findings, United Nations Children's Fund (2013) stated that adequate school WASH services significantly reduce students' school absenteeism, especially for girls of menstruating age and that have hygiene-related diseases. The same UNICEF report further noted that WASH in schools promotes equity as all children are entitled equal access to WASH facilities; all children benefit from improved hygiene practices promoted by WASH in schools' activities (United Nations Children's Fund, 2013).

The present study found no strong statistical evidence to support the existing narrative claiming an association between students' age and sex to students' school absenteeism. The research further noted that improved schools are equipped with separate sanitation facilities for girls including menstrual hygiene management (MHM) rooms that have running water and a dustbin for disposal of used sanitary materials. However, other materials required during the period like sanitary materials, hooks for hanging the clothes/table, soap for cleaning, lighting within the room, and healthcare facilities within the schools, were not found. Improved schools are served with some WASH packages, whereas unimproved schools have a fair to poor level of services. Toilets have no running water in unimproved schools; students should bring water outside toilets if they

desire to use toilets. Furthermore, toilets are not suitable for the disabled and children, and cleaning materials like brush and toilet cleaners, such as Harpic or detergent, are scarce. Though toilets are separate for girls and boys, no MHM rooms were found in unimproved schools. In addition, there were no fixed handwashing stations in unimproved schools. A study by Sharma et al. (2019) in the Rukum district reported identical findings that almost toilets in all schools had no running water and handwashing facilities with soap, including separate MHM rooms. Due to these inadequacies, most girls avoided using school toilets or avoided even going to the school during the period.

Differently, but in line with the findings of the present study, the US CIVIL Rights and Data Collection (CRDC) 2020–2021 reported that children with disabilities are more likely to have chronic absenteeism than children without disabilities, where sex and age of the children had no role in absenteeism. Similarly, children and youth with special healthcare needs were found to have more school absences than children without (Reuben and Pastor, 2013). In a similar vein to the present findings, Graitcer (2011) and Johnson et al. (2015) concluded that students' health condition is closely associated to absenteeism instead of students' age and sex. Thus, the causes of students' school absenteeism vary depending on the specific communities. However, in line with the findings of this study, there is no sufficient evidence to support the claim that students' age and sex have much to do with absenteeism.

We found evidence that students with Brahmin/Chhetri-Terai and Dalit identities were more absent from school than those from Brahmin/Chhetri-Hill, Janajati, and other castes. In contrast to the present findings, Ranabhat et al. (2019) presented no association between caste/ethnicity and school absenteeism in the Kalikot district of Nepal. However, the same study revealed that disadvantaged Janajati adolescent girls were nearly three times more likely and relatively advantaged Janajatis girls were almost two times more likely to be absent from school during the menstruation period than upper caste groups. The higher proportion of school absenteeism among these groups might be due to poor socioeconomic status and perceptions of education within these ethnic groups.

Limitations and Strengths of This Study

In a truly scientific spirit, we would like to disclose the known limitations of this study. The researcher obtained self-reporting information from the respondents, and the underreporting of school absenteeism by teachers and parents may have an important limitation. Similarly, the incidence of absence was lost based on the socioeconomic status of the family and family structure of the students. Another limitation of this study may be the generalization of the findings obtained in only four schools. A unique strength of this study was that it was an adequate assessment of school-based WASH facilities: with and without improved WASH facilities in 768 students from grades 6–8 in Nepal. We were also able to use a causal-comparative/*ex post* facto research design; controlling for several critical matching variables is important from the nonexperimental designs of this study.

CONCLUSION

This study found that school absenteeism was significantly higher among students who were fortunate to enjoy an improved WASH system. This is true for all sociodemographic characteristics. While the school grade, caste, and religion of students have an association with school absenteeism, the findings underscore the importance of access to WASH services and compulsory instruction and practices of WASH behavior in government schools. Therefore, the school needs to ensure access to WASH services throughout the school day and avail handwashing and sanitation lessons at least one time a month.

DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Nepal Health Research Council (NHRC), Nepal. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

MKS led the manuscript. RA did overall supervision for the research. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

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