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From clicks to credits: examining the influence of online engagement and internet addiction on academic performance in Chinese universities

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Abstract

University students' engagement in online activities can impact both internet addiction and academic performance. This research aims to investigate these effects among university students. Using data from the "China College Students Longitudinal Survey" conducted by the Chinese Academy of Social Sciences between 2013 and 2018, this study examines the influence of university students' engagement in online activities. With a sample size of 15,102 university students, we explored the relationship between online activity, internet addiction, and academic performance. Employing stratified random sampling, the study investigates sample characteristics, including gender, study level, time spent online, and experiences accessing websites. Academic performance is assessed through six categories, employing descriptive and inferential statistics such as t-tests, ANOVA, stepwise linear regression, and path analysis. The findings indicate significantly high levels of university students' engagement in online activities, accompanied by a high prevalence of internet addiction. Key factors determining university students' engagement, internet addiction, and academic performance include gender, study level, time spent online, and experiences accessing websites beyond the Great Firewall. The study establishes a complex relationship, revealing negative effects of specific online engagements on internet addiction, while the latter influences university students' engagement. Overall, this research contributes valuable insights into the intricate interplay between online behaviors, addiction, and academic performance among Chinese university students, with implications for educational policies and interventions.

Keywords: University student, Engagement, Online learning, Internet addiction, Academic performance

Introduction

In the ever-evolving landscape of higher education, digital technologies have sparked a profound paradigm shift, disrupted traditional learning modalities and ushered in dynamic and interactive online experiences (Harasim, 2000, Wei, 2023). This transformative wave extends beyond the virtual realm; digital technology has become a cornerstone

in reshaping classrooms and learning methods (Kaputa et al., 2022). The impact of technological advancements on education is undeniable, significantly streamlining the academic experience for higher education students (Alenezi, 2023; Raja & Nagasubramani, 2018). Today's students no longer rely solely on pen-and-paper methods; instead, they harness a diverse array of software and tools to create presentations, collaborate on projects, and engage in a more dynamic and interactive learning environment (Haleem et al., 2022; Khanal, 2023). This monumental shift, facilitated by the seamless integration of online platforms and digital tools, stands as a revolutionary force in shaping contemporary educational practices (Haleem et al., 2022). The benefits are manifold: equipping students with practical skills for the future, improving resource accessibility, and enhancing overall learning efficiency (Costley, 2014). Moreover, digital technologies promote global skills development and support student-centered teaching methods, including active learning and personalized approaches (Kerimbayev et al., 2023).

While digital technologies offer benefits like skill development and resource accessibility (Costley, 2014), the rise of internet addiction among university students presents a significant concern (Mhlongo et al., 2023; Seema & Varik-Maasik, 2023). Fan et al. (2023) highlight its negative impacts, including emotional abuse, neglect, and mental health issues. Kumar (2018) found correlations between internet addiction, depression, anxiety, and low self-esteem. Addressing internet addiction and promoting responsible technology use are essential for fostering a healthy and successful academic journey.

The issue of internet addiction has raised significant concerns regarding its potential impact on university students' engagement and academic performance. Studies conducted by Chen et al. (2010) and Kumar (2018) shed light on this matter, revealing substantial correlations between internet addiction and depression, anxiety, as well as interpersonal sensitivity. Moreover, a connection has been observed between low self-esteem and the likelihood of internet addiction among students. The internet addiction describes it as the inability to regulate one's use of the Internet, leading to challenges across various domains such as psychological, social, and occupational functioning (Yuan et al., 2011). Debates persist regarding whether it constitutes platform addiction or content addiction (Beard, 2005; Young, 1996). Internet addiction manifests through various symptoms (Young, 2008) and can even result in physical discomforts (Kumar & Mondal, 2018). Excessive preoccupations, urges, or behaviors characterize this phenomenon (Shaw & Black, 2008).

Dwivedi et al. (2021) highlight the global rise in internet usage among youth, necessitating a deeper examination of its impact on university students and their online learning engagement. Internet users surged by 1000% between 2000 and 2015, leading to increased research on addictive internet use (Kuss & Lopez-Fernandez, 2016). While internet addiction globally stands at approximately 6%, prevalence rates vary widely by region (Cheng & Li, 2014). In Ethiopia, rates among university students range from 35.2% to 85% (Asrese & Muche, 2020; Zenebe et al., 2021), with Acharya et al. (2023) finding a prevalence of 29.90% (95% CI: 25.0–34.9). Understanding these rates is crucial for addressing their impact on students' well-being and academic success. In Nepal, a chi-squared test identified associations between internet addiction and factors like parental relationships and daily internet usage time ($p < 0.05$). However, research into the link between online engagement, internet addiction, and academic success remains

limited, with recent studies expanding to consider factors like self-efficacy and life satisfaction (Tülübaş et al., 2023).

In the current research landscape, there is a noticeable gap in the literature regarding sample size limitations too. Studies by Sun et al. (2023), Chen and Wang (2023), Jiang (2014), Avcı and Kula (2023), Li et al. (2023), Taş (2017), Zenebe et al. (2021), and Ghimire and Khanal (2021) have addressed specific aspects of the relationship between online activities, internet addiction, anxiety in online learning, and academic performance. However, these studies have been conducted with relatively small sample sizes ranging from 179 to 728 participants, limiting their generalizability due to the small and specific participant pools. For example, Sun et al. (2023) examined game addiction in university students, while Chen and Wang (2023) explored the impact of social media use on academic performance. These studies provide valuable insights but warrant further investigation with larger and more diverse samples.

Therefore, this paper aims to address these limitations by providing a more in-depth exploration of the relationship between online engagement, internet addiction, and academic performance. It builds upon previous research by employing a larger and more diverse sample size, enabling a more comprehensive understanding of these complex associations. Thus, the hypothesis of this study is that the level of engagement among university students in online activities, coupled with their experience of internet addiction, collectively influences their academic performance. Theoretical frameworks cited in this study, such as engagement theory (Kearsley & Shneiderman, 1998), the theory of addiction (West, 2006) from psychological and sociological perspectives, and the cognitive-behavioral model of excessive internet use (Davis, 2001), will be elaborated upon to provide deeper insights into the underlying mechanisms driving the relationship between online engagement, internet addiction, and academic performance.

In our study, internet addiction is defined as compulsive behavior, particularly on social media platforms and mobile phones, negatively impacting various life aspects, including academic or professional performance and basic self-care activities like eating and sleeping (Li et al., 2015). Individuals may struggle to refrain from online activities, affecting their studies and well-being. In our study, internet addiction is defined as compulsive behavior involving excessive use of social media platforms like WeChat or QQ, along with mobile phones. We quantify addiction through assessing individuals' excessive online engagement and its detrimental effects on their studies and well-being. The investigation is driven by the evolving nature of online learning environments and the increasing reliance on digital platforms for academic pursuits. Understanding the level of engagement in various online activities is crucial for grasping the dynamics of contemporary education, as emphasized by previous research (Amjad et al., 2023; Saqr & López-Pernas, 2021). Simultaneously, exploring patterns of internet addiction becomes imperative to unravel the complexities that may hinder or enhance students' educational experiences (Kumar & Mondal, 2018). The research questions sequentially address the current level of engagement, the reciprocal relationship between online engagement and internet addiction, the impact of internet addiction on engagement, and the collective influence of engagement and internet addiction on the academic performance of undergraduate to doctoral students representing various demographics with a large sample size (15,102) university students). By delving into nuanced aspects of online

engagement, such as information-seeking behaviors, social networking patterns, and digital consumption habits, the study seeks to provide a comprehensive understanding of the current landscape. We employed validated assessment tools and methodologies specifically designed to measure internet addiction among Chinese students. These tools involved self-report questionnaires that assess the frequency and intensity of internet usage, as well as the extent of interference with daily functioning.

Thus, the study is guided by the following research questions:

Research questions

1. What is the current level of engagement among university students in China in various online activities, and to what extent does internet addiction manifest within this population?
2. To what extent does university students' engagement in online activities contribute to or influence the development of internet addiction among university students?
3. To what extent do university students' engagement in online activities and their experience of internet addiction collectively affect their academic performance among university students in China?

Conceptual framework and literature review

The concept of Engagement theory suggests that students who are actively involved and deeply engaged intellectually, socially, and behaviorally tend to experience improved learning outcomes (Kearsley & Shneiderman, 1998). Thus, it can be used to examine university students' engagement in online learning environments, investigating gender disparities, variations based on academic levels, and influential factors. According to a group of researchers exemplified by Boulianne (2009), the internet is perceived to have a negative effect on engagement as it is predominantly utilized for entertainment purposes. Fredricks et al. (2004) underscore the multidimensional nature of engagement, encompassing behavioral dimensions. The central theme of technology-mediated engagement has prompted investigations into the impact of various online platforms and tools on student participation and interaction (Kahu, 2013). This could support the relationship between student engagement and academic performance. Second, the Theory of Addiction (West, 2006) explains how and why individuals may develop behaviors that are overly dependent on the alcohol which might be similar to internet. Third, the Cognitive-Behavioral Theory (Beck et al., 1979) suggests that cognition (i.e., thoughts and beliefs) and behavior interact to influence an individual's mental state and performance. This can be used to explain how an individual's academic performance may be affected by internet use.

University students' engagement in online learning environments: gender disparity, academic level variation, and influential factors

Engagement theory posits that students actively connect with learning activities by interacting with others and engaging in meaningful tasks (Kearsley & Shneiderman, 1998). Scholars have extended this theory to learning in technology-based environments and found that such learning often entails collaborative endeavors and project-based

individual and group assignments, which can foster creative, meaningful, and authentic learning experiences (Bernacki et al., 2020). Engagement theory contend in predicting the impact of the internet on student engagement. Boulianne (2009) suggests that the internet's predominant use for entertainment might reduce engagement in academic activities. However, research indicates that common internet activities, such as social interaction and information-searching, contradict this notion (Day et al., 2005). Despite criticisms, increased internet usage for news and social media activities suggests a complex relationship between technology and engagement (Howard et al., 2006). Smith (2010) emphasizes the importance of student engagement for academic success. Students' engagement in online learning environments can be observed from behavioral, emotional, and cognitive aspects. Moreover, Xerri et al. (2018) indicated that the use of the internet and engagement of students in online activities can foster positive relationships, peer connections, and students' sense of purpose within higher education, thus contributing to their overall engagement.

Existing literature on internet use and engagement underscores a focus on gender disparities and academic levels. While Smith and Storrs (2023) emphasize a bias towards undergraduate participants, Smith and Caruso (2010) delve into gender-specific engagement patterns, revealing variations in participation, communication styles, and preferences. Sun et al. (2020) highlight gender differences in internet use patterns, prompting further exploration into their impact on online learning environments. Socio-cultural factors, stereotypes, and biases also contribute to these differences (Broady et al., 2010; Margolis & Fisher, 2003). Understanding these dynamics through the Engagement reveals nuanced insights, such as evolving engagement dynamics across academic stages (Means et al., 2009), heightened involvement in internet activities at higher academic levels (Alalwan, 2022), and the importance of effective course design and instructor practices in shaping engagement (Esteban-Millat et al., 2014). However, it's essential to recognize that online engagement dynamics may vary in different contexts, such as the Chinese educational landscape, due to unique challenges. Understanding the intricate relationship between free internet use restrictions and online engagement among Chinese university students is essential for comprehending engagement patterns accurately (Lee et al., 2013; Kumar, 2023). The exploration of university students' online engagement, focusing on gender disparity and academic level variation, aligns with the multifaceted inquiry of the Theory of Engagement within educational research. The existing gaps in literature, including biases towards gender disparities, undergraduates, and contextual challenges like internet restrictions, underscore the necessity for a more inclusive and context-sensitive approach to advance our understanding of this complex phenomenon.

The Nexus between university students' engagement, internet addiction, and academic achievement

Originally, internet addiction was defined by four main diagnostic criteria: increased investment of resources in online activities, negative emotional changes when offline, tolerance to the positive effects of internet use, and denial of excessive internet use (Kandell, 1998). Today, researchers are increasingly interested in the relationship between student engagement, internet addiction, and academic achievement (Mhlongo et al.,

2023). This scholarly attention reflects the pervasive integration of digital technologies in education, necessitating a nuanced exploration of their impact on academic performance and addictive behaviors (Noor et al., 2022). Engagement, a multifaceted construct, significantly shapes the learning experience (Fredricks et al., 2004), while the rising incidence of internet addiction among students raises concerns about its impact on academic outcomes (Kuss & Lopez-Fernandez, 2016).

Research consistently establishes a link between university students' engagement and academic success (Fredricks et al., 2004; Appleton et al., 2008), aligning with the Theory of Internet Addiction. Gender differences also emerge, with females showing more favorable academic outcomes and lower levels of internet addiction (Zhao et al., 2023). Sun et al. (2023) substantiates a direct association between heightened internet addiction levels and diminished academic engagement, suggesting a manifestation of addictive behaviors within the framework of internet use.

However, Lei et al. (2018) provide a nuanced perspective, challenging the simplistic view of a linear relationship between internet addiction and engagement, thus highlighting the complexity within the Theory of Internet Addiction. Additionally, studies propose that higher academic levels may enhance internet and social media engagement (Alalwan, 2022), further illustrating the interplay between academic progression and internet usage. Engaged students consistently demonstrate elevated motivation, participation, and deeper commitment to learning, impacting academic indicators such as grades and overall educational attainment (Reeve & Tseng, 2011; Skinner et al., 2009), thereby providing insights into the relationship between engagement, addiction, and academic outcomes within the framework of internet addiction theory.

Moreover, Esteban-Millat et al. (2014) suggest that some students channel their engagement into constructive online pursuits, hinting at the potential for positive impacts on academic outcomes, which underscores the complexity of the relationship between internet addiction and academic engagement. Selvitopu and Kaya (2023) emphasize the importance of considering various factors, such as socioeconomic status and learning styles, in future research to better understand their relationship with online engagement and academic performance within the Theory of Internet Addiction.

Excessive internet use and academic achievement

Internet addiction, characterized by excessive and problematic internet use with adverse consequences, remains a significant concern in the academic landscape (Young, 1998). Moving away from addiction pathology, Davis (2001) proposed a cognitive-behavioral model of excessive internet use, suggesting that pre-existing psychosocial difficulties predispose individuals to maladaptive cognitions and behaviors leading to excessive use. Davis (2001) also differentiated between specific and generalized internet use, with certain behaviors being distinct from general internet use. Cognitive-Behavioral Theory explores how excessive internet use affects cognition among young individuals. Results indicate that various aspects of human behavior, lifestyle, cognitive development, academics, and well-being are significantly affected by excessive internet use (Cai et al., 2023; Gao et al., 2024). Cognitive-Behavioral Theory is applicable to explaining the relationship between internet use and academic performance. Dou and Shek, (2021) reveal that prolonged internet use negatively impacts cognitive abilities and subsequently

affects academic achievement. Specifically, using the internet for more than six hours per day shows a decline in academic performance. The impact on academic achievement is a significant concern.

The ubiquity of smartphones, social media, and online gaming platforms amplifies behaviors leading to excessive use and the risk of internet addiction among students (Barnes et al., 2019) ultimately lead to pre-existing psychosocial difficulties. A bidirectional relationship between internet addiction and academic performance is posited, with addictive behaviors potentially undermining academic engagement and achievement (Demetrovics et al., 2008; Lam, 2014). Kuss and Lopez-Fernandez (2016) emphasize the profound impact of internet addiction on daily life activities. Zhang et al. (2020) discuss students facing challenges due to excessive internet use closely align with psychosocial factors like depression and self-esteem. They emphasize the importance of understanding factors leading to time management issues and lack of self-control. This understanding can inform interventions for promoting healthier online behaviors. Furthermore, Brown et al. (2021) highlights the link between excessive internet use and health-related concerns. This dovetails with prior research indicating a connection between excessive internet use and health-related issues. However, counterarguments assert that excessive engagement in certain activities, such as watching livestreams (Naslund et al., 2020) and playing games (Moge & Romano, 2020), may contribute to negative mental health outcomes, including increased stress and anxiety (Primack et al., 2017). Scholars recognize that internet addiction is complex and argue that certain online activities, like using Social Networking Sites, may not directly cause addiction. Instead, they suggest that these activities are part of a larger pattern influenced by individual traits and motivations (Kuss & Griffiths, 2011).

The theories and literature underscore the complex relationships among university students' engagement, internet addiction, and its implications for mental health. This highlights the importance of understanding how students' engagement in online activities and internet addiction correlate with their academic achievement, posing significant concerns in education (Zenebe et al., 2021). These complex relationships warrant further examination and targeted interventions to support positive educational outcomes. The conceptual framework of this study clarifies the intricate connections among university students' engagement in online activities, internet addiction, and academic performance in China. Internet addiction is seen as both a potential outcome of excessive online engagement and a factor that influences academic outcomes (Zubair, 2023). Our premise is that to fully comprehend the causes and effects of online activity engagement, it's crucial to consider engagement as either related to the individual or the situation (Dinc, 2022) as independent variables. Furthermore, it's essential to examine these issues with internet addiction serving as a mediating variable, academic performance as the dependent variable (Chen & Wang, 2023), and demographic characteristics as moderating variables (Chawla & Joshi, 2018).

The first aspect of the conceptual framework focuses on students' active participation in various online activities. These activities include searching for information, social networking, online payment, gaming, and other relevant digital interactions (Alam & Mohanty, 2023). This variable is deemed independent as it is hypothesized to influence both internet addiction and academic performance. Internet addiction serves

as a mediating variable, encapsulating the potential consequences of excessive online engagement (Kuss & Lopez-Fernandez, 2016). It is conceptualized as a multifaceted construct influenced by various online activities. Internet addiction is anticipated to mediate the relationship between students' engagement and academic performance, acting as a bridge that links the two constructs (Taş, 2017).

Academic performance (Dependent Variable) is the ultimate outcome variable, representing the educational achievements of university students. This variable is hypothesized to be directly influenced by students' engagement in online activities and, concurrently, mediated by the presence of internet addiction. The impact of internet addiction on academic performance may vary depending on the nature and extent of online engagement behaviors (Zenebe et al., 2021). The conceptual framework acknowledges the influence of demographic characteristics, such as gender, study level, time spent online, and experience accessing websites beyond the Great Firewall, as potential moderating factors (Moderating Variables). These variables are expected to shape the strength and direction of the relationships among students' engagement, internet addiction, and academic performance (Mari et al., 2023). University students' engagement in online activities is hypothesized to have a direct positive impact on academic performance. Internet addiction is hypothesized to mediate the relationship between students' engagement and academic performance, with potential variations based on the nature of online activities. Demographic characteristics are hypothesized to moderate the relationships among students' engagement, internet addiction, and academic performance.

Our study's conceptual framework elucidates these complex relationships, clarifying the interplay among students' engagement, internet addiction, and academic performance in China. We posit that to fully understand the causes and effects of online activity engagement, it is crucial to consider various variables such as engagement as related to the individual or the situation, internet addiction as a mediating variable, academic performance as the dependent variable, and demographic characteristics as moderating variables (Dinc, 2022; Chen & Wang, 2023; Chawla & Joshi, 2018). The first aspect of our conceptual framework centers on students' active participation in diverse online activities, encompassing behaviors such as searching for information, social networking, online payment, gaming, and other relevant digital interactions (Alam & Mohanty, 2023). This framework provides a theoretical foundation for investigating the intricate connections between students' engagement in online activities, internet addiction, and academic performance among university students in China, serving as a roadmap for our study's design, data collection, and analysis (Fig. 1).

Research methodology

Research setting

This research is an integral part of the comprehensive research initiative known as the "China College Students Longitudinal Survey," a significant sociological investigation spearheaded by the esteemed Chinese Academy of Social Sciences (CASS). Executed through a meticulous collaboration between the Institute of Sociology of the Chinese Academy of Social Sciences (ISCASS) and the China Institute for Educational Development (CIED), this initiative unfolded over an extensive timeframe from 2013 to 2022. Throughout this period, the project systematically conducted ten carefully curated

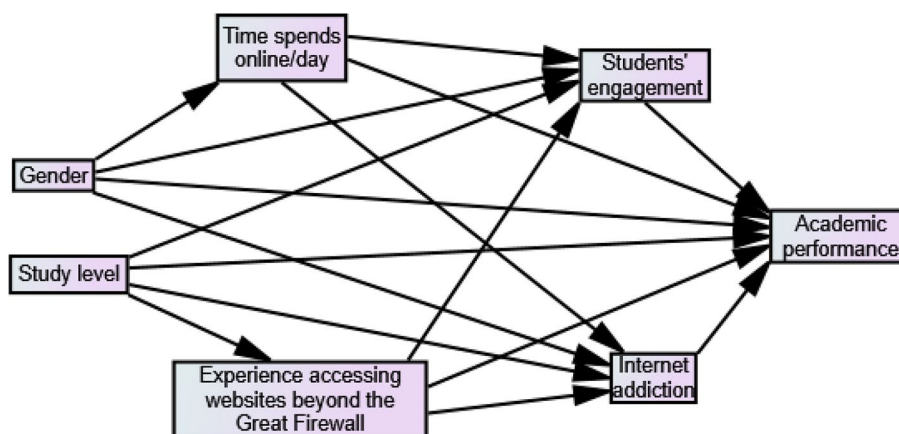


Fig. 1 Conceptual framework

rounds of surveys, capturing a comprehensive view of Chinese university students and graduates. It is essential to highlight that the data utilized in the present research originates from the specific survey period of May to June 2018, thereby contributing to the broader longitudinal narrative of this substantial undertaking. This research, therefore, forms a critical component within the larger context of the longitudinal survey, providing valuable insights into the diverse experiences of Chinese college students during the specified timeframe.

Sample and sampling technique

In the year 2018, this research meticulously obtained a total of 15,102 valid samples as part of the survey, achieving an impressive overall response rate of 70.9%. The chosen sampling strategy was the stratified random sampling technique, selected for its effectiveness in ensuring a robust and representative sample selection. The research employed a systematic approach, strategically selecting four key universities, four conventional universities, and four vocational colleges. Each of these institutions represented different tiers of academic establishments, encompassing key universities, regular universities, and vocational colleges. This selection also embraced diverse university types, spanning comprehensive, science and engineering, humanities, and other disciplines. Geographical diversity was given meticulous consideration, with universities from Beijing, Shanghai, Guangzhou, as well as the Northeast, North China, Northwest, Southwest, Central China, East China, and South China regions all included in the research. After the university selection process, the research further refined its sample pool by randomly singling out one class from each of the eight chosen schools, departments, or majors. Subsequently, a specific number of students from these selected classes were chosen in a wholly random and unbiased manner, ensuring the integrity of the sampling process.

The data collection process was carried out using an online platform. Respondents were required to complete an electronic questionnaire hosted on the Survey and Data Information Center of the Chinese Academy of Social Sciences. This meticulous sampling methodology played a crucial role in ensuring the reliability and comprehensiveness of the dataset that underpins this research endeavor.

Variable information

The research encompasses four key sample characteristic variables: gender, study level, time spent online, and experience accessing websites beyond the Great Firewall. Gender is categorized into two groups, namely male and female, while study level comprises four categories—junior, undergraduate, master, and above master level. Similarly, the variable representing time spent online consists of seven categories ranging from less than 1 h to over 10 h. The experience accessing websites beyond the Great Firewall is delineated into three categories: yes, none, and don't know.

Furthermore, academic performance was evaluated across six distinct categories, each with its respective percentage representation: overall ranking top 10% (15.8%), 10%-25% (22.1%), 25%-50% (30.1%), 50%-75% (21.3%), 75%-90% (7.1%), and bottom 10% (3.6%). To ensure the reliability of learner engagement, Cronbach's Alpha was employed, surpassing the threshold value of 0.70. The validity of the instrument was rigorously maintained through the item-total correlation technique, with detailed findings presented in Table 1. This comprehensive approach in defining and assessing the sample characteristics and variables strengthens the research's foundation and enhances the robustness of its findings.

Data analysis technique

The data analysis employed a combination of descriptive and inferential statistics to yield comprehensive insights. Descriptively, frequency and percentage distributions were

Table 1 Level of students' engagement in online

| Statements | Mean | SD | Alpha | t-value | ITC |
|--|------|------|-------|----------|------|
| Searching for information (ELO01) | 3.52 | 1.13 | 0.843 | 56.86* | 0.43 |
| Navigation, finding routes (ELO02) | 2.80 | 1.06 | 0.839 | -23.31* | 0.53 |
| Doing homework, looking up words (ELO03) | 3.46 | 1.09 | 0.843 | 51.56* | 0.42 |
| Checking emails (ELO04) | 2.53 | 1.15 | 0.842 | -50.10* | 0.46 |
| Contacting classmates, friends and family (WeChat, QQ) (ELO05) | 4.25 | 0.95 | 0.840 | 161.05* | 0.50 |
| Checking social networks like Moments, QQ Zone (ELO06) | 4.08 | 1.03 | 0.839 | 128.94* | 0.53 |
| Checking Weibo (ELO07) | 2.89 | 1.46 | 0.839 | -8.93* | 0.55 |
| Visiting various forums and BBS like Zhihu (ELO08) | 2.49 | 1.32 | 0.837 | -47.47* | 0.57 |
| Watching short videos like TikTok, Kuaishou (ELO09) | 2.38 | 1.39 | 0.847 | -54.41* | 0.40 |
| Watching livestreams like YY (ELO10) | 1.80 | 1.15 | 0.843 | -127.55* | 0.44 |
| Listening to music like Xiami Music (ELO11) | 3.50 | 1.21 | 0.839 | 51.00* | 0.53 |
| Playing games (ELO12) | 2.54 | 1.27 | 0.844 | -44.36* | 0.43 |
| Watching TV series or movies (or downloading them), like Tencent Video, sub groups (ELO13) | 3.01 | 1.07 | 0.836 | 0.58 | 0.59 |
| Reading novels, stories (ELO14) | 2.42 | 1.25 | 0.843 | -56.92* | 0.46 |
| Online shopping, purchasing (ELO15) | 2.59 | 0.95 | 0.835 | -53.06* | 0.63 |
| Online payment, finance, transfer (ELO16) | 3.05 | 1.23 | 0.838 | 5.28* | 0.55 |
| Reading news (ELO17) | 3.03 | 1.10 | 0.837 | 2.92* | 0.56 |
| Commenting on or discussing current affairs or social issues (ELO18) | 2.47 | 1.15 | 0.836 | -57.00* | 0.59 |
| Making and sharing videos or music (ELO19) | 1.74 | 1.02 | 0.840 | -150.70* | 0.50 |
| Helping others online, like purchasing for parents, medical inquiry for grandparents (ELO20) | 2.34 | 0.99 | 0.837 | -82.23* | 0.56 |
| Total | 2.85 | 0.59 | 0.850 | -32.61* | |

* $p < 0.05$, ITC-Item total correlation

utilized to illustrate the status of sample characteristics and the levels of academic performance. Percentage breakdowns were also employed to portray the item-wise status of internet addiction. For a more nuanced examination of university students' engagement, mean, standard deviation (SD), and one-sample t-tests were conducted at the item level. This allowed for a detailed exploration of the students' engagement status. Since the mean score of all items related to university students' engagement in online and internet addiction is scale data which is normally distributed. The normality was tested by using Skewness and Kurtosis methods as the value of Skewness are 0.45 and -0.45 and Kurtosis are 1.68 and 0.45 in students' engagement in online and internet addiction respectively which does not exceed the threshold value Skewness (absolute value is not greater than two) and Kurtosis (absolute value is not greater than 7) (Kim, 2013). Hence, independent sample t-test and analysis of variance (ANOVA) were used to find the significant difference in the mean score of university students' engagement in online, and internet addiction whereas the Man-Whitney U and Kruskal–Wallis H test were used to find the significant results on academic performance (because of the academic performance is in ordinal scale) (Creswell & Guetterman, 2019) based on sample characteristics. Specifically, t-test and Mann Whitney test were employed based on gender because of having two categories whereas ANOVA and Kruskal Wallis test were used based on experience accessing websites beyond the Great Firewall (EAWBGF), study level and time spend online because of having more than two categories. Since the results of mean ranks while using U and H tests were similar to mean score of the group variables hence mean was reported instead of mean rank. The results were calculated by using SPSS-26 software.

Furthermore, stepwise linear regression was applied to uncover the effects of students' engagement in online activities on internet addiction, as well as the reciprocal impact of internet addiction on university students' engagement in online activities. The complexity of the relationships among these variables was further explored using a path analysis model, specifically to investigate the effects of both University students' engagement in online activities and internet addiction on learning performance. This multifaceted analytical approach enhances the depth and precision of the research's findings, contributing to a more comprehensive understanding of the interplay between sample characteristics, students' engagement, internet addiction, and academic performance.

Results

In Fig. 2a, the gender distribution indicates a slight difference, with 52.6% of female participants and 47.4% male participants, resulting in a marginal 5% variance. Figure 2b illustrates the distribution based on study level, revealing that approximately half (47.3%) of the students are at the undergraduate level, while the representation of Ph.D. candidates is notably low at 0.3%. Examining time spent online in Fig. 2c, a predominant majority of Chinese university students dedicate 1–2 h (17.8%), 3–4 h (33.9%), and 5–6 h (20.9%) to internet usage daily. In Fig. 2d, only 23.7% of students report having experience accessing websites beyond the Great Firewall. These visual representations provide a concise overview of key demographics and behavioral patterns among the participants, setting the stage for a more in-depth analysis of the relationships between these variables and their potential impacts on the study's outcomes.

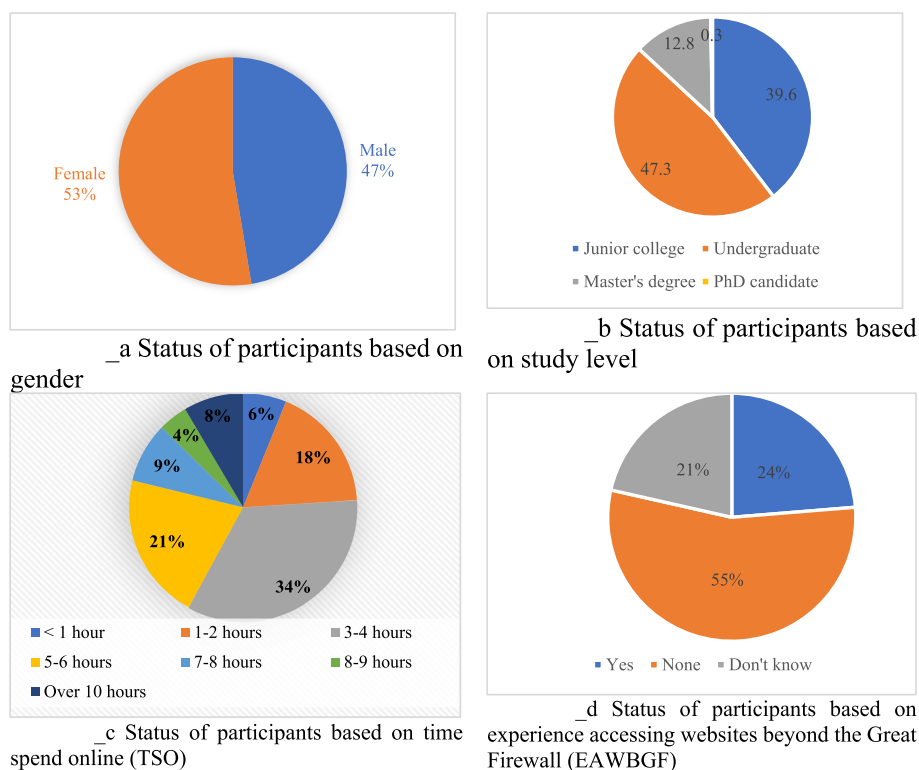


Fig. 2 a Status of participants based on gender b Status of participants based on study level c Status of participants based on time spend online (TSO) d Status of participants based on experience accessing websites beyond the Great Firewall (EAWBGF)

Level of engagement and the manifestation of internet addiction among university students in China

Table 1 presents the status of students’ engagement in online learning, assessed through means, standard deviations (SD), and one-sample t-tests. The results reveal noteworthy variations in the levels of engagement across different activities. Notably, participants displayed a significantly high level of engagement in searching for information (Mean = 3.52, SD = 1.13), doing homework, looking up words (Mean = 3.46, SD = 1.09), contacting classmates, friends, and family (WeChat, QQ) (Mean = 4.25, SD = 0.95), checking social networks like Moments, QQ Zone (Mean = 4.08, SD = 1.03), listening to music like Xiami Music (Mean = 3.50, SD = 1.21), online payment, finance, transfer (Mean = 3.05, SD = 1.23), and reading news (Mean = 3.03, SD = 1.10).

Conversely, the engagement level was found to be significantly low in the remaining activities, with the exception of watching TV series or movies (or downloading them) like Tencent Video, subgroups (Mean = 3.01, SD = 1.07), which yielded an insignificant result. Furthermore, the overall status of students’ engagement in online activities was deemed significantly low. These findings shed light on the diverse engagement patterns among participants, emphasizing specific areas of strength and areas requiring attention or improvement in the context of online learning.

Figure 3 provides an insight into the extend of students’ internet addiction, revealing distinctive patterns in various aspects. Approximately two-thirds of the students

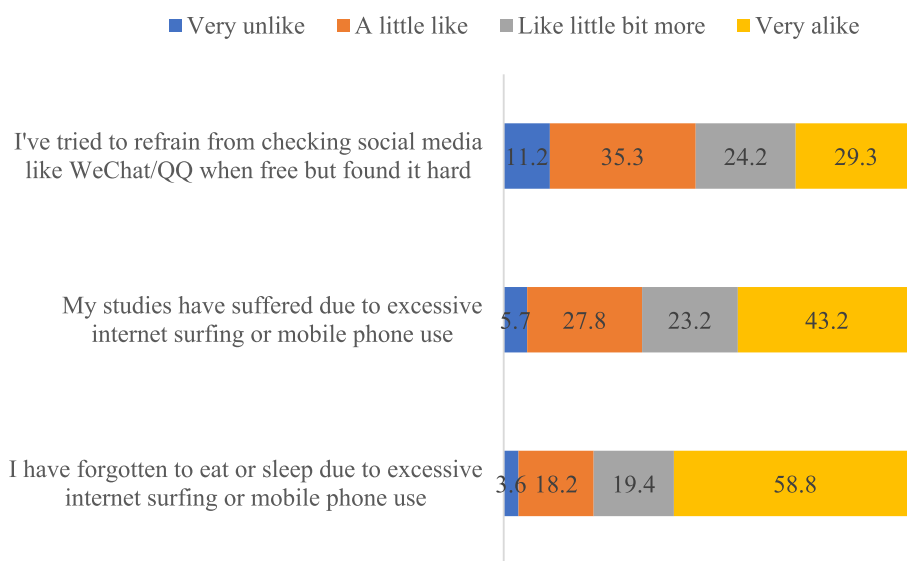


Fig. 3 Extend of internet addiction

(58.8%) exhibit a high tendency, very alike, to forgetting to eat or sleep due to excessive internet surfing or mobile phone use (IA1). Similarly, more than two-thirds (66.4%) express a little bit more to very alike sentiment toward experiencing academic difficulties due to excessive internet surfing or mobile phone use (IA2). Conversely, the rate is comparatively lower for the item "tried to refrain from checking social media like WeChat/QQ when free but found it hard" (IA3), with only 29.3% of students reporting a very alike inclination.

These findings underscore the prevalence of certain internet addiction behaviors among the student population, emphasizing the need for targeted interventions and awareness campaigns to address specific challenges related to excessive internet and mobile phone usage.

Table 2 provides a comprehensive overview of the status of academic performance level, internet usage, and internet addiction based on various sample characteristics. Notably, gender emerges as a significant determinant, showing a favorable role for females in terms of academic performance level and internet addiction. The research yields significant results across academic performance level, students' engagement in online activities, and internet addiction, with *p*-values consistently below 0.05. Regarding study level, the results favor higher academic performance levels for master and Ph.D. students, while engagement in online activities shows similar patterns across study levels. However, internet addiction is comparatively lower among junior-level students than in other categories.

Furthermore, the research demonstrates significant results with TSO (time spent online) and EAWBGF (experience accessing websites beyond the Great Firewall) across all variables, including academic performance level, engagement in online activities, and internet addiction. Students who spend more time online tend to exhibit lower academic performance levels, but they also display lower levels of internet addiction compared to those who spend less time online. Additionally, results

Table 2 Status of academic performance, university students' engagement in online, and internet addiction based on sample characteristics

| Variables | Number | Academic performance | | | Engagement in online | | | Internet addiction | | |
|-----------------|--------|----------------------|------|------|----------------------|------|------|--------------------|------|------|
| | | Mean | SD | P | Mean | SD | p | Mean | SD | P |
| Gender | | | | | | | | | | |
| Male | 7155 | 3.94 | 1.34 | 0.00 | 2.85 | 0.63 | 0.59 | 2.98 | 0.76 | 0.00 |
| Female | 7947 | 4.20 | 1.23 | | 2.84 | 0.54 | | 3.08 | 0.71 | |
| Study level | | | | | | | | | | |
| Junior college | 5976 | 4.08 | 1.22 | 0.00 | 2.85 | 0.60 | 0.00 | 2.96 | 0.74 | 0.00 |
| Undergraduate | 7146 | 3.96 | 1.34 | | 2.83 | 0.58 | | 3.02 | 0.74 | |
| Master's degree | 1933 | 4.48 | 1.24 | | 2.88 | 0.55 | | 3.26 | 0.68 | |
| PhD candidate | 47 | 4.68 | 1.32 | | 2.78 | 0.68 | | 3.02 | 0.82 | |
| TSO | | | | | | | | | | |
| < 1 h | 928 | 4.12 | 1.36 | 0.00 | 2.61 | 0.82 | 0.00 | 3.17 | 0.86 | 0.00 |
| 1–2 h | 2695 | 4.17 | 1.25 | | 2.75 | 0.57 | | 3.16 | 0.69 | |
| 3–4 h | 5126 | 4.08 | 1.27 | | 2.83 | 0.54 | | 3.05 | 0.70 | |
| 5–6 h | 3150 | 4.00 | 1.30 | | 2.91 | 0.55 | | 2.93 | 0.74 | |
| 7–8 h | 1291 | 4.07 | 1.30 | | 2.95 | 0.55 | | 2.93 | 0.74 | |
| 8–9 h | 628 | 4.04 | 1.28 | | 2.95 | 0.53 | | 2.99 | 0.75 | |
| ≥10 h | 1284 | 4.05 | 1.38 | | 2.95 | 0.63 | | 2.94 | 0.82 | |
| EAWBGF | | | | | | | | | | |
| Yes | 3582 | 4.04 | 1.34 | 0.01 | 3.01 | 0.59 | 0.00 | 2.97 | 0.77 | 0.00 |
| None | 8278 | 4.11 | 1.26 | | 2.81 | 0.56 | | 3.05 | 0.71 | |
| Don't know | 3242 | 4.04 | 1.31 | | 2.75 | 0.61 | | 3.05 | 0.76 | |

TSO Time spend online/day, EAWBGF Experience accessing websites beyond the Great Firewall

related to EAWBGF favor respondents who indicated "none" in terms of academic performance level. Conversely, the results indicate lower levels of internet addiction among respondents who answered "yes" to EAWBGF. These findings underscore the intricate interplay between sample characteristics, internet behavior, and academic outcomes, providing valuable insights for future interventions and tailored support programs.

Extent to which university students' engagement in online activities contributes to the development of internet addiction among university students

Table 3 presents the results of the stepwise linear regression analysis, exploring the effect of students' engagement in online activities on internet addiction, with sample characteristics as mediating variables. Nineteen models (Model 1 to Model 19) were generated, each explaining 3% to 9% of the variance and displaying significant ANOVA results. Significant beta values are selectively reported in the models, excluding all insignificant predictors. Notably, ELO12, ELO01, and TSO emerge as key predictors, with the highest absolute beta values across the models. Among the significant predictors, the impact of ELO6, ELO8, ELO10, ELO12, ELO14, ELO15, ELO16, ELO18, and TSO is found to be negative on internet addiction. In contrast, the remaining significant predictors exhibit a positive effect in the models.

The results suggest that internet addiction can be mitigated by increasing activities such as checking social networks like Moments, QQ Zone, visiting various forums and

Table 3 Effect (significant Beta value) of sample characteristics and students' engagement in online on internet addiction

| Variables | M19 | M18 | M17 | M16 | M15 | M14 | M13 | M12 | M11 | M10 | M9 | M8 | M7 | M6 | M5 | M4 | M3 | M2 | M1 |
|-------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| ELO12 | -0.08* | -0.08* | -0.08* | -0.08* | -0.08* | -0.09* | -0.10* | -0.11* | -0.11* | -0.11* | -0.12* | -0.12* | -0.13* | -0.13* | -0.14* | -0.16* | -0.15* | -0.16* | -0.16* |
| ELO01 | 0.10* | 0.10* | 0.10* | 0.11* | 0.10* | 0.10* | 0.11* | 0.11* | 0.11* | 0.11* | 0.12* | 0.13* | 0.13* | 0.17* | 0.16* | 0.16* | 0.17* | 0.15* | |
| TSO | -0.10* | -0.10* | -0.10* | -0.10* | -0.10* | -0.10* | -0.10* | -0.10* | -0.10* | -0.10* | -0.09* | -0.09* | -0.09* | -0.10* | -0.10* | -0.11* | -0.11* | | |
| ELO20 | 0.10* | 0.09* | 0.10* | 0.10* | 0.10* | 0.09* | 0.08* | 0.09* | 0.09* | 0.09* | 0.09* | 0.10* | 0.08* | 0.09* | 0.08* | 0.06* | | | |
| ELO14 | -0.06* | -0.06* | -0.06* | -0.06* | -0.06* | -0.06* | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | | | | |
| ELO16 | -0.06* | -0.06* | -0.06* | -0.05* | -0.06* | -0.06* | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | -0.06* | -0.07* | -0.06* | | | | | |
| ELO03 | 0.05* | 0.05* | 0.05* | 0.05* | 0.05* | 0.05* | 0.05* | 0.06* | 0.06* | 0.06* | 0.07* | 0.07* | 0.07* | | | | | | |
| ELO18 | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | -0.07* | -0.08* | -0.08* | -0.07* | -0.08* | -0.08* | -0.08* | -0.08* | -0.05* | | | | | |
| ELO17 | 0.07* | 0.07* | 0.07* | 0.07* | 0.07* | 0.07* | 0.07* | 0.06* | 0.07* | 0.07* | 0.07* | | | | | | | | |
| Study level | 0.04* | 0.04* | 0.05* | 0.04* | 0.05* | 0.05* | 0.05* | 0.04* | 0.05* | 0.05* | | | | | | | | | |
| EAWBGF | 0.04* | 0.04* | 0.04* | 0.04* | 0.04* | 0.04* | 0.04* | 0.04* | 0.04* | | | | | | | | | | |
| ELO04 | 0.05* | 0.05* | 0.05* | 0.05* | 0.05* | 0.05* | 0.04* | 0.04* | | | | | | | | | | | |
| Gender | 0.04* | 0.04* | 0.05* | 0.05* | 0.04* | 0.05* | 0.04* | | | | | | | | | | | | |
| ELO15 | -0.04* | -0.05* | -0.04* | -0.04* | -0.05* | -0.05* | | | | | | | | | | | | | |
| ELO10 | -0.03* | -0.03* | -0.03* | -0.03* | -0.03* | | | | | | | | | | | | | | |
| ELO06 | -0.06* | -0.06* | -0.05* | -0.03* | | | | | | | | | | | | | | | |
| ELO05 | 0.04* | 0.04* | 0.04* | | | | | | | | | | | | | | | | |
| ELO07 | 0.03* | 0.03* | | | | | | | | | | | | | | | | | |
| ELO08 | -0.02* | | | | | | | | | | | | | | | | | | |
| R ² | 0.03 | 0.05 | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Adjusted R ² | 0.03 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |

* $p < 0.05$, M1 to M19 represent Model 1 to Model 19

Table 4 Effect of sample characteristics and internet addiction on the students' engagement in online

| Predictors | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 6 | |
|-------------------------|---------|------|---------|------|---------|------|---------|------|---------|------|---------|------|
| | Beta | VIF | Beta | VIF | Beta | VIF | Beta | VIF | Beta | VIF | Beta | VIF |
| EAWBGF | -0.14* | 1.03 | -0.14* | 1.03 | -0.14* | 1.03 | -0.14* | 1.03 | -0.14* | 1.01 | -0.15* | 1.00 |
| TSO | 0.13* | 1.06 | 0.13* | 1.04 | 0.13* | 1.03 | 0.13* | 1.02 | 0.12* | 1.01 | | |
| Study level | -0.03* | 1.09 | -0.03* | 1.09 | -0.03* | 1.09 | -0.03* | 1.04 | | | | |
| IA2 | 0.04* | 1.23 | 0.03* | 1.21 | 0.02* | 1.06 | | | | | | |
| IA3 | -0.03* | 1.16 | -0.03* | 1.16 | | | | | | | | |
| Gender | -0.02* | 1.04 | | | | | | | | | | |
| R ² | 0.02 | | 0.04 | | 0.04 | | 0.04 | | 0.04 | | 0.04 | |
| Adjusted R ² | 0.02 | | 0.04 | | 0.04 | | 0.04 | | 0.04 | | 0.04 | |

* $p < 0.05$; IA2-Academic difficulties due to excessive internet use; IA3-Difficulty refraining from checking social media

BBS like Zhihu, watching livestreams like YY, playing games, reading novels and stories, engaging in online shopping and purchasing, participating in online payment, finance, and transfer, and commenting on or discussing current affairs or social issues. This nuanced understanding of the relationships between sample characteristics, students' engagement, and internet addiction provides valuable insights for targeted interventions and strategies aimed at reducing problematic internet behaviors.

Impact of internet addiction on the level of engagement among university students in China in various online activities

Table 4 presents the findings of the stepwise regression analysis, exploring the effect of internet addiction with sample characteristics as mediating variables. Six models (Model 1 to Model 6) were derived, explaining 2% to 4% of the variance and exhibiting significant ANOVA results. EAWBGF (experience accessing websites beyond the Great Firewall) and TSO (time spent online) emerge as the primary predictors with the highest absolute beta value. Additionally, study level, IA2 (academic difficulties due to excessive

internet use), IA3 (difficulty refraining from checking social media), and gender also demonstrate significant effects.

The table further indicates that EAWBGF, study level, IA1 (forgetting to eat or sleep due to excessive internet use), and gender have a negative effect. This suggests that students' engagement in online activities may decrease with an increase in EAWBGF (yes), lower study level (junior level), experiencing academic difficulties due to excessive internet use, and being female. Conversely, the positive beta values for the remaining predictors in the model suggest that University students' engagement in online activities can be enhanced by promoting these factors. This nuanced understanding of the interplay between sample characteristics and internet addiction provides valuable insights for designing targeted interventions and strategies to foster healthier online behaviors among students.

Engagement in online activities and their experience of internet addiction and academic performance among university students in China

Figure 4 depicts the detailed path analysis model for measuring the effect of students' engagement in online activities and internet addiction on academic performance level, with sample characteristics considered as mediating variables. The model explains 2% variance in time spent online and experience accessing websites beyond the Great Firewall, while it elucidates 4% variance in students' engagement, internet addiction, and academic performance level.

The results highlight several significant effects within the model. The study level exhibits a significant negative effect on students' engagement (Beta = -0.03), experience accessing websites beyond the Great Firewall (Beta = -0.15), and academic performance level (Beta = 0.05). Conversely, it has positive significant effects on internet addiction (Beta = 0.13).

Gender demonstrates positive significant effects (favoring males) on time spent online (Beta = 0.13) and internet addiction (Beta = 0.08) while having negative effect (favoring males) on academic performance level (Beta = -0.10) and students' engagement in online activities (Beta = -0.02).

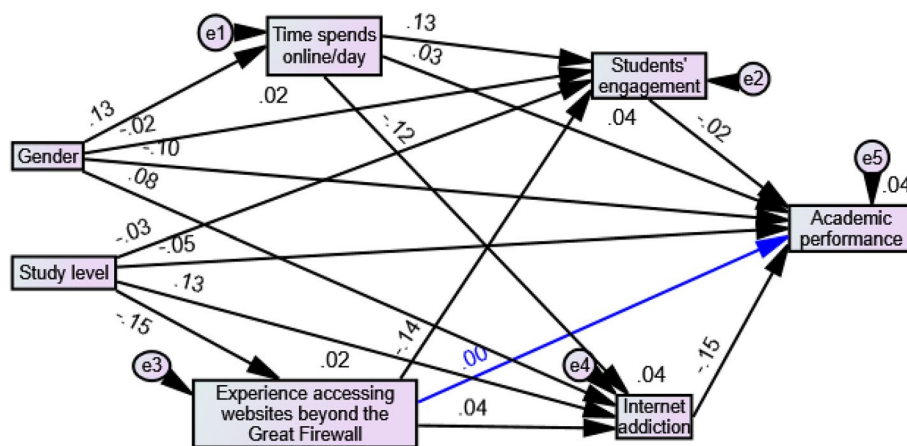


Fig. 4 Students' engagement in online activities and their experience of internet addiction collectively influence academic performance among university students in China

Time spent online has a negative effect on internet addiction (Beta = -0.12) but it exerts a positive effect on academic performance level (Beta = 0.03) and students' engagement in online activities (Beta = 0.13). Experience accessing websites beyond the Great Firewall negatively influences students' engagement in online activities (Beta = -0.14), has a positive effect on internet addiction (Beta = 0.04), and does not significantly affect academic performance level (Beta = 0.00).

Furthermore, students' engagement in online activities (Beta = -0.02) and internet addiction (Beta = -0.15) exhibit negative effects on academic performance level. These nuanced relationships highlight the intricate interplay between students' engagement, internet behavior, sample characteristics, and academic outcomes, offering valuable insights for interventions and strategies aimed at improving academic performance and fostering healthy online behaviors.

Discussion

The study makes a significant theoretical contribution by examining the intersection of three key areas: Engagement theory (Kearsley & Shneiderman, 1998), Addiction Theory (West, 2006), and Cognitive-Behavioral Theory (Beck et al., 1979). By investigating how online platforms influence student participation and interaction, our study aims to deepen our understanding of the complex relationship between engagement, internet addiction, and academic achievement. The conceptual framework of our research delves into the intricate connections among university students' engagement in online activities, internet addiction, and academic performance. Drawing from existing literature (Zenebe et al., 2021), we propose that understanding online engagement necessitates considering individual and situational factors. Furthermore, we posit that internet addiction acts as a mediator in the relationship between engagement and academic performance. Our study focuses on Chinese university students, exploring their current level of engagement and manifestations of internet addiction. We investigate how these factors interact and ultimately impact academic performance. In the discussion section, we organize our findings around gender distribution, levels of engagement, and the effects of engagement and addiction on academic outcomes.

Gender distribution and level of engagement and internet addiction manifest among (15,102) population

The results of the study offer valuable insights into the current level of engagement among university students in China, particularly in online activities, highlighting gender-based differences. Additionally, the study sheds light on the manifestation of internet addiction within this population. The gender distribution reveals a marginal difference, with 52.6% of participants being female and 47.4% male, indicating a slight skew towards female representation. This relatively balanced representation suggests that the study captures insights from both genders. Study level variation indicates a substantial variation in the study levels of participants, with 47.3% at the undergraduate level and only 0.3% at the Ph.D. level. This distribution underscores the need to consider the diverse academic backgrounds of the participants when analyzing the results. The distribution of participants across different study levels is consistent with the existing literature. This literature often reports a higher prevalence of undergraduate participants

in studies involving large populations (Smith & Storrs, 2023). A significant majority of Chinese university students allocate 1–2 h (17.8%), 3–4 h (33.9%), and 5–6 h (20.9%) to internet usage daily. Additionally, results reveals that only 23.7% of students report experience accessing websites beyond the Great Firewall. These visual representations offer a concise overview of key demographics and behavioral patterns among participants, laying the groundwork for a deeper exploration of the relationships between these variables and their potential impacts on the study's outcomes. This finding aligns with global trends showing increased internet usage among the youth (Dwivedi et al., 2021).

The study's findings shed light on significant variations in engagement levels across different online activities. Notably, participants demonstrated notably high engagement in tasks such as information searching, communication with classmates, friends, and family, and interactions on social networks like Moments and QQ Zone. These results suggest that students predominantly utilize the internet for entertainment purposes, aligning with Putnam's perspective (1995, 2000) that such usage negatively impacts engagement, particularly in terms of behavioral dimensions (Gao et al., 2024). Additionally, Cognitive-Behavioral Theory offers insights into how excessive internet use impacts cognition in young individuals. Specifically, the study finds that prolonged internet use, exceeding six hours per day, leads to a decline in cognitive abilities and subsequently affects academic achievement (Dou & Shek, 2021).

Conversely, engagement levels were lower in activities such as watching livestreams and playing games. These findings offer valuable insights into students' engagement patterns and areas requiring attention or improvement in the context of online learning. The data provides a nuanced view of online engagement, allowing for tailored interventions to address specific time brackets. However, this study lacks a comparison with offline activities, making it challenging to ascertain whether the reported online engagement is disproportionately high. Future studies could benefit from a more holistic approach, considering both online and offline activities. Regarding access beyond the Great Firewall suggests that only 23.7% of students have experience accessing websites beyond the Great Firewall. This limited exposure to external online content could influence their perspectives and preferences. This aligns with the known restrictions on internet access in China, which impact the online experiences of its students (Lee et al., 2013; Kumar, 2023). The finding highlights the need for considering the contextual constraints when analyzing online behaviors.

A significant proportion of students exhibit tendencies towards behaviors such as forgetting to eat or sleep due to excessive internet use and experiencing academic difficulties as a result. However, fewer students report difficulties refraining from checking social media when free. Examining internet addiction status among the participants, a substantial proportion (58.8%) reported negative consequences, including forgetting to eat or sleep. This indicates a potential issue with time management and self-control. The negative consequences reported are consistent with established literature on internet addiction and its impact on daily life activities (Kuss et al., 2016). The observed behaviors among students, such as neglecting basic needs and experiencing academic challenges due to excessive internet use, can be understood through the lens of addiction theory (West, 2006). This theory provides insights into how individuals may develop dependency on the internet, as emphasized by Kandell (1998) regarding its negative

consequences. Additionally, cognitive-behavioral theory (Beck et al., 1979) sheds light on the interaction between cognition and behavior, influencing mental states and performance, thereby offering further understanding of the observed behaviors among students in relation to internet use.

This underscores the need for targeted interventions to address these challenges among students. The reliance on self-reporting raises concerns about the accuracy of the data. Social desirability bias could lead participants to underreport or overreport their internet use (Latkin et al., 2017). In examining the relationship between demographic factors, academic performance, online engagement, and internet addiction, gender appears to play a significant role, with females showing favorable outcomes in academic performance and lower levels of internet addiction. This finding aligns with existing research suggesting gender differences in internet use patterns and their impact on various life domains (Sun et al., 2020). This shows that there is a possibility that female students might use the internet, and their engagement in online activities could be to foster positive relationships, peer connections, and students' sense of purpose within higher education (Xerri et al., 2018). Recognizing these differences is essential for tailoring interventions to specific gender-related needs. Notably, significant differences are observed across study level and time spent online, and experience accessing websites beyond the Great Firewall (EAWBGF). Differences are observed across study levels, with master's degree and Ph.D. candidates showing higher academic performance levels and lower internet addiction compared to junior college and undergraduate students. Regarding time spent online, students spending fewer hours online tend to exhibit higher academic performance levels but also higher levels of internet addiction, while those spending more time online show the opposite trend.

The high engagement observed in activities such as contacting classmates, friends, and family through platforms like WeChat and QQ suggests that online platforms serve as effective communication tools for students. This might be one of the symptoms of internet addiction according to the internet addiction theory, involving increasing investment in online activities and ignoring the problems associated with internet use (Kandell, 1998). This finding is novel, as there is currently limited literature available on the specific use of WeChat and QQ. While the study indicates low overall engagement in online activities, it is important to recognize the diversity of these activities. Some students may be involved in educational content or other constructive online pursuits that contribute positively to their overall experience (Esteban-Millat et al., 2014). Key predictors of internet addiction include engagement in activities such as playing games, reading novels and stories, online shopping and purchasing, online payment and finance, and discussing current affairs or social issues.

Moreover, a recent study revealed that 58.8% of Chinese university students struggle with issues such as forgetting to eat or sleep due to excessive internet surfing or mobile phone use (Zhang et al., 2020). This finding underscores potential challenges related to time management and self-control among students. Interestingly, this aligns with prior research that has linked excessive internet use to various health-related concerns (Brown et al., 2021). The interplay between cognitive processes, behavior (Beck et al., 1979), and students' achievement remains a critical area of investigation. The negative consequences on academic performance reported by 66.4% of students further underline the

importance of addressing internet addiction and its impact on students' ability to succeed academically.

Impact of internet addiction on the level of engagement among university students in China in various online activities

Here, we're looking at how students being involved in online activities connects with the growth of internet addiction. This understanding comes from carefully studying nineteen different models using a step-by-step approach called stepwise linear regression. These models collectively elucidate 3% to 9% of the variance in internet addiction, supported by statistically significant ANOVA results. Central to our findings are specific engagement behaviors that emerge as significant contributors to internet addiction. Primary predictors such as experience accessing websites beyond the Great Firewall (EAWBGF) and time spent online (TSO) emerge as key determinants, exerting both positive and negative effects on students' engagement in online activities. Additionally, study level, academic difficulties due to excessive internet use (IA2), difficulty refraining from checking social media (IA3), and gender also demonstrate significant effects. The analysis reveals that factors, such as higher experience accessing websites beyond the Great Firewall, lower study level, and experiencing academic difficulties due to excessive internet use, negatively impact students' engagement in online activities. Conversely, factors such as increased time spent online and being male tend to positively influence engagement.

The negative beta values associated with various online activities, such as checking social networks (e.g., Moments, QQ Zone), visiting forums and BBS (e.g., Zhihu), watching livestreams (e.g., YY), playing games, reading novels, engaging in online shopping, participating in online payment and finance, and commenting on or discussing current affairs or social issues, hint at a potential mitigating effect on internet addiction. These activities seem to act as protective factors, fostering social interaction, entertainment, and informational exchange. Consequently, they offer promising avenues for targeted interventions aimed at alleviating problematic internet behaviors.

However, it is crucial to recognize the multifaceted nature of internet addiction. While these findings shed light on the potential positive impact of certain online activities, counterarguments underscore the potential negative mental health outcomes associated with excessive engagement in activities like watching livestreams and playing games. These downsides include increased stress and anxiety (Moge & Romano, 2020; Naslund et al., 2020; Primack et al., 2017). Prolonged exposure to specific online content may exacerbate mental health issues, and heavy social media use has been linked to psychological distress and reduced well-being (Mougharbel et al., 2023).

However, a more nuanced perspective emerges when we consider activities that promote safety during online interactions. For instance, checking social networks and participating in forums can positively contribute to social interaction and psychological well-being (Bannon et al., 2015). Despite the observed negative associations, these online behaviors may serve as protective factors, indicating a complex relationship between engagement and addiction. Furthermore, some scholars argue

that certain online activities, such as targeted educational content or supportive online communities, can mitigate the risks associated with internet addiction.

Engagement in online activities and their experience of internet addiction and academic performance among university students in China

A path analysis model was constructed to explore the impact of students' engagement in online activities and internet addiction on their academic performance level, while considering sample characteristics as mediating variables. The model elucidates the variance in time spent online, experience accessing websites beyond the Great Firewall, students' engagement, internet addiction, and academic performance level. The study level exhibits both positive and negative effects on different variables, while gender demonstrates consistent positive effects on certain aspects and negative effects on others. Time spent online and experience accessing websites beyond the Great Firewall also exert significant influences on internet addiction, engagement in online activities, and academic performance level.

Existing literature supports the disruptive role of social media and excessive internet use in academic settings. Sun et al. (2023) demonstrated a direct association between higher levels of internet addiction and decreased academic engagement, evidenced by reduced participation in online discussions and lower completion rates of assignments. Moreover, the impact of students' interactions with digital resources on academic performance and the likelihood of addictive behaviors is contingent (Noor et al., 2022). The increasing prevalence of internet addiction among students raises concerns about its potential impact on academic achievement, as discussed by Kuss and Lopez-Fernandez (2016). Conversely, Lei et al. (2018) challenge the notion of a straightforward relationship between internet addiction and engagement. Their research indicates that while excessive internet use can lead to negative outcomes, it may also function as a coping mechanism for stress. Positive coping strategies tend to decrease internet addiction, while negative coping strategies tend to increase it. In certain instances, students may turn to online activities, including social media, as a strategy to manage academic pressure or personal challenges. Consequently, the impact of internet addiction on engagement appears to vary, contingent on individual circumstances and motivations.

Notably, the study level emerges as a significant predictor within the model, revealing nuanced impacts on various factors. It exhibits a significant negative effect on students' engagement (Beta = -0.03) and experience accessing websites beyond the Great Firewall (Beta = -0.15). Conversely, it exerts positive significant effects on academic performance level (Beta = 0.05) and internet addiction (Beta = 0.13). These findings illuminate a complex trajectory — as students' progress academically, there is a decline in engagement and website accessibility, juxtaposed with an increase in both internet addiction and academic performance.

Prolonged internet use has been shown to have a detrimental effect on cognitive abilities, thereby negatively influencing academic achievement. This finding aligns with the theory of internet addiction, which suggests a negative association with learning engagement. Moreover, psychological distress was found to be negatively correlated with school engagement (Öztekin, 2024). Gender demonstrates compelling

effects within the model. Positive significant effects favoring males are observed on time spent online (Beta = 0.13), internet addiction (Beta = 0.08), and academic performance level (Beta = 0.10). However, a contrasting negative effect favoring males' surfaces on students' engagement in online activities (Beta = -0.02). These gender-related effects underscore the divergent patterns in online behavior and academic outcomes.

The impact of time spent online adds further layers to the model. It exerts a negative effect on internet addiction (Beta = -0.12) and academic performance level (Beta = 0.03), while concurrently exerting a positive effect on students' engagement in online activities (Beta = 0.13). This complex relationship suggests that increased online time correlates with heightened engagement but may adversely affect both internet addiction and academic performance. These findings align with prior research, supporting the positive association between higher academic levels and improved performance (Zhang et al., 2018). However, the nuanced dynamics are further underscored by the context-dependent nature of the relationships. While some studies propose that higher academic levels enhance internet and social media engagement (Alalwan, 2022), this study advocates for a more nuanced understanding, contending that the relationships are contingent on individual differences and motivations.

Conclusion and implication

In this study, we delved into the intricate interplay between university students' online engagement, internet addiction, and academic performance. By drawing upon Engagement Theory, Addiction and Internet Theory, and Cognitive-Behavioral Theory, we aimed to deepen our understanding of how digital platforms influence student participation and interaction. Our study revealed a direct association between higher levels of internet addiction and decreased academic engagement. Students who exhibited addictive behaviors online were less likely to actively participate in discussions and complete assignments. The conceptual framework posited that internet addiction acts as a mediator between engagement and academic performance. Individual and situational factors play a crucial role in shaping this relationship. We explored gender differences in engagement and internet addiction among a population of 15,102 Chinese university students. These findings shed light on potential disparities and inform targeted interventions. Recognizing the impact of internet addiction on academic outcomes, educational institutions should design interventions that promote healthy online behavior. Strategies may include awareness campaigns, counseling services, and digital literacy programs. Acknowledging the complexity of engagement and addiction, personalized approaches are essential. Tailoring interventions based on students' unique profiles can enhance their academic success. Practically, educators can enhance online learning by boosting engagement through strategies like gamification. They should address internet addiction with interventions like digital detox programs. Additionally, supporting cognitive-behavioral strategies can help students manage internet use and stay focused on their studies. Faculty development programs should address digital pedagogy, encouraging instructors to create interactive online environments that mitigate addiction risks. Policymakers should consider integrating internet addiction prevention into broader educational policies. Balancing technology use with academic goals is crucial for student well-being. Investigating the long-term effects of internet addiction on academic

trajectories will provide valuable insights. Longitudinal studies can track changes over time and identify critical periods for intervention. Extending this research beyond China to other cultural contexts will enrich our understanding. Comparative studies can highlight universal trends and culture-specific nuances. Leveraging emerging technologies, such as adaptive learning platforms and gamified educational tools, may offer novel ways to enhance engagement while minimizing addiction risks.

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Author contributions

Yongzhong Jiang contributed to conceptualization, data curation, and revision of the manuscript. Dirgha Raj Joshi analyzed the data and wrote the methodology and results sections. Jeevan Khanal contributed to conceptualization, writing the original draft, and revision of the manuscript.

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Availability of data and materials

The data supporting the findings of this study is available upon request. Interested parties may obtain access to the dataset by contacting the corresponding author.

Declarations

Competing interests

The authors declare that they have no competing interests regarding the research, authorship, or publication of this manuscript.

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