BMC Public Health

RESEARCH

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The relationship between Internet addiction and academic burnout in undergraduates: a chain mediation model

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Abstract

Background In the hybrid teaching context, the impact of Internet addiction on academic burnout and its underlying mechanism is still unclear. This study aims to investigate the effect of Internet addiction on academic burnout, and the chain mediating effect of academic engagement and academic self-efficacy in the relationship between Internet addiction and academic burnout.

Methods This study adopted a quantitative and correlational research design. A stratified random sampling method was used and a sample of 534 undergraduates (148 male and 386 female) from three normal universities participated in this study. Instruments used were the Chinese version of the Internet Addiction Test, the Chinese version of the Utrecht Work Engagement Scale-Student, the Chinese version of the Academic Self-efficacy Scale, and the Learning Burnout Scale of Undergraduates. Data were collected through self-report questionnaires and structural equation modeling was adopted to test the hypotheses using AMOS 24.0 software.

Results The findings revealed that Internet addiction demonstrated a statistically significant positive association with academic burnout among undergraduate students. Analysis of mediating effects indicated that academic engagement served as a significant mediator in the relationship between Internet addiction and academic burnout. However, academic self-efficacy failed to exhibit a significant mediating effect between these variables. Further examination revealed a significant chain mediating effect of academic engagement and academic self-efficacy in the relationship between Internet addiction and academic burnout.

Conclusion Internet addiction influences academic burnout of undergraduate students both directly and indirectly through academic engagement and academic self-efficacy. Effective interventions could be implemented in universities to mitigate the negative effects of Internet addiction by enhancing academic engagement and academic self-efficacy, which may reduce students' vulnerability to academic burnout and its associated educational consequences such as course withdrawal, decreased academic performance, or dropping out.

Keywords Internet addiction, Academic engagement, Academic self-efficacy, Academic burnout, Chain mediation, Normal university

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Introduction

Academic burnout among undergraduate students has emerged as a critical concern in higher education, with prevalence rates demonstrating a consistent and alarming upward trajectory [1], from 7.4% in 2017 [2], 33.4% in 2019 [3], 39.29% in 2021 [4], 44.26% in 2022 [5], to 59.9% in 2023 [6], which is associated with significant educational consequences including course withdrawal, decreased academic performance, and increased dropout rates [7]. Moreover, this phenomenon is particularly concerning in normal universities, institutions pivotal for cultivating future educators [8]. The academic well-being of normal students, who bear the responsibility of shaping the next generation's educational landscape, directly impacts educational quality.

Simultaneously, Internet addiction has emerged as a parallel worldwide concern [9], the Internet addiction proportion of undergraduates in China is 13.8%, which is the highest compared with Japan, Singapore, and the United States [10]. The COVID-19 pandemic and the subsequent shift towards online and hybrid learning modalities have further exacerbated this issue. Research suggests that online learning environments may increase susceptibility to Internet addiction and academic burnout [11, 12], characterized by decreased academic engagement and diminished self-efficacy [13, 14].

Recent longitudinal studies reveal the dynamic and heterogeneous nature of these relationships among Chinese university students [15, 16, 17], yet few have explored this in the context of normal universities. Furthermore, while previous research has examined the relationships between these variables individually [7, 18, 19, 20, 21], comprehensive examinations integrating these constructs within a unified framework remain scarce. This study addresses that gap by proposing a chain mediation model linking Internet addiction to academic burnout through academic engagement and self-efficacy based on a theoretical framework integrating Conservation of Resources (COR) theory [22] and self-efficacy theory [23].

According to this theoretical framework, Internet addiction depletes academic resources through multiple mechanisms: reducing academic engagement via time displacement and attention division [24], while undermining academic self-efficacy through decreased academic engagement and repeated academic underperformance [25]. Revealing the chain mediation effect is more meaningful than examining each mediator independently, as it demonstrates how the loss of one academic resource (engagement) triggers the decline of another (self-efficacy), creating a loss spiral toward academic burnout.

This synergy and sequential depletion process of academic resources is largely overlooked in the existing literature and it extends COR theory's application beyond workplace contexts by demonstrating how the resource caravan principle and resource loss spiral corollary operate in educational settings [22, 26]. Additionally, normal university students face unique dual academic pressures: mastering both subject knowledge and pedagogical skills while meeting strict professional standards. This makes them particularly susceptible to academic resource loss, positioning them as an ideal group for testing and extending COR theory's applicability within educational contexts.

Therefore, by focusing on undergraduates from normal universities in H province of China, this study primarily aimed to investigate the effect of Internet addiction on academic burnout and to test the mediating role of academic engagement and academic self-efficacy based on COR theory and self-efficacy theory, which may help researchers find the predictive factors for academic burnout and tailor intervention programs to prevent the negative effect of Internet addiction on academic burnout.

Internet addiction and academic burnout

The COR theory was originally developed in the 1980s and has been extensively applied to stress and burnout research [22, 27, 28]. Its basic tenet is individuals actively seek to acquire and protect their valued resources including personal and energy resources, which typically exist in caravans [22]. The resource loss spiral corollary explicates that initial resource depletion can precipitate a cascade of subsequent losses [22].

Internet addiction represents a significant resource-depleting behavior that can systematically erode students' personal and energy resources [29]. As stress occurs during resource loss, each iteration of the stress spiral leaves individuals with diminishing resources to offset further losses, resulting in accelerating loss momentum and magnitude [22]. When students' academic resource depletion reaches the edge of their resource reserves, they will feel exhausted and have a diminished sense of accomplishment and academic underachievement [30]. In academic settings, this manifests as academic burnout caused by gradually escalating stress from sequential chronic and minor losses [31].

Studies have demonstrated that the loss or depletion of resources, such as time, energy, and social support, can contribute to burnout symptoms [31, 32]. Cross-sectional research has consistently demonstrated a significant positive correlation between Internet addiction and academic burnout among Chinese students [18, 33, 34]. Longitudinal studies across diverse adolescent populations have corroborated this relationship [35, 36]. Building upon the existing body of research, the first research hypothesis is proposed:

H1 Internet addiction has a significant positive effect on academic burnout.

The mediating effect of academic engagement

Academic engagement is defined as the positive learning attitude, abundant learning energy, and full immersion shown by individuals in the learning process and it is marked by vigor, dedication and absorption [19, 37]. Consistent with COR theory, Internet addiction initiates a resource loss spiral by depleting valuable resources including time, energy, and attention invested in academic activities manifests as reduced academic engagement [20, 22]. The state of low engagement accelerates the resource loss spiral and makes additional academic resource investment more difficult, resulting in fewer resources to cope with academic stress, ultimately leading to academic burnout [20, 32].

Furthermore, Internet addiction is widely recognized as a risk factor for reduced academic engagement [38, 39], potentially exacerbated by increased Internet availability and persistent use [19]. Students often use the Internet to chat with friends and play games, even during their class time, while completing homework, which leads to low academic engagement [40]. Drawing from the theoretical and empirical evidence, the second hypothesis is proposed:

H2 There is a significant mediating effect of academic engagement in the relationship between Internet addiction and academic burnout.

The mediating effect of academic self-efficacy

Self-efficacy theory suggests that high academic self-efficacy enhances students' motivation in the face of challenges and stress [23]. According to the resources gain spiral principle of COR theory, academic self-efficacy represents a personal resource as it can foster students' competency to cope with academic challenges, facilitate adaptive stress management strategies, and create a resource gain spiral [22, 41]. Internet addiction depletes students' personal resources including academic self-efficacy, leading to poor academic performance, which further undermines students' academic self-efficacy [32, 42].

Following COR theory's loss spiral principle, diminished self-efficacy accelerates the resource loss spiral making students less capable of effectively managing academic stress, leading to increased susceptibility to burnout [22, 42]. In fact, academic self-efficacy has been consistently identified as a protective factor against academic burnout, with a negative correlation between them [7, 21]. Thus, Internet addiction may lead to academic burnout through the attenuation of academic self-efficacy and the third hypothesis has been drawn:

H3 There is a significant mediating effect of academic self-efficacy in the relationship between Internet addiction and academic burnout.

The chain mediating effect of academic engagement and academic self-efficacy

Internet addiction triggers the initial resource loss through reduced academic engagement, this engagement deficit then undermines academic self-efficacy since resources typically travel and deteriorate together based on COR theory's resource caravan principle, leading students to fall into a progressive resource loss spiral where each step intensifies vulnerability to further resource depletion, ultimately leads to academic burnout due to insufficient resources for managing academic stress [22, 32]. According to self-efficacy theory, continuous engagement in learning strengthens belief, and improves knowledge reserves and judgment abilities, thereby reinforcing academic self-efficacy, lower engagement leads to reduced academic self-efficacy, aligning with the resource caravan principle of COR theory [22, 23, 32]. Studies have also consistently demonstrated a significant positive correlation between academic engagement and academic self-efficacy [39, 43].

While the resource loss spiral corollary and resource caravan principle of COR theory has been extensively applied to occupational contexts [22, 26], its application to academic settings remains underexplored. This study addresses this theoretical gap by examining how Internet addiction triggers a sequential depletion of academic resources (academic engagement and academic self-efficacy), ultimately leading to academic burnout, thereby extending these core principles of COR theory to educational contexts (see Fig. 1 for the hypothesized chain mediation model). Based on the evidence presented, the fourth hypothesis is proposed:

H4 There is a significant chain mediating effect of academic engagement and academic self-efficacy in the relationship between Internet addiction and academic burnout.

Methods

Participants

The research design of this study is quantitative and correlational research design. The participants in this study are from three normal universities, which are located in the H province of China. Considering that the data analysis method used in this study includes structural equation modeling (SEM), the current study referred to the A-priori Sample Size Calculator for Structural Equation Models [44]. Using an anticipated effect size of 0.2, the desired statistical power level of 0.8, a total of 4 latent variables with 79 observed variables, and a probability

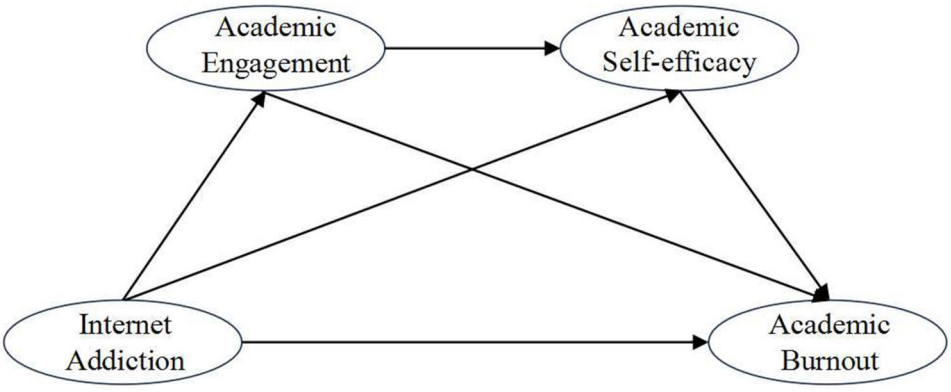

Fig. 1 Hypothesized chain mediation model

level of 0.05, a sample size of 342 is considered appropriate for this study, which is the minimum sample size to detect an effect. As SEM is a technique that requires a large sample, the researchers collected an extra sample by 50% to account for the loss of samples and non-responders [45], which means an additional sample of 171 (50% of 342) was needed. Consequently, a total sample size of more than 513 participants was necessary. With this sample size, most of the rules of thumb listed in the related literature of SEM are satisfied.

This study employed stratified random sampling from a population of 55,250 undergraduate students across three normal universities in H province, China. The participating institutions had student populations of 25,000 (45.3%), 17,684 (32.0%), and 12,566 (22.8%), respectively. Following the stratified sampling formula ($Sample = \frac{size\ of\ entire\ sample}{population\ size} \times layer\ size$) [46], the minimum required sample sizes were calculated as 232, 164, and 117 students from each respective institution. Participants were subsequently selected using SPSS 26.0's random sample function applied to the student ID number, with inclusion criteria specifically targeting undergraduate students enrolled in these three normal universities.

Procedure

After obtaining approval from the Ethics Committee for Research involving Human Subjects of University Putra Malaysia Research (JKEUPM-2023-137), the study proceeded to the data collection phase. Participants received comprehensive instructions detailing the study's purpose, requirements, and procedures. They were assured that participation was voluntary, their responses would remain confidential and anonymized, and they could withdraw at any time without consequences. All participants reviewed these instructions and gave their informed consent before participating in the research.

The expert panel's evaluation regarding the instrument's content and face validity yielded satisfactory results. Specifically, the panel found no significant issues with item relevance, content representation, linguistic clarity, or overall alignment with the study's objectives. After experts reviewed the questionnaires, the electronic questionnaires were distributed in classroom settings through the Questionnaire Star tool. A pilot study was conducted among 236 undergraduate students who were subsequently excluded from the actual study to assess the validity and reliability of the instruments. Finally, the actual research involved 534 participants from the target population.

Measurement instruments

Internet addiction scale

Internet addiction was measured by the Chinese version of the Internet Addiction Test (IAT), which was developed by Young [47] and validated in 2008 based on Hong Kong undergraduates [48]. It contains 20 items and adopts a 5-point Likert scoring method ranging from 1 (rarely) to 5 (always) with an average score of 3. More serious Internet addiction is indicated by a higher score. An example item is: "Do you find that you stay online longer than you intended?" Previous psychometric validation reports suggested that some items of this scale are outdated [49, 50]. To make sure the items are more suitable to the population of this study, items 2 [51], 3 [50], 7 [49], and 8 [52] were rephrased. The revised items and the scale are provided in the Supplementary file (see Supplementary file).

Exploratory factor analysis was conducted based on the pilot study with a sample ($n = 208$) similar to the actual study and a three-factor solution was supported. The three factors are emotional and cognitive preoccupation (ECP), withdrawal and social problems (WSP), and loss of control and interference with daily life (LCI). The Cronbach's alpha coefficient for each sub-construct was 0.88, 0.83, and 0.77, respectively. The confirmatory

factor analysis (CFA) results indicated that the three-factor model fits the data of the actual study well: $\chi^2(113) = 235.52$, $p < 0.001$; $\chi^2/df = 2.084$, RMSEA = 0.047, CFI = 0.948, and SRMR = 0.040. The results showed that the reliability and validity of IAT were good in this study.

Academic engagement scale

Academic engagement was evaluated by the Chinese version of UWES-Student (UWES-S), which was compiled by Schaufeli et al. [53] and the Chinese version of it was validated based on a sample of college students [37]. There are three dimensions including vigor, dedication, and absorption, with a total of 17 items. It is a 7-point Likert scale with 1 representing "never" and 7 representing "always". A sample item is: "I experience happiness when I concentrate on learning." The Cronbach's alpha coefficient for each sub-construct was 0.83, 0.83, and 0.79, respectively. The CFA results suggested that the three-factor model fits the data well: $\chi^2(61) = 175.98$, $p < 0.001$; $\chi^2/df = 2.885$, RMSEA = 0.062, CFI = 0.955, and SRMR = 0.036. Hence, the reliability and validity of the scale were good in this study.

Academic self-efficacy scale

The Academic Self-Efficacy Scale (ASS) was used to test academic self-efficacy. The ASS was developed by Pintrich and DeGroot [54] and was revised by Liang based on a sample of Chinese undergraduate students [55]. Learning ability self-efficacy (LAS) and learning behavior self-efficacy (LBS) are two distinct dimensions of ASS, which have 22 items, and each dimension has 11 items. The scale was scored at 5 points on a Likert scale with 1–5 points from "completely inconsistent" to "completely consistent". Higher scores correspond to higher levels of academic self-efficacy. A representative item is: "I believe in my ability to do well in my studies." Cronbach's alpha coefficients for the two sub-constructs were 0.88 and 0.83. The CFA results showed that the two-factor model fits the data well: $\chi^2(74) = 175.09$, $p < 0.001$; $\chi^2/df = 2.366$, RMSEA = 0.053, CFI = 0.962, and SRMR = 0.038. To conclude, the scale has good reliability and validity in this study.

Academic burnout scale

The current study adopted the Learning Burnout Scale of Undergraduates (LBSU) compiled by Lian et al. [56] to assess academic burnout, which has 20 items and covers three dimensions, namely, low mood (LM), misbehavior, and low sense of accomplishment (LSA). Each item was rated from 1 (not at all like me) to 5 (very much like me) with an average score of 3. Higher scores indicate greater academic burnout. An example item is: "I felt exhausted after learning for a whole day". The Cronbach's alpha coefficient for each sub-construct was 0.81, 0.71, and 0.71, respectively. The CFA results indicated that the three-factor model fits the data well: $\chi^2(74) = 165.47$, $p < 0.001$; $\chi^2/df = 2.236$, RMSEA = 0.050, CFI = 0.961, and SRMR = 0.042. Therefore, the reliability and validity of LBSU were good in this study.

Statistical analysis

Preliminary to hypothesis testing, data were subjected to examination, reliability analysis, and descriptive statistical analysis using SPSS version 26.0. The measurement model was evaluated through CFA using AMOS version 24.0. Model fit was appraised using multiple indices: Chi-Square/Degrees of Freedom ratio (χ^2/df), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). Acceptable model fit was determined based on the following criteria: $\chi^2/df \leq 5$, CFI ≥ 0.90, RMSEA ≤ 0.08, and SRMR ≤ 0.08 [57]. A non-significant χ^2 generally indicates good model fit; however, in large samples and complex models, the test becomes overly sensitive, making significance less informative for evaluating fit [58]. Therefore, the chi-square results are reported in line with standard practice for completeness. The hypothesized chain mediation model was examined using path analysis within the SEM framework. To assess the stability of indirect effects, bootstrap resampling (5000 samples) was employed to compute bias-corrected 95% confidence intervals. Significant mediation was inferred when confidence intervals excluded zero [59].

Results

Data examination

A total of 534 respondents (148 male and 386 female) participated in the actual study. It took about 10 min to complete the entire questionnaire and the questionnaires answered in less than 3 min were excluded from further analysis. As a result, the sample size decreased to 525.

Initial data analysis commenced with an examination of missing values through frequency distribution analysis [60], which revealed no missing data. Subsequently, unengaged responses were identified by calculating the standard deviation (*SD*) of individual response patterns. Following Lanning's recommendations [61], three cases exhibiting *SD* values below 0.50 were eliminated, reducing the sample size to 522. The next phase involved outlier detection. Univariate outliers were identified using standardized scores (z-scores), with cases falling outside the range of ± 3.29 considered outliers [62]. This process resulted in the removal of 8 cases, further reducing the sample to 514. Multivariate outliers were assessed using the squared Mahalanobis distance (Mahalanobis d^2). In accordance with Collier's criterion [63], cases of Mahalanobis d^2 with both $p1$ and $p2$ values below 0.001 were deemed potential outliers and subsequently removed,

leading to the elimination of an additional 22 cases. Following this comprehensive data screening and cleaning process, the final sample size was 492, with an effective rate of 92.13%.

Normality examination of the data ($n = 492$) showed that the values of the skewness and kurtosis of items ranged from – 0.49 to 1.32 and – 1.06 to 1.63, respectively, which means the data were distributed normally [62].

Common method bias test

Since this study adopts a questionnaire survey method and the data come from participants' self-reports, there may be common method bias. Harman's One-Factor Test was performed to detect whether common method bias exists or not [64]. Exploratory factor analysis was conducted based on all the items of this study and principal components un-rotated factor analysis was used. The results showed that the first component explained 22.20% of the total variance, which was less than 50% of the variance, indicating the common method bias problem was not serious in this study [65].

Testing for the measurement model

Results revealed that all items from the sub-constructs have a factor loading of more than 0.50, ranging from 0.73 to 0.98. The measurement model demonstrated an adequate fit to the data ($\chi^2(1569) = 2661.62$, $p < 0.001$; $\chi^2/df = 1.696$; RMSEA = 0.038; CFI = 0.903; SRMR = 0.051), supporting the model's validity for further structural analyses. The Average Variance Extracted (0.67–0.74) and Composite Reliability (0.86–0.95) values surpassed their respective thresholds of 0.50 and 0.60 [60, 66], establishing satisfactory convergent validity and composite reliability for all constructs.

Table 1 Distribution of participants by demographic information ($n = 492$)

Demographic Variables		Frequency (*n*)	Percentage (%)
University	1	223	45.3
	2	157	31.9
	3	112	22.8
Gender	Male	121	24.6
	Female	371	75.4
Academic Year	First Year	129	26.2
	Second Year	124	25.2
	Third Year	122	24.8
	Fourth Year	117	23.8
Major	Humanities	264	53.7
	Science and Engineering	156	31.7
	Arts	72	14.6
Family Location	Rural	332	67.5
	City	160	32.5
Single-Parent Family	Yes	33	6.7
	No	459	93.3
Family Financial Situation	Wealthy	11	2.2
	Average	404	82.1
	Poor	77	15.7

Descriptive analysis

The demographic profiles of participants

The study included 492 valid responses from three normal universities. Participants' mean age was 19.13 ± 1.00 years. The sample was predominantly female (75.4%) and evenly distributed across academic years. Most students majored in humanities (53.7%), came from rural areas (67.5%) and middle-income families (82.1%). This distribution, particularly the gender and major imbalances, reflects the typical demographic composition of normal universities in the region. Detailed demographic breakdowns are provided in Table 1.

Testing for the structural model

The structural equation model demonstrated satisfactory fit indices across multiple criteria ($\chi^2(1569) = 2661.62$, $p < 0.001$; $\chi^2/df = 1.696$; RMSEA = 0.038; CFI = 0.903; SRMR = 0.051), warranting subsequent hypothesis testing. The structural relationships among the studied variables are depicted in Fig. 2. Examination of the direct effect demonstrated that Internet addiction had a significant positive effect on academic burnout (β = 0.22, 95% CI [0.13, 0.32]), accounting for 45.83% of the total effect and confirming the first hypothesis (Table 2).

The summary of mediating effect is presented in Table 2. Utilizing bias-corrected bootstrap resampling procedures (5000 samples), it was identified a significant mediating effect of academic engagement in the relationship between Internet addiction and academic burnout (β = 0.16, 95% CI [0.08, 0.25]). This mediating pathway explained 33.33% of the total effect, supporting the second hypothesis regarding the indirect influence of Internet addiction on academic burnout through academic engagement. Notably, the mediating effect of academic self-efficacy in the relationship between Internet addiction and academic burnout was non-significant (β = 0.00, 95% CI [-0.04, 0.04]), leading to the rejection of the third hypothesis. Further analysis revealed a significant chain mediating effect through academic engagement and academic self-efficacy (β = 0.10, 95% CI [0.05, 0.17]), supporting the fourth hypothesis. This chain mediation accounted for 20.83% of the total effect. Collectively, all mediating pathways explained 54.17% of the total effect between Internet addiction and academic burnout.

Discussion

The effect of Internet addiction on academic burnout

The present study aimed to investigate the effect of Internet addiction on academic burnout among

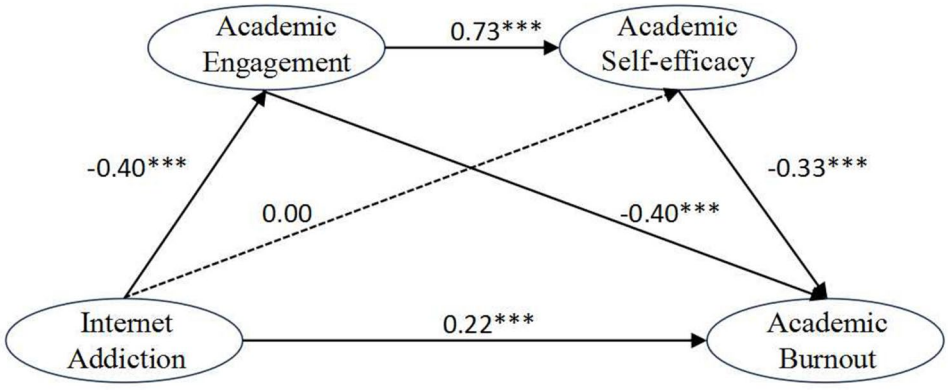

Fig. 2 Summarize of structural model. Note: The values shown are the standardized coefficients. ***$p < 0.001$

Table 2 Summary of mediating effect

Hypothesized Path	Standardized effect value	*SE*	Boot 95% CI	*p*	Total effect ratio
IA→AB	0.22	0.05	[0.13, 0.32]	0.00	45.83%
IA→AE→AB	-0.40 × (-0.40) = 0.16	0.04	[0.08, 0.25]	0.00	33.33%
IA→AS→AB	0.00 × (-0.33) = 0.00	0.02	[-0.04, 0.04]	0.97	0.00%
IA→AE→AS→AB	-0.40 × 0.73 × (-0.33) = 0.10	0.03	[0.05, 0.17]	0.00	20.83%
Total mediation effect	0.26	0.04	[0.19, 0.33]	0.00	54.17%
Total effect	0.22 + 0.26 = 0.48	0.05	[0.37, 0.57]	0.00	100.00%

Note: IA (Internet addiction); AE (academic engagement); AB (academic burnout); AS (academic self-efficacy); *SE* (standard error)

undergraduate students from normal universities. Results indicated that Internet addiction was a significant positive predictor for academic burnout, suggesting that higher levels of Internet addiction were associated with increased levels of academic burnout. In the context of previous related research, this finding aligns with and extends upon existing literature highlighting the detrimental effects of Internet addiction on academic outcomes and mental health [10].

Prior studies have consistently demonstrated a link between excessive Internet use and negative academic outcomes, including decreased academic performance and increased psychological distress [9]. Furthermore, research has indicated that Internet addiction is associated with heightened levels of stress, anxiety, and depression, all of which are key components of academic burnout [10, 18, 33]. The result is also in line with past studies conducted on adolescents [34, 67] and undergraduate students from other types of universities [18, 33]. Moreover, this finding is consistent with the results that mobile phone addiction predicts academic burnout [5, 67]. The above evidence collectively supports the notion that Internet addiction can serve as a significant risk factor for the emergence of academic burnout among undergraduate students from normal universities.

The mediating effect of academic engagement

There is a significant mediating effect of academic engagement in the relationship between Internet addiction and academic burnout, which indicates that Internet addiction influences academic burnout through academic engagement. To be more specific, the higher the level of Internet addiction the lower the level of academic engagement, which results in a higher level of academic burnout.

The finding demonstrated that the positive effect of Internet addiction among undergraduate students from normal universities on increasing academic burnout may have worked through weakening their academic engagement. Previous investigations have also established a strong correlation between problematic Internet use and reduced engagement in academic activities, such as decreased motivation, lower levels of concentration, and diminished self-regulation, all of which contribute to the development of academic burnout [7, 14, 38]. Moreover, previous studies have also highlighted the importance of addressing problematic Internet use in promoting academic engagement and preventing burnout [34].

Building upon these existing findings, the current study highlights the importance of academic engagement in understanding the internal mechanism between Internet addiction and academic burnout. According to COR theory, when undergraduate students put many of their resources into Internet entertainment activities, their resources including their time, energy, and cognitive resources would be depleted, which would result in very few resources being left for academic tasks [22]. By this, their engagement in academics would be reduced, so

when facing academic stress, they are prone to fall into the lose spiral and experience academic burnout [32].

Moreover, research has indicated that Internet addiction can act as a barrier to active learning behaviors, such as participation in class discussions, completion of assignments on time, and seeking out additional educational resources [32, 42], aligning with the resource investment principle of COR theory. This lack of engagement can further exacerbate feelings of isolation, stress, and disconnection from academic pursuits, ultimately impacting the academic experience of students, which may lead to academic burnout.

The mediating effect of academic self-efficacy

The study found that academic self-efficacy can independently mediate the relationship between Internet addiction and academic burnout, suggesting that students' beliefs in their academic abilities play a crucial role in determining their experience of academic burnout. However, in the chain mediation model including academic engagement, its mediating effect becomes non-significant. It is suggested that in the chain mediation model, the mediating effect of academic self-efficacy is overshadowed by the mediating effect of academic engagement, which indicates that academic engagement plays a more dominant role in mediating the relationship between Internet addiction and academic burnout compared to academic self-efficacy.

This can be explained using COR theory [22] and self-efficacy theory [23]. According to COR theory [22], Internet addiction depletes critical resources like time and energy, directly affecting academic engagement, which involves active, behavioral involvement (vigor, dedication, absorption). In contrast, academic self-efficacy, a more stable belief shaped by accumulated experiences, changes more gradually based on self-efficacy theory [23], making academic engagement more sensitive to immediate resource loss.

Internet addiction has been linked to various negative outcomes, including decreased academic self-efficacy, which has been shown to be a protective factor against academic burnout [7, 21, 39]. Students with higher levels of academic self-efficacy tend to be more resilient and motivated in the face of academic challenges [15], which will make them less susceptible to academic burnout. This may be the reason that academic self-efficacy independently mediates the relationship between Internet addiction and academic burnout. This also confirms the speculation on this mediating mechanism based on COR theory and self-efficacy theory.

The chain mediating effect of academic engagement and academic self-efficacy

There is a chain mediating effect of academic engagement and academic self-efficacy in the link between Internet addiction and academic burnout, suggesting that Internet addiction indirectly affects academic burnout through academic engagement and academic self-efficacy. Specifically, students addicted to the Internet may be less engaged in academic pursuits, leading to lower levels of academic self-efficacy and increased academic burnout symptoms. The higher the level of Internet addiction, the lower the level of academic engagement, which leads to the decline of academic self-efficacy level and, ultimately, increases the risk of academic burnout.

The COR theory posits that individuals strive to acquire, protect, and maintain their resources, which typically exist in caravans [22]. The resources lost through addictive behaviors (such as Internet addiction) would leave fewer resources to use for academic tasks (academic engagement), contributing to lower academic self-efficacy based on the resource loss spiral corollary and resource caravan principle of COR theory, and resulting in the experience of academic burnout. Studies have shown that Internet addiction has negative effects on academic performance and mental health including increased levels of stress, anxiety, and depression [10]. It highlights the importance of both academic engagement and academic self-efficacy in influencing the academic outcomes of students [7, 15, 39]. Academic engagement and academic self-efficacy have been consistently linked to resilience, well-being, higher levels of confidence, adaptive coping strategies, and academic achievement [15, 38, 43].

Combined with the findings of previous studies, the current study has proved the mediating mechanisms underlying the relationship between Internet addiction and academic burnout by focusing on academic engagement and academic self-efficacy and further revealing the complex relationship between these variables. This study also further confirms that the previous explanation of the mediating mechanism of Internet addiction affecting academic burnout based on COR theory and self-efficacy theory is in line with the actual situation.

Implications

The findings of this research showed that Internet addiction influences academic burnout of undergraduate students both directly and indirectly through academic engagement and academic self-efficacy, which contribute to a deep understanding of the internal mediating mechanisms underlying the impact of Internet addiction on academic burnout among undergraduate students, particularly in the online and offline hybrid teaching context, and provide an empirical basis for targeted interventions.

For practical implications, reducing the level of academic burnout among undergraduate students from normal universities is of significant importance for promoting their academic performance, which can help cultivate a high-quality teacher workforce and enhance education quality because they are future educators. Correspondingly, reducing students' addiction to the Internet may be the key to preventing or mitigating academic burnout. To address this, higher education institutions should implement comprehensive interventions that foster healthier digital behaviors. These interventions may include structured educational programs and campus-wide digital detox initiatives designed to recalibrate students' online habits [68]. Additionally, universities could implement network management systems that regulate non-academic Internet access during instructional periods, particularly in online learning contexts. Dormitory administrators can establish technology-free zones or designated offline hours within residence halls, promoting a more academically supportive residential environment [69]. Moreover, counseling centers could provide specialized counseling services including targeted group therapy sessions and workshops focused on technology-related maladaptive behaviors.

Furthermore, advancements in technology further enable universities to adopt AI-driven interventions such as early detection mechanisms, chatbot-based behavioral support systems and virtual coaches, AI-enhanced time management tools and wearable technology that tracks online behavior, offering more personalized and proactive support systems [70, 71]. Beyond reducing Internet addiction, fostering academic engagement and self-efficacy is crucial. Universities can design programs to boost these factors, including gamified learning platforms to enhance engagement, virtual reality simulations to build self-efficacy, and structured academic coaching to support students' goal-setting and progress monitoring, creating a more immersive, rewarding academic experience that competes with the appeal of non-academic online content [72].

Theoretically, the study contributes to the literature by validating the COR theory in explaining academic burnout. The structural model demonstrates that academic resource loss is crucial in the mechanism linking Internet addiction to academic burnout. While previous research has predominantly focused on direct resource depletion processes, this study illuminates how Internet addiction leads to academic burnout by triggering a complex resource loss spiral through multiple mediating pathways. In addition, it advances COR theory by extending its resource caravan principle to academic settings, a domain where this principle has been underutilized compared to occupational contexts. Specifically, it highlights how these academic resources travel together in a sequential pattern of depletion when exposed to stressors. They do not exist in isolation but instead form an interconnected system that, once depleted, collectively contributes to academic burnout. The chain mediation model validates both the resource loss spiral corollary and the resource caravan principle in an educational context beyond the well-established domain of work-related burnout [22, 26]. This extension marks a contribution to COR theory, demonstrating its relevance and explanatory power in understanding academic burnout among undergraduate students.

Limitations and recommendations

As the data was collected by questionnaire survey, it relies heavily on the self-report of the participants. Their self-report may not be as accurate as the actual situation because of the social approval effect and subjective bias, and their answers may tend to be less serious than the real situation. Although filling out the questionnaires of this study is anonymous and this study screened the data using multiple methods, this may still not completely eliminate the negative impact of the social approval effect and subjective bias.

Another research limitation lies in the generalizability of the research findings. The participants of this study were undergraduate students from three normal universities and the survey was conducted in one province in China due to the limitation of research resources, so it needs to be treated with caution when generalizing the research findings to other groups. Subsequent investigations should aim to broaden the scope and diversity of the sample, which would not only enhance the generalizability of findings but also facilitate more nuanced analyses of underrepresented demographic subgroups, leading to the possibility of making a more comprehensive examination of whether individual characteristics may moderate the relationships. Furthermore, future studies should consider incorporating additional psychosocial and environmental variables that may exert moderating or mediating effects on the established relationships, such as achievement motivation orientations, social support, coping strategies, and learning environment (fully online, hybrid, and traditional in-person).

This study adopts a correlational research design, which provides a snapshot of the relationship between Internet addiction and academic burnout. However, to gain a deeper understanding of the causal relationship between these two variables, it is recommended that future research employs a longitudinal research design to investigate this relationship and to explore the underlying mechanisms and the potential moderating factors that may impact this relationship, by which researchers can track changes in Internet addiction and academic burnout over time, allowing for the examination of causality

and the identification of potential risk factors and protective factors. This is particularly necessary given that previous longitudinal studies have illuminated the dynamic nature of the interrelationships among several key variables pertinent to the current study [14, 15, 16].

Conclusions

The findings reveal that Internet addiction has a significant positive effect on academic burnout, indicating that elevated levels of Internet addiction correspond to increased manifestations of academic burnout symptomatology. Furthermore, this relationship is mediated by academic engagement, suggesting that Internet addiction's impact on academic burnout operates through the mechanism of diminished academic engagement. More notably, there is a chain mediating effect of academic engagement and academic self-efficacy in the relationship between Internet addiction and academic burnout, which illustrates that Internet addiction exerts its influence on academic burnout through a progressive deterioration of academic engagement and academic self-efficacy. Specifically, heightened levels of Internet addiction are associated with decreased academic engagement, which subsequently leads to reduced academic self-efficacy, ultimately culminating in elevated levels of academic burnout. These findings provide crucial insights into how Internet addiction affects academic burnout through engagement and self-efficacy, offering both theoretical validation of COR theory in educational contexts and practical intervention strategies to protect student well-being and enhance educational outcomes.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22719-y.

Supplementary Material 1

Acknowledgements
The authors express their gratitude to everyone who dedicated their valuable time to participate in this research.

Author contributions
All authors contributed to the research design. Zhixia Wei collected and analyzed the data, and wrote the first draft. Norlizah Che Hassan, Siti Aishah Hassan and Normala Ismail revised the draft. Xiaoxia Gu checked the data and reviewed the content and format of the manuscript. Jingyi Dong checked the literature and reviewed the manuscript. All authors contributed to and approved the final manuscript.

Funding
This study was funded by Science Research Project of Hebei Education Department (Grant ID: QN2025751). The funding body had no role in the whole process of the research.

Data availability
The datasets used in the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted in compliance with the Declaration of Helsinki and was approved by the Ethics Committee for Research involving Human Subjects of University Putra Malaysia Research (JKEUPM-2023-137). Informed consent was obtained from the participants prior to the survey.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 10 June 2024 / Accepted: 9 April 2025
Published online: 24 April 2025

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