

Internet Addiction Mediated the Association Between Loneliness and Learning Engagement Among College Students- The Moderating Effect of Grade

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Abstract Extensive evidence has recognized the importance of loneliness in shaping the learning experiences of college students. However, the mechanisms linking loneliness to student engagement, as well as the contextual factors that may influence this relationship, remain underexplored. This study aims to investigate the associations among loneliness, internet addiction, and student engagement, with a particular focus on internet addiction as a mediator and grade level as a moderator. In this regard, a sample of 2,390 Chinese college students was surveyed, and data were analyzed using SPSS with PROCESS Models 4 and 5 to test mediation and moderation effects, respectively. The results revealed that loneliness significantly negatively correlated with student engagement. Furthermore, this relationship was partially mediated by internet addiction and moderated by grade level, with the effect being stronger among lower-grade students compared to their higher-grade counterparts. The study highlights the need for targeted interventions that reduce internet addiction and enhance engagement, particularly among early-year students, to promote mental health and academic success.

Keywords: Loneliness, Internet Addiction, Student Engagement, College Student, Grade

1 Introduction

Humans have a fundamental need for interpersonal connection. 1 . Loneliness arises from the discrepancy between an individual's desired social relationships and the actual relationships they experience, representing a negative emotional state characterized by a perceived lack of meaningful social bonds. 2. This experience has become increasingly prevalent, now affecting nearly one-quarter of the global adult population, which amounts to more than one billion individuals. 3 and has consequently become a global concern.

Loneliness is widespread among college students. 4 , partly because they are in a transitional developmental stage characterized by role changes, the formation of new interpersonal relationships, the development of social skills, and increasing independence 5. In educational contexts, loneliness is considered detrimental to students' learning experiences and mental well-being⁶. Previous studies have shown that loneliness can negatively influence academic achievement 7,8 and increase the intention to drop out 9 . Although the research specifically examining the link between loneliness and student engagement in higher education remains limited, existing evidence suggests that loneliness is negatively associated with student engagement 10,11 . Student engagement plays a pivotal role in individual success in higher education. Substantial empirical evidence indicates that engagement is a strong predictor of course completion 12 and academic achievement 13 , and is closely tied to students' subjective well-being 14 . Consequently, promoting learning engagement has long been a central focus of institutional interventions 15 . Moreover, engaged learners are better prepared to address contemporary global challenges with the skills, knowledge, and perspectives required to thrive in diverse professional environments 16. Higher education institutions that foster such engagement not only advance knowledge but also promote social mobility and innovation, thereby serving as catalysts for global progress 17 . In recent years, student engagement has become a focal point in higher education research worldwide 18. Conceptually, student engagement refers to a psychological state in which learners feel active, exert effort, and remain fully absorbed in learning activities; it encompasses emotional, behavioural, and cognitive dimensions 15,19 . Loneliness, in turn, can affect individuals' behaviour, emotions, and cognition 20 . Scholars have argued that loneliness may diminish students' sense of accomplishment and learning-related emotions 21 and is closely associated with avoidance behaviors, thereby undermining their learning engagement 11.

Building on prior research, the present study investigates the impact of loneliness on student engagement, examining the mediating role of internet addiction and the moderating role of academic grade. By proposing and testing a moderated mediation model, this study offers an integrated understanding of how emotional and technological factors jointly influence students' learning in higher education contexts. This approach not only deepens the existing body of research on loneliness but also provides practical insights for preventive and intervention strategies targeting college students.

Internet addiction may represent another closely related and significant personal factor influencing student engagement. It has been attributed to impairments in impulse control inhibition and disruptions in the prefrontal executive control network 22, arising from dysregulation of self-control mechanisms 23 . This mechanism appears to be linked to learning engagement, as high levels of self-control are required to resist external temptations and maintain focus on academic tasks 24 . according to the

Conservation of Resources theory, individuals possess limited resources and strive to acquire, retain, and protect valued assets such as time, energy, attention, social support, and self-esteem. Stress emerges when these resources are depleted, threatened, or insufficiently replenished²⁵. Internet addiction constitutes a severe form of resource depletion, consuming both personal and cognitive resources²⁶. Excessive internet use drains substantial time and energy that could otherwise be allocated to attending classes, completing assignments, revising coursework, or resting. Consequently, students with high levels of internet addiction frequently experience losses in academic resources. Wei et al.(2025), in their study of Chinese college students, found that internet addiction encroaches upon study time and cognitive attention, thereby reducing academic engagement. Similarly, a recent survey of Turkish college students revealed that those with higher levels of internet addiction exhibited significantly lower behavioral, emotional, and cognitive engagement in their academic activities²⁸.

Internet addiction and loneliness may also be connected. College students, being in a stage of role transition and adaptation, must adjust to new environments and establish new interpersonal relationships, which can give rise to distress and psychological difficulties.⁵ Consequently, they are prone to emotional experiences such as loneliness. Excessive or compulsive internet use is a common behavior among lonely individuals, and loneliness is positively associated with pathological internet use among college students.²⁹ Some lonely individuals may turn to the internet as an avoidant coping strategy to escape from reality, with the hope of alleviating stress and mitigating loneliness-related negative emotions.³⁰ While such a coping strategy may appear effective in the short term, over time, it can foster dependence on the internet and diminish students' engagement in academic activities. Consequently, we hypothesize that student engagement may be influenced by loneliness, with internet addiction serving as a mediator in this relationship.

Beyond the mediating role of internet addiction in the association between loneliness and student engagement, this study also focuses on the moderating role of academic grade. Students encounter different developmental tasks and academic challenges at various stages of their college education, which substantially shape their psychological and behavioral responses.

Entering college is often a stressful experience, leading to maladaptive outcomes³¹, including heightened feelings of loneliness⁵. Academically, this stage may also be accompanied by challenges such as academic difficulties³² and even dropout risks³³. As students' progress academically, the initial novelty of college life fades, yet they face new pressures related to graduation, which can bring different psychological impacts. Loneliness often shows a declining trend over time³⁴, whereas research findings on grade-level differences in student engagement have been mixed. Salmela-Aro and Read (2017) found that lower-year students reported higher engagement than upper-year students. However, other scholars argue that first-year students are more prone to academic adjustment difficulties (Guo et al., 2023). A large-scale cross-sectional study reported that upper-year students demonstrated higher levels of engagement, particularly in research activities³⁶. Korhonen et al.(2024) further provided empirical evidence that, with increasing academic grade, students exhibit greater maturity, responsibility, and intrinsic motivation in academic engagement, especially in cognitive and emotional dimensions. While prior research suggests that grade level influences both loneliness and engagement, how it moderates the relationship between these two variables remains unclear.

1.1 Current study

Loneliness has emerged as a global public health concern, with particularly high prevalence among college students (Gritsenko et al., 2021; Yung et al., 2023). The mechanisms through which loneliness affects student engagement in higher education are likely complex and remain incompletely understood. One potential pathway is that loneliness may foster dependence on the internet, which in turn diminishes student engagement. Furthermore, both loneliness and student engagement may be influenced by academic grade level, suggesting that grade could moderate the association between loneliness and engagement. In this context, internet addiction may function as a mediator between loneliness and student engagement, while grade level serves as a moderator of the direct relationship between these variables.

Existing research in this area remains limited. First, empirical studies directly examining the relationship between loneliness and student engagement among college populations are scarce. Second, the potential role of grade differences has been largely overlooked, and it remains unclear how grade moderates the link between loneliness and engagement. The present study addresses these gaps by testing a moderated mediation model, in which internet addiction accounts for the relationship between loneliness and learning engagement, and grade level moderates the direct pathway from loneliness to engagement. By integrating these four variables for the first time, our study not only elucidates the mechanism through which loneliness undermines engagement via problematic internet use but also reveals whether this mechanism differs between lower- and upper-year students—a contribution that is both theoretically novel and practically significant for supporting student well-being in the digital era. Based on these insights, we develop the following hypothesis.

Hypothesis 1. Loneliness will be negatively related to student engagement.

Hypothesis 2. Loneliness will be positively related to internet addiction.

Hypothesis 3. Internet addiction will be negatively related to student engagement.

Hypothesis 4. The relation between loneliness and student engagement will be mediated by internet addiction.

Hypothesis 5: Grade will moderate the direct effect of loneliness and student engagement.

2 Method

2.1 Participants and procedures

This study employed a cross-sectional survey design to recruit a representative sample of college students from four institutions in Guangdong Province, China. A combination of simple random sampling and convenience sampling was used to select participating schools and recruit respondents. A total of 2,557 students completed the questionnaire. Following data screening, questionnaires displaying identical response patterns across all items were excluded, resulting in 2,390 valid responses (response rate = 93.47%). The college's ethics committee approved the study protocol. Participation was entirely voluntary, anonymous, and based on informed consent.

Among the participants, 844 were male (35.3%) and 1,546 were female (64.7%). In terms of grade level, 1,520 (63.6%) were first-year students, 676 (28.3%) were second-year students, and 190 (7.9%) were third-year students. Regarding family structure, 288 (12.1%) were only children, whereas 2,102 (87.9%) had siblings. In terms of residence, 1,720 (72%) were from rural areas and 670 (28%) from urban areas.

2.2 Measures

Loneliness. Loneliness was assessed using the Chinese six-item short version of the College of California, Los Angeles Loneliness Scale (ULS-6; Rong & Jingwen, 2023). The instrument comprises six items measuring feelings such as lacking companionship, having no one to trust, being left out, feeling distant from others, feeling unhappy due to loneliness, and perceiving that no one cares even when surrounded by people. Each item is rated on a four-point Likert scale (1 = never, 4 = always), with total scores ranging from 6 to 24. Higher scores indicate greater loneliness severity. In the present study, the scale demonstrated excellent internal consistency (Cronbach's $\alpha = 0.95$).

Internet Addiction. Internet addiction was measured using the Chinese Internet Addiction Scale-Revised (CIAS-R), a standardized instrument for assessing internet addiction in Chinese populations. Initially developed by Chen et al. (2003) at National Taiwan College based on DSM-IV diagnostic criteria for addictions and clinical case observations, the scale was later adapted by Bai and Fan (2005) for use among college students in mainland China. The CIAS-R consists of 19 self-report items rated on a four-point Likert scale (1 = strongly disagree, 4 = strongly agree), yielding total scores from 19 to 76, with higher scores reflecting greater severity of addictive symptoms. In this study, the CIAS-R demonstrated excellent reliability (Cronbach's $\alpha = 0.964$).

Student Engagement. We measured student engagement using the National Survey of Student Engagement-China (NSSE-China), a localized Chinese version of the widely-used NSSE questionnaire. The NSSE-China was developed by Chinese researchers, drawing inspiration from Western engagement research, and was first introduced by a Tsinghua College team. In recent years, the conceptual structure of NSSE-China has been refined based on Fredricks et al. (2004) The tripartite model of engagement, which distinguishes behavioral, emotional, and cognitive dimensions of student engagement (Yang & Han, 2014). Yang and Han (Yang & Han, 2014) Reorganized the NSSE-China along these three dimensions, a restructuring that enhanced the instrument's construct validity and reliability in the Chinese context. In this study, the Cronbach's α coefficient of the scale was 0.909.

2.3 Data Analysis

Data analyses were conducted using SPSS 29.0 and the PROCESS macro. The reliability of each scale was assessed using Cronbach's α coefficient, and Harman's single-factor test was employed to examine potential standard method bias. Descriptive statistics and Pearson correlation analyses were performed to explore the relationships among loneliness, internet addiction, and student engagement. A mediation analysis (PROCESS Model 4) was conducted to examine whether internet addiction mediated the relationship between loneliness and student engagement, while Model 5 was applied to test the moderating effect. All inferential analyses employed a bootstrap resampling procedure with 5,000

iterations to generate 95% confidence intervals for effect size estimates. An indirect or moderated effect was considered statistically significant if its 95% bootstrap confidence interval did not include zero.

3 Results

3.1 Common Method Variance Test

Given that four self-report instruments were administered to the same participants, Harman's single-factor test was conducted to mitigate concerns about common method bias. The results showed that nine common factors with eigenvalues greater than one were extracted, equal to the number of variables in the study. The variance explained by the first common factor was 27.409%, which is below the 50% threshold, indicating that no serious standard method bias was present in this study.

3.2 Preliminary analyses

Table 1 presents descriptive statistics and correlations, showing loneliness was significantly positively correlated with both internet addiction ($r=0.466$, $p < 0.01$) and significantly negatively correlated with student engagement ($r=0.468$, $p < 0.01$). Internet addiction was significantly negatively correlated with student engagement ($r=0.576$, $p < 0.01$). Thus, Hypotheses 1, 2, and 3 were supported.

Table 1. Descriptive Statistics and Correlation Analysis Results for Each Variable.

Variable	M	SD	1	2	3
1. Loneliness	1.92	0.805	-		
2. Internet Addiction	2.02	0.62	0.539**	-	
3. Student Engagement	2.854	0.536	0.247**	0.249**	-

Note: *** $p < 0.001$.

Abbreviations: M, mean; SD, standard deviation.

3.3 Analysis of the effect of mediation

Based on preliminary analyses, a mediation model using PROCESS Model 4 was employed to determine whether the effect of loneliness on student engagement was mediated by internet addiction. As shown in Table 2, after controlling for gender, place of birth, only-child status, and grade level, the total effect coefficient of loneliness on student engagement was -0.16, with a 95% confidence interval excluding zero, indicating a significant total effect. The direct path from loneliness to student engagement was significant ($\beta = -0.099$, $p < 0.001$), accounting for 61.875% of the total effect. The indirect effect via internet addiction was also significant ($\beta = -0.061$, $p < 0.001$), accounting for 38.125% of the total effect. These findings suggest that loneliness exerts a negative influence on student engagement through internet addiction, thereby supporting Hypothesis 4.

Table 2. The mediating role of internet addiction between loneliness and social withdrawal.

Effect	Influence path	Effect	95% CI		Relative Effect
		Coefficient	Lower Limit	Upper Limit	
Total Effect	Loneliness→Learning Engagement	-0.16	-0.186	-0.134	
Direct Effect	Loneliness→Learning Engagement	-0.099	-0.129	-0.069	61.875%
Indirect Effect	Loneliness→Internet	0.061	-0.079	-0.043	38.125%
	Addiction→Learning Engagement				

3.4 Analysis of the effect of moderation

Hypothesis 5 expected that grade. To test this hypothesis, the present study employed Hayes' PROCESS macro (Model 5) to examine the moderating role of grade within the mediation model. The results indicated that, after controlling for gender, place of birth, and only-child status, grade level significantly moderated the relationship between loneliness and student engagement, thereby supporting Hypothesis 5. Specifically, the negative impact of loneliness on student engagement was and more substantial among lower-grade students. In contrast, this negative association was weakened among higher-grade students (see Figure 1 and Table 3).

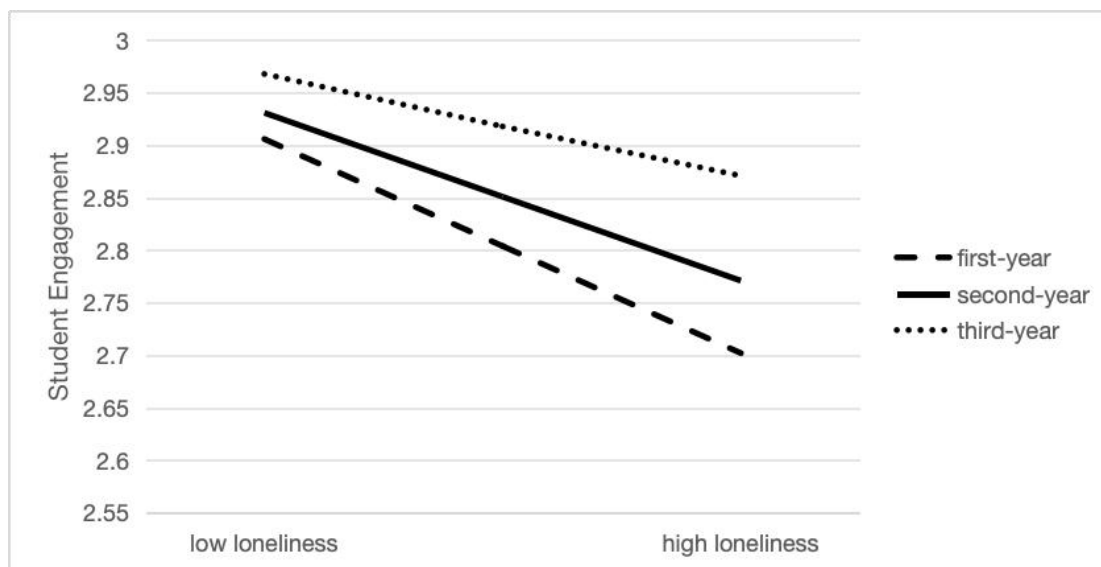


Figure 1: Grade's moderation in loneliness and student engagement

Table 3. The conditional direct effects.

Grade	Effect	BootSE	95%CI	
			LLCI	ULCI
First year	-0.127	0.018	-0.161	-0.092
Second year	-0.099	0.015	-0.1293	-0.0694

Third year -0.06 0.02 -0.0988 -0.0208

Table 4 presents the direct, indirect, and interaction effects of loneliness on student engagement. Regarding the direct effect, higher levels of loneliness among college students were associated with lower levels of student engagement ($\beta = -0.099$, $p < 0.001$). In terms of the mediating effect of internet addiction, the 95% bias-corrected bootstrap confidence interval for all indirect effects did not include zero, indicating that the indirect effect of loneliness on student engagement via internet addiction was significant ($\beta = -0.15$, $p < 0.001$). The results also showed that higher-grade students reported higher levels of student engagement. As for the moderating effect of grade level, the interaction term between loneliness and grade level on student engagement was significant ($\beta = 0.061$, $p < 0.01$) (see Table 4).

Table 4. The moderating effect of Grade.

Effect	Path	R	R ²	F	β	t	95%CI	
							LLCI	ULCI
Direct	Loneliness→SE	0.342	0.117	45.024***	-0.099	-6.504***	-0.129	-0.069
Indirect	Loneliness→IA→SE				-0.15	-7.518***	-1.89	-0.111
Grade	Grade→ SE				0.106	6.49***	0.074	0.138
Interaction	Loneliness×Grade→SE				0.061	3.082**	0.022	0.1

Note: SE student engagement; IA = SE student engagement; IA = internet addiction. *** $p < 0.001$, ** $p < 0.01$

4 Discussion

In summary, this study examined the relationship between loneliness and student engagement among college students, while also testing the roles of internet addiction and grade level. The findings revealed a negative association between loneliness and student engagement, with internet addiction serving as a mediator. Furthermore, grade level moderated the direct relationship between loneliness and student engagement.

4.1 Relationship Between Loneliness and Student Engagement

The finding that loneliness negatively affects student engagement is consistent with previous research. (ie., Mizani et al., 2022; Ramli et al., 2023). Loneliness-induced stress and insecurity can impair emotional regulation and self-regulatory capacities, thereby hindering students' ability to manage their thoughts and behaviors effectively 42. Loneliness also triggers selective attention and hypervigilance toward perceived social threats, accompanied by memory and interpretive biases. This "vigilance-avoidance" processing style consumes limited cognitive resources, thereby undermining executive functioning, task persistence, and deep processing abilities43. As a result, students may find it more challenging to maintain focus and engage in strategic learning, leading to reduced cognitive

engagement. Furthermore, lonely individuals tend to make more negative self-evaluations, which in turn lowers their self-esteem and self-confidence⁴⁴, and they often experience negative emotions such as hostility, stress, pessimism, and anxiety^{20,45}. These factors further erode students' interest and confidence in their studies, making them more prone to decreased learning engagement and feelings of helplessness. Finally, loneliness has been closely linked to various learning behaviors. For example, it has been identified as a predictor of academic procrastination⁴⁶ and dropout intentions⁹.

4.2 Mediating Role of Internet Addiction

The present study also found that internet addiction mediated the relationship between loneliness and student engagement. Specifically, loneliness was positively associated with internet addiction, whereas internet addiction was negatively associated with student engagement. Previous studies have shown that individuals experiencing short-term loneliness tend to have a heightened desire for social interaction⁴⁷, but they often exhibit greater positivity toward unfamiliar individuals and more negativity toward close contacts⁴⁸. In other words, lonely individuals may be motivated to meet new people while keeping their distance from familiar ones. In the online environment, college students can satisfy their social needs while simultaneously avoiding close in-person interactions, which may lead to excessive internet use.

Consistent with expectations and prior studies²⁸, internet addiction was associated with poorer student engagement in this sample. This finding can be interpreted through the Conservation of Resources theory, which posits that prolonged resource depletion can lead to a "loss spiral," reducing individuals' investment in other important domains⁴⁹. Previous studies have confirmed that college students with internet addiction spend substantial amounts of time and energy online, resulting in insufficient study time and reduced attention. Wei et al.(2025), in their study of Chinese college students, further demonstrated that internet addiction encroaches upon study time and cognitive attention, leading to reduced class attendance, assignment procrastination, diminished academic participation, and overall disengagement from the learning process. Future efforts could focus on enhancing college students' digital health literacy, limiting excessive internet use, and cultivating healthy online habits. Such measures may help mitigate the negative impact of loneliness on student engagement and promote a more positive relationship between technological advancement and mental well-being.

4.3 Moderating Role of Grade

The present study found that students' grade level weakened the direct negative association between loneliness and student engagement. Loneliness has been linked to reduced student engagement and academic success across educational stages.⁵⁰ Prior research indicates that first-year college students report the highest levels of loneliness.⁵¹ Possibly because they have recently left home, need to establish new friendships, and must find their place within the campus environment. For these less experienced students, loneliness may trigger maladaptive coping strategies and suppress adaptive ones.⁵², thereby undermining academic adjustment. In contrast, senior students appear to be more resilient to the effects of loneliness. They often develop stronger emotion regulation skills and social coping strategies, which enhance their resilience. A longitudinal study found that between the first and

second years of college, the frequency of seeking social support tends to increase. In contrast, the use of emotional suppression tends to decrease.⁵³ , suggesting that senior students possess more mature coping abilities, which better protect them from the negative academic consequences of loneliness.

Senior students may also have achieved deeper identity integration⁵⁴ and clearer learning goals, such as academic performance and graduation⁵⁵ , through prolonged engagement with their field of study. They often view themselves as competent, autonomous scholars who can sustain academic engagement even in the presence of loneliness. In other words, a well-developed academic identity and strong personal motivation can buffer them from the emotional impact of loneliness. Accordingly, institutions should design anti-loneliness and engagement-enhancement initiatives tailored to students' stages in the academic lifecycle. Colleges may need to focus particular attention on first-year freshmen, who are most vulnerable to feelings of loneliness and social disconnection during the transition to college life. This can be achieved through social events and gathering spaces that foster interpersonal connections and promote active coping with loneliness. In contrast, interventions for senior students may focus on sustaining engagement through mentorship, research opportunities, and career preparation activities, aligning with their evolving needs rather than focusing solely on basic social integration.

4.4 Limitations and Future Directions

The cross-sectional design of the present study does not permit conclusions about causal or temporal relationships. Although our findings indicate associations between loneliness, internet addiction, and student engagement, the directionality of these associations remains unclear. Moreover, internet addiction accounted for less than 40% of the total effect. While grade level was introduced as a moderating variable, other potential mediators between loneliness and student engagement likely exist. Future research should employ longitudinal and experimental designs to identify additional relevant factors and clarify their causal pathways.

In addition, reliance on self-report measures may introduce bias, as students' responses can be influenced by social desirability or momentary emotional states, potentially confounding the reported associations. Future research should combine validated self-report instruments with behavioral indicators (e.g., learning analytics, platform usage logs) and teacher/peer ratings. It should also examine measurement invariance across different grade levels.

4.5 Implications

This study is the first to reveal the potential mechanism linking loneliness to reduced student engagement through internet addiction, and to clarify how grade level moderates this direct association. These findings extend prior research by emphasizing a developmental perspective and identifying possible predictors of student engagement, which can help in designing targeted actions and solutions to prevent unnecessary educational exclusion and dropout risk.⁵⁶ The results suggest that lower-year students are more vulnerable to the adverse effects of loneliness on learning engagement, whereas senior students demonstrate greater resilience. From an applied perspective, interventions aimed at reducing loneliness and preventing excessive internet use may be most effective for first-year students who are navigating the academic and social transition phases—a systematic review by Yan et al. (2025) that behavioral strategies, such as exercise interventions, are effective in helping students adjust

internet use habits, offering a practical avenue for change. Moreover, exercise has been shown to help regulate emotions among college students. 58 The collaborative nature of physical activities may provide lonely students with a healthier way to meet social needs.

In addition, colleges could implement structured social integration programs, peer-mentoring schemes, and digital health workshops to reduce loneliness while curbing excessive internet use. For senior students, strategies could shift toward maintaining high levels of cognitive engagement through research projects, internships, and professional development opportunities, capitalizing on their increased autonomy and competence 37 . Such grade-tailored interventions have the potential to enhance engagement and promote positive academic trajectories.

These findings also carry implications for higher education policy. Recognizing the interconnected roles of loneliness, internet addiction, and engagement can inform the design of campus support systems that integrate mental health services, academic advising, and digital literacy education. Embedding these services within the broader learning environment may foster a culture of engagement and resilience, thereby reducing the risks and academic costs associated with maladaptive internet use. Furthermore, given that online connectivity has become deeply embedded in the daily academic life of Chinese college students and is now an indispensable part of learning⁴ It is crucial to develop policies that encourage balanced use of technology without limiting access to educational resources.

5 Conclusion

This study suggests that loneliness negatively affects student engagement among Chinese colleges, with internet addiction serving as a partial mediator and grade level moderating the direct effect. The disengaging effect of loneliness is and more substantial among lower-grade students. In contrast, higher-grade students appear more resilient, potentially due to greater academic experience, self-regulation skills, and social adaptation. These findings provide empirical evidence for stage-specific intervention strategies in higher education. By addressing both the psychological (loneliness) and behavioral (internet addiction) pathways, colleges can better promote student engagement, foster academic achievement, and support students' overall well-being throughout their academic journey.

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