

# Effect of College Students' Smartphone Addiction on Academic Achievement: The Mediating Role of Academic Anxiety and Moderating Role of Sense of Academic Control

Jiahui Zhang , Youlai Zeng 

Department of Education, Liaoning Normal University, Liaoning, Dalian, 116029, People's Republic of China

\*These authors contributed equally to this work

Correspondence: Youlai Zeng, Email 382765058@qq.com

**Background:** College students are the backbone of future national construction and shoulder the hope of the future development of the country and the nation. Smartphone addiction among college students will not only affect their own mental health and learning attitude, but it will also significantly affect their future academic achievement, academic emotion and academic engagement. However, the relationship between academic anxiety and academic control and academic achievement, as well as their internal mechanisms and boundary conditions, has received little attention. The purpose of this study is to examine whether and how smartphone addiction influences academic achievement.

**Purpose:** This study aims to explore the mechanistic role of academic anxiety and academic control in the influence of smartphone addiction on academic achievement in college students, and hopes that the results can guide education and teaching.

**Methods:** A sample of N=2097 participants, this study evaluated the relationship between smartphone addiction, academic control, academic anxiety and academic achievement among college students, and the participants filled in the college students' smartphone addiction scale, academic control questionnaire, academic anxiety questionnaire and grade points.

**Results:** (1) There is a significant negative correlation between smartphone addiction and academic achievement; (2) academic anxiety serves as a complete mediator in the relationship between smartphone addiction and academic achievement; (3) the interaction between smartphone addiction and academic control moderates academic anxiety, with higher levels of academic control associated with a weaker impact of smartphone addiction on academic anxiety; (4) academic control also moderates the mediating role of academic anxiety between smartphone addiction and academic achievement, demonstrating a moderated mediating effect.

**Conclusion:** Smartphone addiction had negative direct effect on academic achievement, as well as completely mediating effect through academic anxiety. Academic control moderated the relationship between of smartphone addiction and academic anxiety. This study enriches the research on the relationship between smartphone addiction and academic achievement in theory, and has important guiding significance for education and teaching in practice.

**Keywords:** smartphone addiction, academic anxiety, sense of academic control, academic achievement

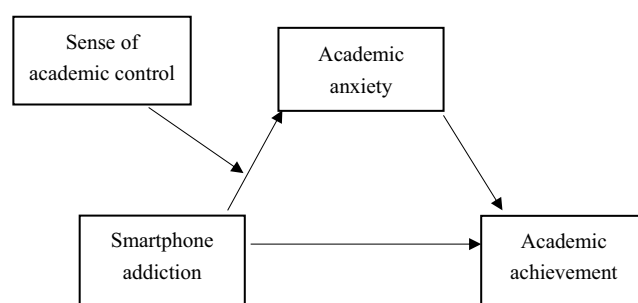
## Introduction

In the information age, smartphones play an indispensable role as mobile terminals in the lives and studies of college students. Smartphones have become essential tools for college students to access information, engage in games, entertainment, and social activities. However, while smartphones bring convenience, they also give rise to new psychosocial problems, such as smartphone addiction and other problematic smartphone usage behaviors.<sup>1</sup> While previous research has explored the antecedents of smartphone addiction behavior among college students,<sup>2,3</sup> and its relationship with depression and anxiety,<sup>4,5</sup> few studies have delved into the mechanism by which

smartphone addiction affects academic achievement in college students, considering the factors of academic control and academic anxiety. For example, research by Qin et al showed that negative emotions such as anxiety and stress could predict smartphone addiction among college students, but the results also showed that there was no significant relationship between academic achievement and smartphone addiction.<sup>6</sup> The findings of Amez et al show that for each additional unit of smartphone use, the test score decreases by a corresponding value, and the proportion of people who pass the test also decreases.<sup>7</sup> Therefore, the relationship between smartphone addiction and academic achievement of college students needs to be further studied. The Compensatory Internet Use Theory suggests that individuals may resort to excessive smartphone usage as a coping mechanism to alleviate negative emotions when faced with adverse life situations, effectively using smartphones as a means of escaping from real-life challenges.<sup>8</sup> When college students encounter difficulties in their academic lives, such as academic pressure or interpersonal issues, they may develop a dependence on smartphones, increasing the likelihood of smartphone addiction. Research has shown that negative emotions and other factors may contribute to a heightened tendency towards smartphone addiction.<sup>9</sup> College students often experience intense emotions during their learning processes,<sup>10</sup> which can directly impact their behavior, learning outcomes, and personal growth. Therefore, it is plausible that academic anxiety negatively predicts academic achievement, providing a theoretical basis for investigating the relationship between smartphone addiction, academic anxiety, and academic achievement.

The Control-Value Theory places learners' emotional factors at its core, positing that academic emotions are influenced by the learning environment and value evaluation factors. These emotions significantly impact academic achievements.<sup>11</sup> Value evaluation factors encompass a learner's level of control over the learning process and the value they place on learning activities and objectives. Mastery goal orientation, an important component of value evaluation, reflects a learner's pursuit of self-improvement and knowledge mastery during the learning process. Academic affective factors encompass emotions directly related to a learner's learning, classroom teaching, and academic achievement.<sup>12</sup> This theory offers a multifaceted perspective on the relationship between the learning environment, value evaluation, emotional factors, and academic achievement. It aids in comprehensively and profoundly understanding the causes of learners' psychological factors and their impact on academic achievements, providing a foundation for exploring the mechanisms linking the learning environment, academic control, academic emotions, and academic achievements. Given the potential significance of smartphone addiction on academic achievement, this study aims to explore the relationship between college students' smartphone addiction, academic anxiety, academic control, and academic achievement.

Based on control-value theory and compensatory network use theory, this study constructs a conceptual model (see Figure 1), which examines the "how" and "when" of college students' smartphone addiction affect college students' academic achievement, with three main objectives: (1) to examine the correlation between smartphone addiction and academic achievement among college students; (2) to examine whether academic anxiety plays a mediating role between college students' smartphone addiction and academic achievement; (3) to explore whether the sense of academic control can regulate the mediating first half of college students' smartphone addiction and academic anxiety.



**Figure 1** Conceptual model.

## Hypothesis

### College Students' Smartphone Addiction and Academic Achievement

The term “smartphone addiction” initially emerged in research related to driving safety. As smartphones became increasingly ubiquitous and their impact on individuals grew, the concept of problematic smartphone use, akin to addictive behaviors such as gambling, gaming, shopping, and internet usage, gained attention among researchers.<sup>13</sup> Scholars like Bianchi and others propose that excessive smartphone usage is the central characteristic of smartphone addiction, with individuals becoming obsessed with smartphones due to various motivations.<sup>2</sup> According to Chóliz, specific features of smartphone addiction include high communication costs due to excessive smartphone use, conflicts with parents arising from smartphone use, interference with other activities such as learning, increasing time spent on smartphones to derive pleasure, and emotional fluctuations when smartphone use is restricted.<sup>14</sup>

In light of these definitions, this study defines smartphone addiction as an individual's inability to control the timing and location of smartphone use, excessive dependence on smartphones, and a range of inappropriate behaviors. These behaviors encompass withdrawal symptoms (negative physiological and psychological reactions when individuals do not use smartphones), heightened preoccupation with smartphones (where individuals prioritize smartphones in their thoughts and activities), increased reliance on smartphones for social interactions, and mood swings linked to smartphone usage.

Academic achievement plays a vital role in education as it is one of the most important outcomes of the educational process. It serves as the key for students to understand their talents, abilities, and potential.<sup>15</sup> Generally, academic achievement is manifested as academic performance in school.

Excessive use of smartphones can negatively impact students' academic performance. Individuals with high levels of smartphone addiction have a higher probability of procrastination<sup>16</sup> and consequently, lower academic performance.<sup>17</sup> Students who abstain from using smartphones in class tend to pay more attention to their studies, resulting in higher scores on knowledge tests.<sup>18</sup> Smartphone use during study has been associated with lower grade point averages,<sup>19</sup> and frequent smartphone use has led to a significant decline in students' academic performance.<sup>20</sup> In daily study and life, if college students cannot effectively resist the temptation of smartphones and indulge in uncontrolled smartphone use, often referred to as smartphone addiction, it may have a detrimental effect on their academic achievements. This paper proposes the following hypothesis:

Hypothesis 1: Smartphone addiction in college students has a significant negative correlation with academic achievement.

### Mediating Role of Academic Anxiety

Academic anxiety encompasses negative emotions such as restlessness and neuro-emotions (affective components), worry (cognition), avoidance motivation (motivation), anxious facial expressions (expressiveness), and peripheral physiological activation (physiological).<sup>21</sup> It encompasses emotions like worry, nervousness, and restlessness related to academic performance in a school environment, including study anxiety, classroom anxiety, and test anxiety.<sup>22–24</sup>

In studies examining the relationship between smartphone addiction and academic anxiety among college students, it has been found that anxiety and smartphone addiction are significantly positively correlated. Negative emotions can exacerbate problematic smartphone behavior.<sup>25,26</sup> Psychological distress, including anxiety, among college students, can lead to excessive smartphone use as a coping mechanism, as individuals may turn to smartphones to alleviate negative emotions.<sup>27–29</sup> Conversely, when individuals refrain from using smartphones or have their smartphone usage restricted, they often experience feelings of loss, irritability, restlessness, and anxiety.<sup>30</sup> Research by McCann suggests a negative correlation between state anxiety and academic achievement.<sup>31</sup> Many studies have shown that anxiety is significantly negatively correlated with academic achievement,<sup>32,33</sup> and the interaction between anxiety and physiological anxiety levels in adolescents can affect academic achievement,<sup>34</sup> students with reading and math learning difficulties both reported higher levels of anxiety.<sup>35</sup> Anxiety, especially in the context of foreign language learning, has been found to be related to poorer language proficiency.<sup>36</sup> In a study by Da et al exploring the role of mathematics anxiety in the relationship between smartphone addiction and mathematical achievement, it was discovered that mathematical anxiety

mediated between smartphone addiction and mathematical achievement. The intensity of smartphone addiction can regulate mathematical anxiety, and in turn, affect mathematical achievement.<sup>37</sup> This paper proposes the following hypothesis:

Hypothesis 2: College students' academic anxiety mediates the relationship between smartphone addiction and academic achievement.

## Moderating Role of Academic Control

The term "academic control" was first introduced by Perry in 1991. Academic control refers to a student's belief in their ability to predict and influence their academic performance. It is an individual's perception of their capacity to control and forecast academic outcomes to a certain extent.<sup>38,39</sup> Sense of academic control for college students entails feelings and perceptions of their ability to influence academic outcomes, a belief in their capability to achieve academic goals, and the conviction that academic success depends on factors they can control. Additionally, it involves recognizing the factors that contribute to academic success and experiencing a sense of gradual progress toward goals through hard work. This fosters a sense of personal strength and value.<sup>40</sup>

Data from Respondek et al suggests that students who use smartphones for more than 7 hours per week tend to pay less attention to their academic abilities. Excessive smartphone usage can have a detrimental effect on students' sense of academic control. Consequently, students with low academic control may predict higher levels of anxiety,<sup>41</sup> whereas students with a high sense of academic control tend to experience lower levels of academic anxiety and are more likely to allocate more time to learning and less time to smartphone use. Research by Kang et al shows that anxiety plays a significant moderating role in the relationship between a sense of academic control and self-regulated learning.<sup>42</sup> Students with a strong sense of academic control experience lower stress,<sup>43</sup> and anxiety-induced increased arousal, such as distraction, can adversely affect cognitive executive control.<sup>44</sup> Sense of academic control is positively associated with positive emotions such as enjoyment and is negatively correlated with negative emotions like anxiety.<sup>45</sup> Sense of academic control is especially important for college students to adapt to the learning environment and overcome stress.<sup>46,47</sup>

Building on the above hypotheses, our study further infers that there may be a moderating effect on the mediating role of college students' sense of academic control in academic anxiety between smartphone addiction and academic achievement. In other words, when college students have a higher level of academic control, the indirect effect of smartphone addiction on academic achievement through academic anxiety is correspondingly weaker. Conversely, when the level of academic control is lower, the indirect effect of smartphone addiction through academic anxiety on academic achievement is stronger. Therefore, the hypothesis is put forward:

Hypothesis 3: College students' sense of academic control moderates the mediating effect of academic anxiety. In essence, a higher level of academic control weakens the mediating effect, while a lower level of academic control strengthens it.

## Research Methods

### Participants and Procedure

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethical Committee of Liaoning Normal University and all participants provided informed consent. Participants were selected with cluster sampling method with the school as a sampling unit from 20 schools in Liaoning Normal University. The cluster sampling method is used to obtain the data information of a group more comprehensively, which is easy to organize and implement, and can save manpower and material resources. This study involved undergraduates from Liaoning Normal University, including students from the Department of Education, the School of Government Management, the School of Psychology, the School of Chemistry and Chemical Engineering, the School of Mathematics, the School of Foreign Chinese, the School of Fine Arts, and so on. A total of 2097 questionnaires were distributed using purposive sampling and the college-student duality method. After eliminating 41 invalid questionnaires with missing or inconsistent answers, we obtained 2056 (98.04%) valid responses. Of the participants, 407 (19.8%) were

male, and 1649 (80.2%) were female. Additionally, 1210 (58.9%) were enrolled in humanities and social sciences, while 846 (41.1%) were in science, engineering, and medicine. Moreover, 849 (41.3%) were registered in rural areas, and 1207 (58.7%) were registered in urban areas.

## Measures

### Smartphone Addiction

We used the “College Students’ Smartphone Addiction Tendency Scale” developed by Xiong Jie, Zhou Zongkui, Chen Wu, You Zhiqi, and Zhai Ziyang in 2012.<sup>48</sup> The scale has a total of 16 items encompassing four dimensions, which are withdrawal symptom, conspicuous behavior, social comfort and mood change., items such as “I feel more fulfilled in my life with more phone calls and text messages” and “I feel lonely without a smartphone.” Participants rated these statements on a scale of 1 (“not at all”) to 5 (“very conform”). Higher total scores indicate more intense feelings of smartphone addiction. The internal consistency confidence of the scale in this study was  $\alpha=0.94$ .

### Academic Anxiety

We employed the Academic Anxiety Scale from the Achievement Emotional Questionnaire (AEQ) as developed by Pekrun, Goetz, Titz, and Perry in 2002.<sup>49</sup> This scale originally contained 39 items, but after the exploratory factor analysis and confirmatory factor analysis after of the initial test data recovery, we retained 21 items with a total of three dimensions, which are classroom anxiety, learning anxiety and test anxiety, items such as “Sitting in class, I feel uneasy” and “I am nervous in class”. Participants rated their responses on a scale of 1 (“not at all”) to 5 (“very conform”). Higher total scores indicate more intense feelings of academic anxiety. The internal consistency confidence of the scale in this study was  $\alpha=0.98$ . The structural validity of the scale was assessed, resulting in  $X^2/df=4.82$ , GFI=0.974, NFI=0.981, IFI=0.985, CFI=0.985, and RMSEA=0.043 as fitting indices.

### Sense of Academic Control

We used the revised Academic Control Scale developed by Perry, Hladkyj, Pekrun, and Pelletier in 2001 and adapted by Ju Yachan in 2012.<sup>50,51</sup> The scale originally contained 8 items, but we retained 6 items after initial testing to suit our research context. With a total of two dimensions, which are internal action control and external environment control, items statements include “I think I have a great degree of control over my academic performance” and “The more effort I put into my studies, the better my academic performance will be”. Participants rated these statements on a scale of 1 (“not at all”) to 5 (“very conform”). The reverse scoring questions are 4, 5, and 6. Higher total scores indicate less intense feelings of external environment control. The internal consistency confidence of the scale in this study was  $\alpha=0.72$ .

### Academic Achievement

Academic achievement was measured based on university students’ achievement points, which were weighted in the analysis.

## Results

### Common Method Variance

We conducted the Harman univariate test, as recommended by Jakobsen and Jensen, to assess the extent of common method bias in the data. The results indicated that there were seven characteristic factors with values greater than 1. However, the first factor explained only 37.46% of the variation, which did not exceed the 40% threshold suggested by Jakobsen and Jensen. Therefore, we concluded that there was no serious common method bias in this study.<sup>52</sup>

### Descriptive Statistical Analysis of Each Variable

Table 1 presents the means, standard deviations, and correlation coefficients for each study variable. The results reveal that the statistically significant negative correlation between smartphone addiction and academic achievement is very low ( $r = -0.05$   $p < 0.05$ ). Furthermore, smartphone addiction is significantly positively correlated with academic anxiety ( $r = 0.61$ ,  $p < 0.01$ ), while academic anxiety is significantly negatively correlated with academic achievement ( $r = -0.11$ ,  $p < 0.01$ ). Additionally, sense of academic control is significantly positively correlated with academic achievement

**Table 1** Means, Standard Deviation, and Correlation Coefficients for Variable Scores

Variable	M	SD	1	2	3	4
1.Smartphone addiction	2.86	0.72	1			
2.Academic anxiety	2.43	0.77	0.61**	1		
3.Sense of academic control	3.59	0.53	-0.23**	-0.47**	1	
4.Academic achievement	3.23	0.52	-0.05*	-0.11**	0.24**	1

Note: \* $p < 0.05$ , \*\* $p < 0.01$ , the same below.

( $r = 0.24$ ,  $p < 0.01$ ). As a result, hypothesis 1 has been preliminarily verified, providing a solid foundation for subsequent hierarchical regression analysis.

## Testing of Research Hypotheses

Firstly, hierarchical regression analysis was conducted to examine the simple and direct impact of smartphone addiction on academic achievement among college students. The data revealed that, after controlling for demographic variables (gender, major, domicile place, annual household economic income, monthly disposable income in school, parenting style and graduation plan), smartphone addiction among college students had a significant negative effect on academic achievement ( $b = -0.05$ ,  $p < 0.05$ ), confirming the verification of hypothesis 1.

Secondly, we employed the SPSS macro program PROCESS, developed by Hayes, to analyze the simple mediating effect of academic anxiety on the relationship between college students' smartphone addiction and academic achievement (as shown in Table 2). The analysis results indicated that, after accounting for demographic variables (gender, major, domicile place, annual household economic income, monthly disposable income in school, parenting style and graduation plan), smartphone addiction among college students had a significant positive effect on academic anxiety (M1,  $b = 0.65$ ,  $p < 0.01$ ). Furthermore, when smartphone addiction and academic anxiety were simultaneously included in the regression model, the results demonstrated that academic anxiety significantly influenced academic achievement (M2,  $b = -0.1$ ,  $p < 0.01$ ). Additionally, the nonparametric percentile Bootstrap method, corrected for bias, was employed to assess the mediating effect of academic anxiety. The results indicated that the mediating effect of academic anxiety was significant in the pathway from college students' smartphone addiction to academic achievement, with an indirect effect value of  $-0.067$  ( $p < 0.01$ ) and a 95% confidence interval of Boot ( $-0.069$ ,  $-0.018$ ). The confidence interval did not include zero, confirming the significance of the pure mediating effect of academic anxiety and thus verifying hypothesis 2.

Subsequently, this study employed the PROCESS macro program to investigate the moderating effect of academic control on the relationship between smartphone addiction and academic anxiety, as well as its moderating effect on the mediating role of academic anxiety (as presented in Table 3). The analysis outcomes indicated that the interaction effect between smartphone

**Table 2** Mediating Effect Analysis of Academic Anxiety

Variable	Academic Anxiety (M1)			Academic Achievement (M2)		
	b	SE	t	b	SE	t
Gender	-0.10**	0.03	-2.85	0.19***	0.03	6.16
Major	0.06*	0.03	2.07	-0.10***	0.02	-4.21
Domicile Place	0.02	0.03	0.66	0.01	0.02	-0.47
Annual household economic income	-0.02	0.02	-0.87	-0.01	0.02	-0.66
Monthly disposable income in school	-0.08**	0.03	-2.66	0.05	0.02	1.89
Parenting style	0.00	0.02	0.06	-0.03	0.01	-1.90
Graduation plan	0.07***	0.02	4.16	-0.06***	0.02	-4.03
Smartphone addiction	0.65***	0.02	34.94	0.05	0.02	0.27
Academic anxiety				-0.07***	0.02	-3.63
R2	0.39			0.06		
F	161.22***			14.29***		

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ , the same below. (1) the b value in the table is the non-standardized regression coefficient; (2) the number of Bootstrap repeat samples used to estimate the bias correction confidence interval is 5000, the same below.



**Table 3** Analysis of Mediating Effects with Regulation

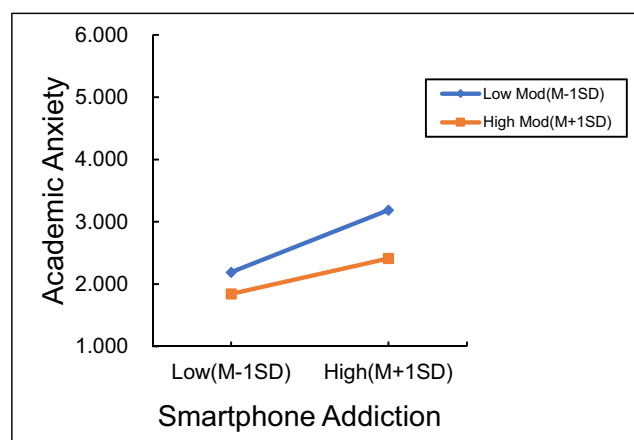
Variable	Academic Anxiety (M3)			Academic Achievement (M4)		
	b	SE	t	b	SE	t
Gender	-0.04	0.03	-1.30	0.19***	0.03	6.16
Major	0.02	0.03	0.86	-0.10***	0.02	-4.21
Domicile place	0.03	0.03	1.09	0.01	0.02	-0.47
Annual household economic income	-0.01	0.02	-0.17	-0.01	0.02	-0.66
Monthly disposable income in school	-0.07**	0.03	-2.69	0.05	0.02	1.89
Parenting style	0.02	0.02	-1.15	-0.03	0.01	-1.90
Graduation plan	0.02	0.02	1.47	-0.06***	0.02	-4.03
Smartphone addiction	0.55***	0.02	31.53	0.05	0.02	0.27
Academic anxiety				-0.07***	0.02	-3.63
Sense of academic control	-0.51***	0.02	-21.66			
Smartphone addiction× Sense of academic control	-0.28***	0.03	-10.21			
R2	0.51			0.06		
F	214.25***			14.29***		

Note: \*\*p<0.01, \*\*\*p<0.001, the same below.

addiction and the level of academic control in the regression model achieved statistical significance (M3,  $b=-0.28$ ,  $p<0.01$ ). In other words, the interaction between smartphone addiction and academic control significantly influenced the relationship between smartphone addiction and academic anxiety.

To provide a more intuitive representation of the moderating effect in the relationship between smartphone addiction and academic anxiety, the researchers created a simple slope diagram illustrating the regulatory impact (refer to Figure 2). As depicted, when college students possess a strong sense of academic control, the positive association between smartphone addiction and academic anxiety is attenuated. Conversely, when college students exhibit a weak sense of academic control, the positive relationship between smartphone addiction and academic anxiety becomes more pronounced. This observation validates hypothesis 3.

To further investigate the moderating effect of the sense of academic control on the mediating influence of academic anxiety, a detailed analysis was conducted (refer to Table 4). The outcomes indicated that when college students possessed a strong sense of academic control, the indirect effect of smartphone addiction on academic achievement through academic anxiety was diminished ( $\rho=0.40$ , Boot 95% CI does not include 0). Conversely, when college students exhibited a weak sense of academic control, the indirect effect of smartphone addiction on academic achievement through academic anxiety remained low ( $\rho=0.69$ , Boot 95% CI does not include 0). Following the moderated mediation effect analysis method proposed by Hayes (2015), the parameter Index was tested, resulting in a value of 0.02 with

**Figure 2** Moderating effect of the relationship between smartphone addiction and academic anxiety.

**Table 4** Conditional Indirect Effects Analysis

<b>A Sense of Academic Control</b>	<b>Effect</b>	<b>BootSE</b>	<b>BootLLCI</b>	<b>BootULCI</b>
Low sense of academic control	0.69	0.02	0.65	0.74
Middle sense of academic control	0.55	0.02	0.51	0.58
High sense of academic control	0.40	0.02	0.35	0.45
Smartphone addiction × Sense of academic control	−0.28	0.03	−0.33	−0.22

a Boot 95% confidence interval of (0.01, 0.03), which does not contain 0. In summary, these findings demonstrate that the mediating effect of academic anxiety in the relationship between smartphone addiction and academic achievement is subject to regulation by the sense of academic control, confirming the empirical support for hypothesis 3.

## Discussion

### Direct Effect of College Students' Smartphone Addiction and Academic Achievement

It is evident that smartphone addiction among college students has a detrimental effect on their academic achievement. This aligns with numerous prior studies supporting this notion. For instance, as supported by 36 reviewed studies,<sup>53</sup> smartphone use was negatively correlated with students' academic performance. Samaha and Hawi noted that individuals with high levels of smartphone addiction tended to achieve lower academic outcomes.<sup>17</sup> This conclusion is in line with the media dependence theory,<sup>54</sup> suggesting that the more individuals rely on media, such as smartphones, to meet their needs, the greater the impact of media on them. At the same time, in line with this conclusion, the uncontrolled use of smartphones leads to a series of physical and mental problems in students, as well as reduced academic achievement.<sup>55</sup> Moreover, his study reaffirms the negative effect of smartphone addiction on academic achievement among college students. Smartphone addiction consumes substantial time originally designated for learning activities, consequently jeopardizing the quality of task completion. Additionally, students may develop an excessive psychological dependence on smartphones, seeking solace and understanding, which detracts from their academic pursuits. Therefore, it is imperative to guide students in adopting a balanced approach to smartphone usage to mitigate the prevalence of smartphone addiction.

The reason for the low negative correlation coefficient between smartphone addiction and academic performance may be that college students use mobile phones for studying, and students spend a lot of time using smartphones to acquire knowledge and improve their academic performance, but they cannot reasonably control the use time, resulting in smartphone addiction.

### Mediating Role of Academic Anxiety

Academic anxiety among college students plays a pivotal mediating role in the relationship between smartphone addiction and academic achievement. Smartphone addiction not only directly affects students' academic performance but also indirectly influences academic achievement by exacerbating academic anxiety. This perspective, grounded in academic emotions, enhances our understanding of the connection between smartphone addiction and academic achievement, better reflecting the real academic experiences of students. This conclusion aligns with previous findings,<sup>56</sup> which suggest that anxiety can drive individuals to use smartphones excessively as a coping mechanism, thereby predicting smartphone addiction.<sup>36,57</sup> Students developed learning anxiety in foreign language classrooms, and the higher the level of anxiety themselves, the lower the foreign language proficiency.<sup>37</sup> Furthermore, it is consistent with control-value theory.<sup>11</sup> This research highlights that negative academic emotions like academic anxiety can significantly impact students' academic achievement, broadening our perspective on the relationship between academic anxiety and academic performance.

### Moderating Role of Sense of Academic Control

The study found that college students' sense of academic control significantly moderates the relationship between smartphone addiction and academic anxiety. Additionally, this sense of academic control also moderates the overall



mediating effect of academic anxiety. These findings have important implications for educational psychologists and researchers. It suggests that strategies or interventions aimed at enhancing students' sense of academic control can potentially reduce academic anxiety, thereby mitigating the adverse effects of smartphone addiction on academic achievement. Students with a strong sense of academic control are more likely to allocate more time to their studies, resulting in lower anxiety levels.<sup>58</sup> In line with this, students who exhibit good self-control are less susceptible to smartphone addiction.<sup>59</sup> Students who use smartphones for more than 7 hours per week will pay less attention to ability in the curriculum, and excessive use of smartphones will have a harmful effect on students' sense of academic control, that is, smartphone addiction will lead to a decrease in academic control. A good sense of self-control moderated the relationship between personal growth initiative and the risk of smartphone addiction, thereby reducing the risk of smartphone addiction; this is also consistent with the results of the study of 571 college students: smartphone addiction has a negative impact on individual self-control and further leads to poor academic performance;<sup>60</sup> Embodies the idea of Compensatory Internet Use Theory,<sup>61</sup> students gain comfort and understanding in the Internet by using smartphones to escape negative emotions such as academic anxiety during academic activities; while control-value theory, students with the high sense of academic control overcome obstacles and focus on learning, thereby reducing the probability of smartphone addiction behaviors and indirectly regulating academic anxiety.

Furthermore, when college students who are addicted to mobile phones enter the society, they may restrain their addictive behaviors in order to make a living or reduce their addictive behaviors through educational interventions at school. If the problem of mobile phone addiction is not improved, it may cause some harm to Chinese society. For example, frequent use of mobile phones by drivers in driving cars will lead to traffic safety problems. In the future, we will further explore and verify the opportunity.

## Implications

At a theoretical level, this study enriches our understanding of the impact of smartphone addiction on the academic achievement of college students. By examining the influence of academic anxiety on these two factors, as well as considering the role of academic control, it offers a fresh perspective for future research and contributes to the expansion of theoretical frameworks related to smartphone addiction.

On a practical level, this study provides empirical support for educational and psychological interventions for college students. Educators should pay close attention to students' academic anxiety and take effective measures to reduce it, which in turn can help mitigate the risks associated with smartphone addiction. Additionally, promoting stronger connections with friends and family can be beneficial in alleviating anxiety.

## Limitations and Future Directions

This study has certain limitations. Firstly, it relies on cross-sectional data, which may limit the ability to establish causal relationships. Future research should consider longitudinal study designs for more robust conclusions. Secondly, the study's participants were solely from one university, which may limit the generalizability of the findings. Subsequent studies could expand the sample size and consider the moderating effects of demographic variables for a more in-depth analysis. Finally, the reasons affecting college students' academic achievement are complex and diverse. This study only selected three factors: smartphone addiction, sense of academic control and academic anxiety for analysis. At the same time, this study only selected academic anxiety as the mediating variable and the sense of academic control as the moderating variable, and whether academic anxiety is the only mediating variable, whether the sense of academic control is the only moderating variable, and whether there are other mediating and moderating variables, these questions still need to be discussed in the next step.

## Conclusion

In summary, this study reveals that smartphone addiction among college students negatively predicts academic achievement. Academic anxiety acts as a complete mediator in the relationship between smartphone addiction and academic achievement. Moreover, students' sense of academic control significantly moderates the relationship between smartphone addiction and academic anxiety, further influencing the overall mediating effect of academic anxiety. Specifically,

smartphone addiction impacts academic achievement through academic anxiety, and this effect is moderated by the degree of academic control.

## Data Sharing Statement

All data included in the current study can be obtained from the corresponding authors through their email address upon reasonable request.

## Ethics Statement

The study was approved by the Human Research Ethics Committee of Liaoning Normal University, and we have obtained the informed consent from the study participants. All procedures performed in studies involving human participants were in accordance with the ethical standards and with the Helsinki Declaration and its later amendments or comparable ethical standards (Number: LL2023043).

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising and critically reviewing the article; gave final approval of the version published; have agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

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## Disclosure

The authors report no conflicts of interest in this work.

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