Impact of Mobile Phone Addiction on College Students' Learning Investment under COVID-19: The Intermediary Role of Time Management Tendency and the Regulation of Self-Control

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Abstract—Under the background of the COVID-19 epidemic, the problem of mobile phone addiction in college students has become increasingly serious. This study takes the relationship between mobile phone addiction and college students' learning input under the COVID-19 epidemic as the main line, investigates the intermediary role of time management tendencies on mobile phone addiction and their learning input, and investigates the regulatory role of self-control. It is hoped that this study can help college students realize the harm from mobile phone addiction, thus reducing the time they spend in using mobile phones and improving their learning investment. In this study, 972 valid questionnaires were selected from 6 colleges and universities in Henan Province, and the effects of the variables such as mobile phone addiction, time management tendency, and self-control on college students' learning input were explored. The results show that: (1) There is a significant negative correlation between learning investment tendency and mobile phone addiction. (2) Time management tendencies play an intermediary role between mobile phone addiction and college students' learning input, that is, mobile phone addiction mainly affects college students' learning investment through time management tendencies. (3) Self-control plays a regulatory role in the mediating effect of time management tendencies.

Keywords—COVID-19, junior high school students, self-control, mobile phone addiction, learning engagement, chain mediation

I. INTRODUCTION

During the COVID-19 (Coronavirus Disease 2019, COVID-19) epidemic in early 2020, in face of the severe epidemic situation, China took strict control measures, requiring a home quarantine, the reduction of traveling, and a delay of the official start for school. To ensure the safety of students without disrupting the normal teaching order of colleges and universities, on February 4, 2020, the Ministry of Education of the People's Republic of China released a statement of "The Ministry of Education to deal with the COVID-19 epidemic work leading group office about the epidemic prevention and control of online teaching organization and management guidance". However, due to the long-time isolation and online learning, the frequency of college students' mobile phone use greatly increased. In the context of the "continuous suspension of classes" during the epidemic, college students' studies and life were largely depended on various online platforms such as WeChat and QQ. This undoubtedly provided them with more opportunities to use mobile phones.

Thus, it virtually led to the serious problem of mobile phone addiction among college students. After March 15, 2020, students returned to offline classes. But it was generally found that after a long-time home quarantine, the problem of mobile phone addiction in college students got worse, which resulted in the lack of learning investment among them.

On August 27, the China Internet Network Information Center (CNNIC) released the 48th Statistical Report on China's Internet Development (hereinafter referred to as the Report) in Beijing. According to the report, as of June 2021, the number of Internet users had reached 1.011 billion, with an increase of 21.75 million from December 2020, and the Internet penetration rate reached 71.6%. One billion users have gained access to the Internet, forming the world's largest and vibrant digital society. Mobile phone addiction has a high detection rate among college students (21.4%–27.4%) [1]. Fu *et al.* [2] conducted a survey of 363 college graduate students in Nanjing and found that 38.29% of graduate students have mobile phone addiction problem. Mobile phone addiction (mobile phone addiction), also known as mobile phone dependence, similar to watching TV addiction and online game addiction, is regarded as an impulse control disorder. The specific symptoms are: focusing attention on the phone; being worried about missing the phone or information without using it for a period of time; being unable to control the time of mobile phone use; feeling confused, uneasy, moody, depressed, or irritable without phones [3]. Previous studies have found that mobile

phone addiction hinders relationships, reduces academic performance, and leads to lower life satisfaction, well-being, anxiety, etc. [4]. The research has found that mobile phone addiction will induce negative emotions [5], increase individual excessive desire for mobile phones, reduce individuals' resistance to mobile phone temptation, and cause individuals' delay behavior [6]. Most of the studies also focus on the relationship between mobile phone addiction and academic delay, but they rarely explore the relationship between mobile phone addiction and learning investment. In view of this, this study aims to investigate the impact of mobile phone addiction on learning investment and role.

Schaufeli held that learning engagement refers to a positive, fulfilling mental state related to learning, including the three dimensions [7]: vitality, dedication, and focus. Fredricks *et al.* [8] suggested that learning input includes three dimensions, including behavior (behavioral), emotion (emotional), and cognition (cognitive). Ibrahimoglu, Unaldi, Samancioglu, and Baglibel [9] defined learning investment as a state of students showing continuous positive feelings for learning and others. Li [10] believed that learning investment refers to the degree of students being involved in behavior, the quality of emotional experience and the level of cognitive strategy application in the implementation of learning activities. It includes the three dimensions of behavioral investment, emotional investment, and cognitive investment, which is a serious psychological investment for students in their studies. At present, there has been a lot of research on learning investment, but little has been done on mobile phone addiction and learning investment. Mobile phone addiction of college students will cause their dependence on mobile phones, leading to the academic delay, and even the reduction of learning investment.

Time management tendency refers to the psychological and behavioral characteristics of time use. Individuals should cherish the function and value of time, and utilization and transportation time, including three aspects: time value, that is, the stable attitude and concept of time; time monitoring, namely individual ability and concept to use time, reflected by explicit activities, such as planning arrangement, target setting, etc.; time efficiency, individual belief and expectation of time control [11].

Self-control refers to an individual's ability to change or overcome the tendency to respond to predominance, regulate thoughts, emotions, and behavior, and is a prerequisite for achieving self-regulation [12]. Individuals will often act for reality. Now your goals or adapt to the outside environment, and restrain their emotional impulses, control their behavior. And high self-control has been shown to be a protective factor against adolescent Internet addiction [13]. University is a relatively free environment, so self-control is a necessity for students to improve themselves. Talents with relatively strong self-control can achieve good academic performance. Also, self-control can improve the efficiency of learning investment.

A. The Relationship between Mobile Phone Addiction and Learning Investment

The media dependence theory [14] suggests that the more the individual relies on their needs through media (such as mobile phones), the greater the media impact is on them. Cell phone addiction can cause cognitive failure, impair individuals' attention control [15], and reduce sleep quality [16], inducing anxiety and depression [17]. Individuals with high mobile phone addiction are more prone to academic delay [18] and academic burnout, indirectly bringing adverse effects on students' learning input. According to the previous research, it is found that mobile phone addiction will bring adverse effects to learning investment. Especially under the influence of the outbreak of online teaching, college students use mobile phones frequently. Besides, during the outbreak of epidemic, activities are reduced, so the main entertainment is the use of mobile phones, leading to mobile phone addiction of the college students. At the same time, it makes the vast majority of college students difficult to enter the learning state, bringing adverse effects on learning investment. We therefore hypothesized a negative correlation between cell phone addiction and learning investment during the outbreak.

B. Intermediation Role of Time Management Tendency

Time management tendency refers to the psychological and behavior characteristics. Time value refers to the individual attitude and concept of time. This stable attitude and concept can point to the meaning of life as well as the development of society, usually with personal emotion, and guide personal use and grasp of time [19]. The tendency of time management is strongly associated with the positive response patterns of individuals [20]. Facing the same time, different people have different perceptions, attitudes, and behavior. The attitudes towards time and the cognition of time values often drive people to act towards certain goals [21]. Good time management tendency helps college students improve their own investment level in learning activities. Meanwhile, a good time management tendency is conducive to improving students' learning investment. In addition, the existing research has concluded that mobile phone addiction is inversely correlated with students' time management tendency [22]. Cell phone addiction leads to frequent cell phone use by students, which distracts students, makes them lose the concept of time and affects their time management tendency, causing the delay of learning tasks, and finally, an adverse impact on learning input. Hence, we assume that time management tends to play a mediating role between mobile phone addiction and learning engagement.

C. Regulatory Effects of Self-Control

Self-control system (hereinafter referred to as control system) is the inhibitory control ability of an individual in the face of temptation. On the one hand, previous studies have revealed that self-control can significantly affect cell phone addiction [23]. High self-control ability can reduce the problem of mobile phone addiction, and can resist mobile phone addiction. The higher the individual self-

control level is, the more their learning input is [24]. Also, the individual impulsivity is significantly predictive of their learning input [25]. According to the self-control model built by Li *et al.* [26], self-control (cognitive monitoring), the tendency of time management is an external embodiment of the self-control ability. Studies have shown that there is a close relationship between time management tendency and self-control [27], and self-control positively affects the time management tendency. So it is assumed that: time management tendency may be regulated by self-control between mobile phone addiction and college student input.

This study proposes a regulated mediation model, that is, the mediation role of mobile phone addiction and college students' learning input is regulated by self-control through the mediation role of time management tendencies, and the study of this problem helps to understand the relationship between mobile phone addiction and learning input, what role time management tendencies will bring to college students' learning input, and how self-control plays a regulatory role. The model mainly contains a mediation path that has a tendency to go through time relations and a moderating path on the front and back half of the mediation path. As shown in Fig. 1:
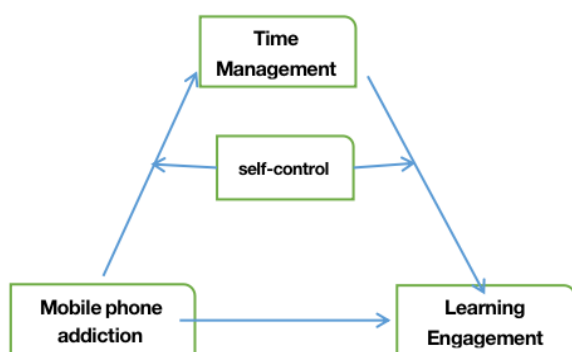

Fig. 1. A moderated mediation model diagram.

II. METHODS

A. Study Design and Sample

From 10 undergraduate degrees, junior college, graduate student, and above, in universities of Henan Province, 1,200 questionnaires were distributed, and 972 valid questionnaires (the recovery rate was 97%) were obtained. The subjects were between 17 and 30 years old, including 443 boys (45.58%), 529 (54.42%) girls, with 357 undergraduate (36.73%), 221 specialist (22.84%), and 393 (40.43%) masters and above.

B. Instruments

1) Time management propensity scale

Huang and Zhang [28] proposed a 3D structure model of time management tendency through combining the TMQ scale, TMB scale, as well as TSQ scale, and compiled the Adolescent Time Management Lensity Scale (Adolescence Time Management Disposition Scale, referred to as ATMD) It is the most widely used tool in domestic time management research, with 44 items, and 3

factors, namely time value, time monitoring view and time efficiency. It uses the Likert white rating 5-point scale, where the internal consistency reliability coefficient was between 0.62 and 0.81 and the retest reliability coefficient was between 0.71 and 0.85. This scale was also used as a research tool for time management tendency variables in this study.

2) College students study investment

The College Student Learning Investment Scale (the Utrecht Work Engagement Scale-student, UWES-S) was compiled by Schaufeli equals 2003 based on the Utrecht Work Investment Scale (the Utrecht Work Engage-ment Scale, UWES) with a total of 17 topics, including 3 dimensions, namely motivation, energy, and focus. The scale adopts a 7-point scoring method, where the coefficient was: 0.88, 0.87, 0.84, 0.90, for confirmatory factor analysis, with: $x / d f = d f = 8.01$ (df = 116), RMSEA = 0.07, NFI = 0.93, RFI = 0.93, IFI = 0.94, TL = 0.92, and CFI = 0.93.

3) College students mobile phone addiction tendency scale

The scale of mobile phone addiction tendency for college students compiled by Liu *et al.* [29] consists of 16 items, including withdrawal symptoms, prominent behavior, social comfort, and mood change. For the five-point score (1 = "very inconsistent", 5 = "very consistent"), the higher the total score is, the more serious the mobile phone addiction is. This scale is widely used in previous studies and has good reliability and validity. The coefficient of this scale in this study was 0.92.

4) College student self-control scale

Tan and Guo [30] revised the College Student Self Control Scale (SCS) based on the work of Fung, Kong, and Huang [31] and retained 19 questions in the original scale, which were divided into five dimensions, namely impulse control, health habits, resisting temptation, focusing on work, and moderate entertainment. A of the self-control scale, with a coefficient of 0.862. Three weeks later, the test-retest reliability was 0.850. The total correlation for all questions was 0.333–0.560. The validity of the self-control scale was good, which was significantly associated with mental health level, life satisfaction, and interpersonal relationship satisfaction. The correlation coefficients were 0.317, 0.280, and 0.163, respectively.

The reliability validity and internal consistency of college students' self-control scale can be used as a measurement tool for their self-control ability. The scale uses five points, with "completely inconsistent" to "full compliance" scored as 1 to 5: the higher total score represents the higher level of self-control.

5) Study procedures and statistical analysis

The team testing in random sampling was performed by professionally trained graduate students in educational psychology. All questionnaires were filled out anonymously and recovered on the spot. Data processing was performed with the SPSS21.0 and the process plugin.

The common method bias test was performed using Harman's single-factor analysis. The results showed that a total of four factors were generated without rotation,

with characteristic root values greater than 1; and the amount of variation explained by the largest factor was 32%, less than the critical standard of 40%, so there is no common method bias in this study.

TABLE I. THE MEAN, STANDARD DEVIATION AND CORRELATION MATRIX OF EACH VARIABLE

Variable	M	SD	1	2	3	4
1. Time Management Dispositon	3.474	0.69	1			
2. Mobile phone addiction	3.349	0.67	0.333**	1		
3. Learning Engagement	3.237	0.905	0.297**	0.277**	1	
4. Mobile phone addiction	2.596	0.825	−0.463**	−0.273**	−0.304**	1

Note: * $p < 0.05$, ** $p < 0.01$.

III. RESULT

A. Statistical Description and Related Analysis of Each Variable

As seen from the above Table I, the correlation analysis was used to study the correlation between the four items of mobile phone addiction, learning input, self-control, and time management tendency, and the Pearson correlation coefficient was used to indicate the strength of the correlation. The specific analysis shows as follows:

The correlations of learning investment with tendency and mobile phone addiction, self-control, and time management tendency were all significant. Specifically, the correlation coefficient between learning investment tendency and mobile phone addiction was 0.304, and presents a significance at the level of 0.01, thus indicating a significant negative relationship between learning investment tendency and mobile phone addiction. The correlation coefficient between learning investment tendency and self-control was 0.297, significant at the level of 0.01, thus indicating a significant positive correlation between learning investment tendency and self-control. The correlation coefficient between learning investment tendency and time management tendency was 0.277, significant at the 0.01 level, indicating a significant positive relationship between learning investment tendency and time management tendency.

In addition, the analysis of variance (known as one-way analysis of variance) to study the difference of time management tendency, as seen from the above table: samples with different education degrees for time management tendency were significant (p <0.05), meaning that different education degrees have different samples for time management tendency. The specific analysis shows as follows:

Education degree showed significant at the 0.01 level (F = 1 = 228.435, p = 0.000). For the specific comparison differences, the group average score comparison results with obvious differences were "graduate and above> undergraduate; graduate and above> junior college".

In summary, all the samples with different education degrees showed significant differences in the time management tendency.

B. The Relationship between Mobile Phone Addiction and Learning Investment in College Students: An Adjusted Intermediary Effect Test

First, the intermediary effect of time management tendency in the relationship between mobile phone addiction and learning investment in college students was tested. The results (see Tables II and III) showed that mobile phone addiction predicted learning input significantly (B = −0.334, t = −9.951, p < 0.01), and the direct predictive effect of mobile phone addiction remained significant (B = −0.271, t = −7.953, p < 0.01). The negative predictive effect of mobile phone addiction on time management tendency was significant (B = −0.222, t = −8.832, p < 0.01), and the positive predictive effect of time management tendency on learning input in college students was also significant (B = 0.283, t = 6.731, p < 0.01). In addition, the upper and lower limits of the bootstrap 95% confidence interval of the direct effect of mobile phone addiction on learning investment and the time management tendency did not include 0 (see Table III), indicating that mobile phone addiction can not only directly predict delay behavior, but also predict delay behavior through the intermediary effect of attention control. Second, the regulated mediation models were tested using Model 58 in the SPSS macro compiled by Hayes [32]. The results (see Table IV) indicate that, after placing the self-control into the model, The product items of mobile phone addiction and self-control were significantly predictive of learning input and time management tendency (learning input: B = 0.192), t = 5.136, p < 0.01; time management tendency: B = 0.055, t = 1.963, p < 0.05). It shows that self-control can not only play a regulatory role in the direct prediction of mobile phone addiction on learning input, but also regulate the predictive effect of mobile phone addiction on time management tendency.

According to the simple slope diagram (see Figs. 2 and 3), subjects with low levels of self-control (M − 1SD) have significant negative predictors of mobile phone addiction on college students' learning input. While for subjects with high levels of self-control (M + 1SD), mobile phone addiction also has a negative predictor on learning input, but with less predictive effect. It shows that the predictive effect of mobile phone addiction on time management tendency gradually decreases with the increasing level of self-control. At the same time, the intermediary effect of time management tendency in mobile phone addiction and learning investment also decreases, that is, with the improvement of self-control level, mobile phone addiction is less likely to lead to poor learning investment by the interference of the time management tendency.

TABLE II. REGRESSION ANALYSIS

	Learning Engagement				Learning Engagement			
	β	SE	t	p	β	SE	t	p
Constant	0.751	0.638	1.177	0.239	3.235	0.282	11.484	0.000**
Mobile Phone Addiction	−0.192	0.037	−5.146	0.000**	−0.296	0.092	−3.207	0.001**
self-control	0.643	0.176	3.647	0.000**	0.115	0.078	1.473	0.141
Mobile Phone Addiction* self-control					0.055	0.028	1.963	0.050*
Time Management Dispositon	0.689	0.179	3.841	0.000**				
Time Management Dispositon* self-control	−0.132	0.051	−2.597	0.010**				
N	972				972			
R^2	0.156				0.132			
F	$F_{(4,967)} = 44.779, p = 0.000$				$F_{(3,968)} = 49.079, p = 0.000$			

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

TABLE III. ADJUSTMENT EFFECT ANALYSIS

	Learning Engagement				Learning Engagement			
	β	SE	t	p	β	SE	t	p
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* $p < 0.05$, ** $p < 0.01$.

TABLE IV. CONDITIONAL INDIRECT EFFECT

The mediation variable	Effect	BootSE	BootLLCI	BootULCI
Time Management Disposition	−0.046	0.016	−0.080	−0.019
	−0.024	0.009	−0.044	−0.009
	−0.009	0.007	−0.028	0.001

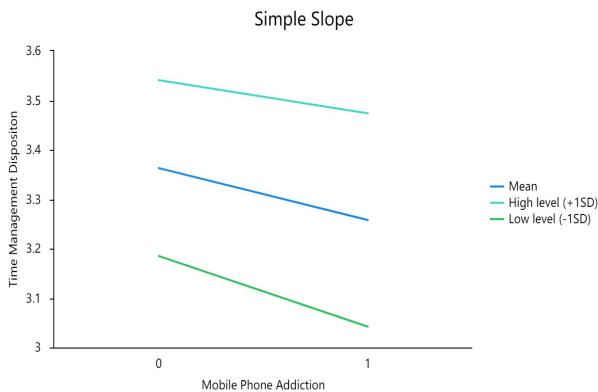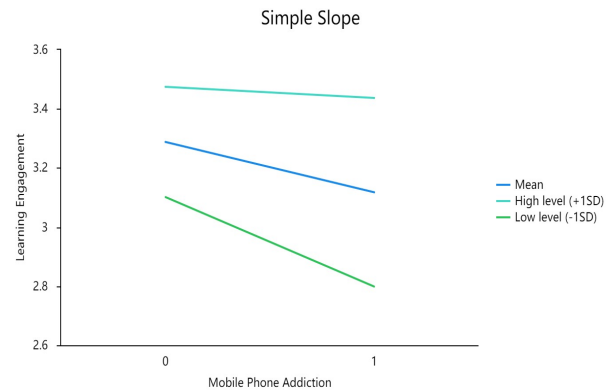Fig. 3. The moderating effect of time management tendency on mobile phone predicting learning investment in junior high school students.

Fig. 2. The quality of self-control is a regulatory effect on parental harsh discipline to predict time management tendency.

IV. DISCUSSION

In this study, it is found that in the context of the epidemic, there is a significant negative correlation of college students' mobile phone addiction with their learning investment and time management tendency. It means, the more serious the mobile phone addiction of college students is, the lower the time management tendency is, which leads to the lower learning investment

of them. Based on previous studies, the role of mobile phone addiction on learning investment during the outbreak constructed a mediation model with time management tendency and self-control. The model not only clarified how mobile phone addiction "affects" mobile phone addiction (mediation of time management tendency), but also responded to the influence of mobile phone addiction on learning investment (regulatory effect of self-control). The research results are of certain theoretical and practical significance for deepening the research on the relationships of mobile phone addiction with individual psychological and behavioral maladaptation, so as to guide college students to use mobile phones reasonably, which is beneficial to their psychological and social adaptation.

A. Intermediation Role of Time Management Tendency

Among the influential factors of addiction behavior, time management is of significant importance, which is evident in the network addiction of mobile phones, with different vectors [33]. Good time management tendency is conducive to improving students' learning investment. while the existing researchers have reached the conclusion that the study of the intermediary role of time management tendency in the relationship between mobile phone addiction and individual learning investment can help to reveal how mobile phone addiction affects college students' learning investment, and find ways to improve their learning investment [34]. It is found in this study that mobile phone addiction can predict the learning investment of college students through the mediation effect of time management tendency.

Cell phone addiction can cause cognitive failure damage the individual attention control [35] and reduce sleep quality. Mobile phone addiction mainly leads to the individual attention processing bias and time monitoring effect loss, thus bringing bad effects on the time management tendency. Studies have shown that the tendency of time management helps college students to improve their own investment level in learning activities, which is closely related to the positive coping methods of individuals [36]. Facing the same time, different people have different perceptions, attitudes, and behavior. The attitudes towards time and cognition of time values often drive people to act towards certain goals. Therefore, students with high time management tendency are more able to resist the influence of mobile phones, thus having high learning investment. At the same time, students with low time management tendency also have a direct adverse impact on learning investment due to the problem of mobile phone addiction. Finally, mobile phone addiction leads to low investment in learning by damaging college students' time management tendency.

B. Regulatory Role of Self-Control

This study constructed a regulated mediation model. The regulatory role of self-control in the relationship between mobile phone addiction and time management tendency and learning input was investigated. The result shows that self-control can not only play a regulatory role in the relationship between mobile phone addiction and

learning investment, and it's right "Cell phone addiction-Time management tendency-learning input". This intermediary chain regulates. The results of this study found that the effects of mobile phone addiction on learning input are regulated by self-control. Self-control system (hereinafter referred to as control system) is the inhibitory control ability of an individual in the face of temptation. On the one hand, previous studies have revealed that self-control can significantly affect cell phone addiction [37]. High self-control ability can reduce the problem of cell phone addiction, and can resist mobile phone addiction. The higher the individual self-control levels are, the more their learning investment are [38]. The results show that personal motivation has a significant predictive effect on their academic investment [39], indicating that a high degree of self-control can effectively promote students' academic investment and reduce the negative impact of mobile phones on academics. Addiction problem. Self-control is closely related to the trend of time management. High self-control can effectively adjust its tendency to manage time, thereby adjusting its contribution to learning. According to this study, self-control can not only play a regulatory role in the direct prediction of mobile phone addiction on learning input, but also can regulate the role of mobile phone addiction on time management tendencies.

C. Significance and Insufficiency of the Study

Regulated mediation models have not only revealed a mediation role of the time management tendency on learning inputs due to mobile phone addiction, but also a regulatory role on self-control. An in-depth study on the relationships of mobile phone addiction with individual learning input, self-control, and time management tendencies has positive significance. The results suggest that time management tendency plays an important mediation role in learning investment during the epidemic, and this mediation role will be regulated by self-control. This study is of positive significance for college students to correctly use their mobile phones to avoid mobile phone addiction. First, college students should actively guide themselves to use mobile phones reasonably, so as to avoid the low time management tendency due to mobile phone addiction, which leads to poor learning investment. At the same time, it is conducive to helping college students realize that the problem of mobile phone addiction can be regulated by self-control, thus helping college students to do a good job of self-control, reduce the use of mobile phones, put more energy on learning, and cultivate good learning investment habits.

D. Limitations

Despite the significance of this study, there are also shortcomings which need to be noticed. Firstly, in this study, only the student data results at a time node were drawn, and the dynamic development of junior high school students was not continuously tracked. Therefore, in future studies, more specific impacts of each dimension should be explored; the research on different genders can be conducted; more student data can be tracked. Secondly, this study only examined the impact of

mobile phone addiction on learning input, so in future studies, the impact of more factors on learning input can be investigated.

V. CONCLUSION

In conclusion, this study conducted an in-depth analysis of the mobile phone addiction, the time management tendency, the self-control, and the learning investment of college students during the epidemic period. It has been proved that learning input can be negatively predicted by mobile phone addiction; self-control, as a regulatory mediator, affects the relationship between mobile phone addiction and learning input; self-control, as a regulatory variable, has a regulatory effect on the mediating effect of time management tendency. Theoretically, the mechanism of mobile phone addiction, time management tendency, and self-control jointly influence college students' learning investment. In practice, it provides a reference for college students to improve their investment in learning. The main conclusions are as follows:

(1) Mobile phone addiction negatively predicts college students' learning investment.

(2) The tendency of time management plays an intermediary role between mobile phone addiction and college students' learning investment, that is, college students' mobile phone addiction mainly affects their learning investment through the time management tendency.

(3) The tendency of time management is regulated by the self-control ability between mobile phone addiction and college students' investment.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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