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Unlocking academic success: the impact of time management on college students' study engagement

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Abstract

Background In this study, the purpose was to examine the impact of time management on college students' study engagement and to determine the mechanisms involved. Consequently, we examined the relationship between time management and engagement in study, as well as self-control and mobile phone dependence.

Methods The Adolescence Time Management Disposition Scale (ATMD), College Student Mobile Phone Dependence Questionnaire (CSMPDQ), Utrecht Work Engagement Scale-student (UWES-S), and Self-Control Scale (SCS) were administered to 1016 college students. A Pearson's correlation analysis and a mediation analysis using bootstrapping were performed in order to test for standard method bias using SPSS 22.0.

Results ①Time management was positively associated with self-control and study engagement, and negatively associated with mobile phone dependence (p <.001). self-control was positively associated with study engagement, and negatively associated with mobile phone dependence (p <.001). Mobile phone dependence was negatively associated with study engagement (p <.01). ②Time management can not only directly predict study engagement (95%CI, 0.102 − 0.208) but also affects study engagement through three indirect paths: self-control was a mediator (95%CI, 0.066 − 0.158), mobile phone dependence was a mediator (95%CI, 0.043 − 0.109), and self-control and mobile phone dependence were a chain mediator (95%CI, 0.012 − 0.032).

Conclusion Time management not only influences study engagement directly, but also through the mediating effect of self-control and mobile phone dependence indirectly.

Keywords Chinese college students, Time management, Self-control, Mobile phone dependence, Study engagement

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Introduction

The quality of education serves as a crucial metric for evaluating the effectiveness of educational efforts, serving as the foundation for higher education and essential for the sustainability and advancement of academic institutions. Enhancing educational quality is a central objective in the advancement of higher education. With the continual growth of China's higher education sector, there is a growing emphasis on the importance of maintaining high standards in educational quality across various sectors of society. Traditionally, the evaluation of educational quality has predominantly concentrated on external metrics, including physical infrastructure and scientific research outcomes. In recent years, scholars have shifted towards a student-centric approach to evaluating education quality, prioritizing the learning and development of students. Study engagement has gained increasing attention from researchers as a determinant of students' experiential growth and of higher education quality [1, 2].

Estell and Perdue (2013) defined study engagement as the perceptions and attitudes of students towards school, which impact their participation in learning activities and sense of belonging to the school community [3]. Study engagement represents a novel approach to assessing the quality of undergraduate education in China by prioritizing students' subjective perspectives. This paradigm shift holds significant implications for enhancing the quality of undergraduate education in China, advancing theoretical research on higher education assessment, and fostering deeper exploration of quality assessment in higher education. It can enhance the theoretical and methodological framework for assessing the quality of undergraduate education, advance the field of higher education quality assessment, and contribute to the enhancement of higher education quality, particularly in the realm of fostering talent. To gain a more comprehensive understanding of the influence of study engagement on educational quality, scholars have initiated investigations into various determinants affecting study engagement.

Time management and study engagement

The concept of time management tendency primarily pertains to the psychological and behavioral attributes associated with one's capacity to manage time effectively and the perceived value of time [4]. Individuals who exhibit a high proficiency in time management demonstrate robust skills in coordinating and controlling time, enabling them to organize their academic and personal lives efficiently. Consequently, they tend to lead fulfilling lives, maintain positive interpersonal relationships, and experience a heightened sense of well-being [5]. Schaufeli (2002) emphasizes that study engagement encompasses vitality, dedication, and concentration, indicating a positive state characterized by initiative in thought and behavior, enthusiastic participation, and focused attention on learning [6]. Empirical research indicates that time management significantly influences the level of study engagement among college students. The relationship between individual time management and study engagement has been explored in several studies. Pan et al. (2011) found that higher levels of time management were associated with increased study engagement [7]. Similarly, Zhao et al. (2012) demonstrated that a tendency towards effective time management positively predicted levels of study engagement [8]. Additionally, Huang et al. (2017) showed that improving students' time management skills led to greater dedication to important learning tasks, ultimately enhancing study engagement [9]. A meta-analysis conducted by Claessens et al. (2007), which integrated data from 32 studies, established a significant correlation between time management behaviors (such as planning and prioritization) and both academic performance (r =.38) and engagement (r =.29) among college students [10]. These results are consistent with the findings of Liu and Zhang (2020), whose meta-analysis demonstrated that time management interventions, including goal-setting training, enhance study engagement by mitigating procrastination and promoting self-regulated learning [11]. Collectively, these meta-analytic findings highlight the critical role of time management in enhancing study engagement. Consequently, it is hypothesized that time management is a significant predictor of study engagement (Hypothesis 1).

The mediating role of self-control

As previously stated, our hypothesis posits that time management significantly impact study engagement. However, mere confirmation of a positive correlation between time management tendencies and study engagement is insufficient; it is imperative to elucidate the specific processes or mechanisms by which time management tendencies operate, including identifying potential mediating variables. Muraven and Baumeister (2000) proposed that self-control encompasses the capacity of an individual to consciously restrain impulses, desires, and manage their own conduct in order to enhance the attainment of enduring objectives [12]. In determining the mediating variables for this study, we evaluated various potential factors, including emotional regulation and cognitive flexibility, among others. Nevertheless, self-control has demonstrated a more extensive and significant impact on the regulation of individual behavior and emotional responses. Consequently, we have chosen to designate self-control as the primary mediating variable in this research [13]. Diamond (2013) posited that self-control is demonstrated through the capability to maintain concentration amidst external diversions, restrain impulsive actions, and consistently fulfill assigned duties

[14]. According to the power model of self-control, self-control ability is primarily shaped by personality traits, emotions, and the tendency for effective time management. Specifically, the trait of time management plays a significant role in enhancing self-control, as evidenced by its positive correlation with the regulation of emotions, behaviors, and cognitive processes in individuals [15]. Individuals who exhibit higher levels of time management tendencies are also likely to demonstrate greater self-control [16]. A meta-analysis conducted by de Ridder et al. (2012), which examined 102 studies, identified self-control as a significant predictor of academic success (r =.33) and as a mediator in the relationship between time management and study engagement [17]. These results align with the findings of Duckworth et al. (2016), whose meta-analysis of 67 studies revealed that self-control interventions, such as delayed gratification training, substantially enhance study engagement by minimizing distractions and fostering persistence [18]. Furthermore, Mercer et al. (2011) reported a positive correlation between self-control and study engagement [19]. Based on these findings, we propose Hypothesis 2: Self-control mediates the relationship between study engagement and time management.

The mediating role of mobile phone dependence

According to the 50th Statistical Report on the Development of the Internet in China, published by the China Internet Network Information Center, as of June 2022, the number of Internet users in China had reached 1,051 billion. Among these users, 99.6% accessed the Internet via mobile phones, with students comprising the largest demographic group at 23.7% [20]. The term "mobile phone dependence," often referred to as mobile phone addiction or problematic mobile phone use, describes the condition where individuals experience significant physiological, psychological, and social dysfunction as a result of excessive mobile phone usage and an inability to control it [21]. Mobile phone dependence is considered a significant non-drug addiction of the 21st century. Research indicates that the factors contributing to mobile phone dependence are closely associated with external environmental influences, including family upbringing styles, school belonging, and school adaptation [22–24]. Additionally, individual factors such as personality traits, self-esteem, basic psychological needs, depression, anxiety, and sleep quality also play a crucial role [25–28]. Time management propensity, as a facet of personality traits related to the temporal dimension, reflects an individual's capacity for self-regulation over time, a factor closely associated with addictive behaviors. In their study, they highlighted the significant negative correlation between college students' ability to manage time and their dependence on mobile phones [29, 30]. A meta-analysis conducted by Liu et al. (2021), which synthesized data from 41 studies, corroborated the negative impact of mobile phone dependence on study engagement, with a correlation coefficient of r = –.41. The study identified poor time management and low self-control as significant risk factors [31]. These results are consistent with the findings of Elhai et al. (2017), whose meta-analysis of 53 studies revealed an association between mobile phone dependence and diminished attention spans, increased academic procrastination, and decreased study engagement, with a correlation coefficient of r = –.37 [21]. Additionally, Li et al. (2019) discovered that mobile phone dependence can predict study engagement levels, with the development of mobile phone dependence directly impacting the amount of study engagement [32]. Huang et al. (2019) discovered a negative correlation between study engagement and mobile phone dependence [33], while Gao et al. (2021) found that core self-evaluation moderates the predictive effect of mobile phone dependence on study engagement [34]. Hypothesis 3 suggests that mobile phone dependence mediates the relationship between time management and study engagement.

The chain intermediary role of self-control and mobile phone dependence

In their research on the association between mobile phone dependence and self-control among college students, Li et al. (2017) [35] found a significant negative correlation between mobile phone dependence and self-control. Similarly, Zhang et al. (2017) [36] reported that mobile phone dependence was significantly negatively correlated with self-control and was associated with lower levels of self-control in individuals. Zhang et al. (2019) [37] research revealed that mobile phone dependence is a predictor of self-control, leading to a decrease in students' ability to regulate their behavior. Zhao (2021) [38] study demonstrated that time management tendencies can indirectly influence mobile phone dependence through self-control. Additionally, Wang and Jia (2020) [39] findings indicated that individuals with higher levels of time management tendencies exhibit greater self-control, which in turn can mitigate the likelihood of developing mobile phone dependence. Rozgonjuk et al. (2020) conducted a meta-analysis involving 28 studies, which confirmed that self-control mediates the relationship between time management and technology addiction, including mobile phone dependence, with a standardized indirect effect of $\beta = -0.18$ [40]. This finding supports the chain mediation model proposed in their study. Additionally, Billieux et al. (2015) highlighted that interventions targeting self-control, such as cognitive-behavioral therapy, are effective in reducing mobile phone dependence and enhancing academic engagement [41]. In conclusion, time management propensity is typically

considered an individual's capacity to effectively organize their time and resources, which is crucial for sustaining an efficient learning environment. However, time management alone does not directly influence an individual's susceptibility to phone dependence; rather, it operates through the individual's ability to exercise self-control. Therefore, an individual with strong time management skills, who can effectively regulate their behavior and impulses, is more likely to avoid excessive reliance on their phone, thereby maintaining a productive learning state. Consequently, Hypothesis 4 posits that self-control and mobile phone dependence serve as mediators in the relationship between time management and study engagement.

The tertiary education phase is a critical period for academic growth, where the degree of students' engagement in learning serves as a pivotal indicator of their academic success. Therefore, this study focuses on college students as participants to delve deeper into the factors that impact study engagement. This study examines the characteristics and interrelationships of time management, self-control, mobile phone dependence, and study engagement. It explores the impact of time management on study engagement, investigating the mediating roles of self-control and mobile phone dependence. Additionally, it uncovers the connections among these four variables. This research contributes to the empirical literature on study engagement and offers theoretical insights for mental health education in higher education settings.

Materials and methods

Participants

This research utilized a randomized questionnaire survey to gather data from undergraduate college students in Shandong Province, utilizing the Questionnaire Star platform. The research protocol received approval from the Ethics Committee of Jining Medical University. Participation in the study required completion of an informed consent form, with additional parental or guardian consent obtained for participants under the age of 18. Upon obtaining subjects' consent, online surveys were administered adhering to protocols for voluntary participation, confidentiality, and anonymity. The surveys were completed within a time frame of 10 to 20 min, and all data collected were kept confidential. Monetary incentives were not provided to volunteers during the trial. In this study, a total of 1,100 subjects were analyzed, collected from October to December 2023. Eighty-four questionnaires were excluded from the analysis due to insufficient response time (less than 200 s), the presence of randomized or patterned responses, uniform selection of options across all questions, and consistent responses to both reverse and forward questions. Consequently, 1,016 questionnaires were deemed valid, resulting in an effective response rate of 92.36%. The sample comprised 487 male students (47.93%) and 529 female students (52.07%). The ages of the participants spanned from 17 to 25 years, with a mean age of 21.80 years and a standard deviation of 1,770 years. Of the participants, 616 individuals (60.6%) were only children, whereas 400 individuals (39.4%) had siblings. Furthermore, 497 participants (48.9%) reported residing in urban areas, while 519 participants (51.1%) indicated that their families lived in rural areas.

Measurements

Adolescence time management disposition scale (ATMD)

Chinese scholars Huang and Zhang (2001) [42] compiled the Adolescence Time Management Disposition Scale (ATMD) according to the domestic situation in China based on foreign research literature. The scale consists of three dimensions: sense of time value (e.g., "I think the phrase 'an ounce of time is worth an ounce of gold' is true"), time monitoring (e.g., "I usually organize my daily activities into a schedule"), and time effectiveness (e.g., "The phrase 'time is money' is true"). It consists of a total of 44 items, assessed using a five-point Likert scale ranging from 1 (hardly at all) to 5 (always). Total scores were calculated by summing all items, with higher total scores indicating better time management skills. The scale exhibited a commendable overall consistency coefficient of.962, indicating strong reliability. Construct validity was supported by confirmatory factor analysis (CFA) in the original study, with fit indices meeting acceptable thresholds (CFI =.93, TLI =.91, RMSEA =.05) [42].

College student mobile phone dependence questionnaire (CSMPDQ)

The study employed the Mobile Phone Dependence Scale for College Students, which was developed by Wang (2013) [43]. This scale includes five dimensions: conflict (e.g., "Mobile phones interfere with my daily life"), salience (e.g., "Mobile phones are more important than clothes and food"), withdrawal (e.g., "I feel uneasy without my cell phone"), persistence (e.g., "I spend more time on my phone than I intend to"), and technology (e.g., "I'd rather lose my wallet than my mobile phone"). It consists of a total of 20 items, assessed using a five-point Likert scale ranging from 1 (hardly at all) to 5 (always). Total scores were derived by summing all items, with higher scores indicating a stronger inclination towards mobile phone dependence. The questionnaire exhibited a commendable overall consistency coefficient of 0.936, indicating acceptable internal consistency. Construct validity was established in the original validation study through exploratory factor analysis (EFA), which confirmed the five-factor structure (cumulative variance explained = 68.4%) [43].

Utrecht work engagement scale-student (UWES-S)

In this study, the utilization of the Utrecht Work Engagement Scale-student (UWES-S) developed by Liao (2011) was implemented [44]. This scale comprises three distinct dimensions: behavioral input (e.g., "The usual holiday will not relax study"), cognitive input (e.g., "Spare time will not relax study"), and emotional input (e.g., "After class will be self-review"). It consists of a total of 20 items, assessed using a five-point Likert scale ranging from 1 (not at all) to 5 (completely). Total scores were calculated by summing all items, with higher scores on this scale indicate higher levels of study engagement. The scale demonstrated a high internal consistency, with an alpha coefficient of 0.916, indicating favorable structural validity.

Self- control scale(SCS)

Tan and Guo (2008) [45] revised Tangney's (2004) [46] Self-Control Scale based on the reality of Chinese college students. The scale includes five dimensions: impulse control (e.g., "I can resist temptation well"), healthy habits (e.g., "It is difficult for me to break bad habits"), resisting temptation (e.g., "I can delay gratification"), focusing on work (e.g., "I am lazyv), and entertainment moderation (e.g., "I can control my leisure activities"). It consists of 19 items, assessed using a five-point Likert scale ranging from 1 (not at all) to 5 (completely). Total scores were obtained by summing all items, with higher scores, greater self-control was indicated, as measured by a five-point Likert scale. The internal consistency reliability of the SCS was.941, indicating strong reliability.

Statistical analysis

Analyses were conducted using total scores of all scales. SPSS 22.0 was used to perform descriptive statistics and correlation analysis. To test the hypothesized mediation effects, we employed Hayes' PROCESS macro program (Models 4 and 6) to conduct mediation analysis. Simultaneously, this study employed the Bootstrap method to examine the mediation effect. A total of 5,000 Bootstrap samples were selected to investigate the effects of self-control and mobile phone dependence on time management and study engagement, within a 95% confidence interval. To assess the potential for common method bias, Harman's single-factor test was conducted. This test examines whether a single factor accounts for the majority of the covariance among the variables, which would indicate the presence of common method bias.

Results

Common method bias test

Harman's single-factor test was used to determine whether the dataset under examination had a common method bias in order to validate the precision of the statistical analysis. A total of 18 common factors exhibiting eigenvalues exceeding 1 were identified, with the unrotated first factor explaining 25.32% of the variance, falling short of the recommended threshold of 40%. Consequently, it can be deduced that the outcomes derived from the survey instrument are not substantially influenced by common method bias.

Descriptive statistics and correlation analysis of the research variables

The mean scores on time management, self-control, mobile phone dependence, and study engagement were 3.760 ± 0.697, 3.698 ± 0.796, 3.000 ± 0.939, and 3.508 ± 0.763, respectively. Table 1 displays the relationships between each variable. Pearson correlation analysis showed that time management was positively correlated with self-control ($r = .481$, $p < .01$) and study engagement ($r = .365$, $p < .01$), and negatively correlated with mobile phone dependence ($r = -.462$, $p < .01$). These correlations provide preliminary support for the hypothesized mediation pathways.

Analysis of the mediating effect

The mediation effects were tested using the process v4.1 macro program model 6 developed by Hayes et al.(2013) [47]. Self-control and mobile phone dependence were used as mediating variables, time management as the independent variable, and study engagement as the dependent variable. The mediating effects of self-control and mobile phone dependence between time management and study engagement were explored. The analysis results are shown in Table 2. In Model 1, the independent variable time management has a significant positive effect on the dependent variable study engagement ($\beta = 0.365$, $t = 12.474$, $p < .001$), indicating that the total effect of time management on the impact of study engagement is

Table 1 The main variables and their correlation analysis

	M	SD	Time management	Self-control	Mobile phone dependence	Study engagement
Time management	3.760	0.697	1			
Self-control	3.698	0.796	0.481**	1		
Mobile phone dependence	3.000	0.939	−0.462**	−0.385**	1	
Study engagement	3.508	0.763	0.365**	0.367**	−0.350**	1

N = 1016; M, mean; SD standard deviation

**$p < .01$

Table 2 Tests of the mediation model for each variable

	Model 1		Model 2		Model 3		Model 4	
	Study engagement		Self-control		Mobile phone dependence		Study engagement	
	β	t	β	t	β	t	β	t
Time management	0.365	12.474***	0.481	17.453***	−0.360	-11.602***	0.177	5.222***
Self-control					−0.212	-6.835***	0.209	6.407***
Mobile phone dependence							−0.188	-5.815***
R	0.365		0.481		0.499		0.455	
R^2	0.133		0.231		0.249		0.207	
F	155.594***		304.594***		167.457***		88.169***	

****P<.001*

Table 3 Tests of the mediation model for each variable

Benefit type		Effect	BootSE	BootLLCI	BootULCI	Proportion of relative effect
Total effect		0.399	0.040	0.314	0.473	/
Direct effect		0.194	0.045	0.102	0.280	48.63%
Indirect effect	TOTAL	0.205	0.027	0.153	0.260	51.37%
	Ind1	0.110	0.024	0.066	0.158	27.56%
	Ind2	0.074	0.017	0.043	0.109	18.54%
	Ind3	0.021	0.005	0.012	0.032	5.26%
	(C1)	0.036	0.032	−0.027	0.099	/
	(C2)	0.089	0.024	0.045	0.139	/
	(C3)	0.053	0.015	0.028	0.084	/

Ind1: Time management→Self-control→Study engagement

Ind2: Time management→Mobile phone dependence→Study engagement

Ind3: Time management→Self-control→Mobile phone dependence→Study engagement

(C1): Ind1-Ind2

(C2): Ind1-Ind3

(C3): Ind2-Ind3

significant. Model 2 independent variable time management (β = 0.481, t = 17.453, p <.001) has a significant positive effect on the mediating variable self-control. Model 3: Time management (β = −0.360, t = -11.602, p <.001), self-control (β = −0.212, t = -6.835, p <.001) has a significant negative effect on the mediator variable mobile phone dependence, indicating that the first half of the two mediating paths are significant. Model 4: Time management (β = 0.177, t = 5.222, p <.001), self-control (β = 0.209, t = 6.407, p <.001) have a significant positive effect on the dependent variable study engagement, and mobile phone dependence (β = −0.188, t = -5.815, p <.001) have a significant negative effect on the dependent variable study engagement, indicating that the mediator's direct effect was significant and the two second half paths were significant. The mediating effect exists, and self-control and mobile phone dependence partially mediate the relationship between time management and study engagement.

The mediating roles of self-control and mobile phone dependence between time management and study engagement were tested using the bootstrap method, and the results are shown in Table 3; Fig. 1 below. The analysis revealed both direct and indirect effects of time management on study engagement. The direct effect of time management on study engagement was significant (β = 0.194, 95% CI [0.102, 0.280]), indicating that time management has a substantial direct impact on study engagement, independent of the mediating variables. The first indirect path through "self-control" was significant (β = 0.110, 95% CI [0.066, 0.158]), indicating that time management enhances study engagement by improving self-control. The second indirect path through "mobile phone dependence" was also significant (β = 0.074, 95% CI [0.043, 0.109]), suggesting that time management reduces mobile phone dependence, which in turn increases study engagement. The third indirect path through the "chain mediation of self-control and mobile phone dependence" was significant (β = 0.021, 95% CI [0.012, 0.032]), indicating that time management improves self-control, which reduces mobile phone dependence, ultimately leading to higher study engagement. The total effect of time management on study engagement was significant (β = 0.399, 95% CI [0.314, 0.473]), with the indirect effects accounting for 51.37% of the total effect. These results suggest that self-control and mobile phone dependence partially mediate the relationship between time management and study engagement.

The results of this study show that time management predicts study engagement indirectly through

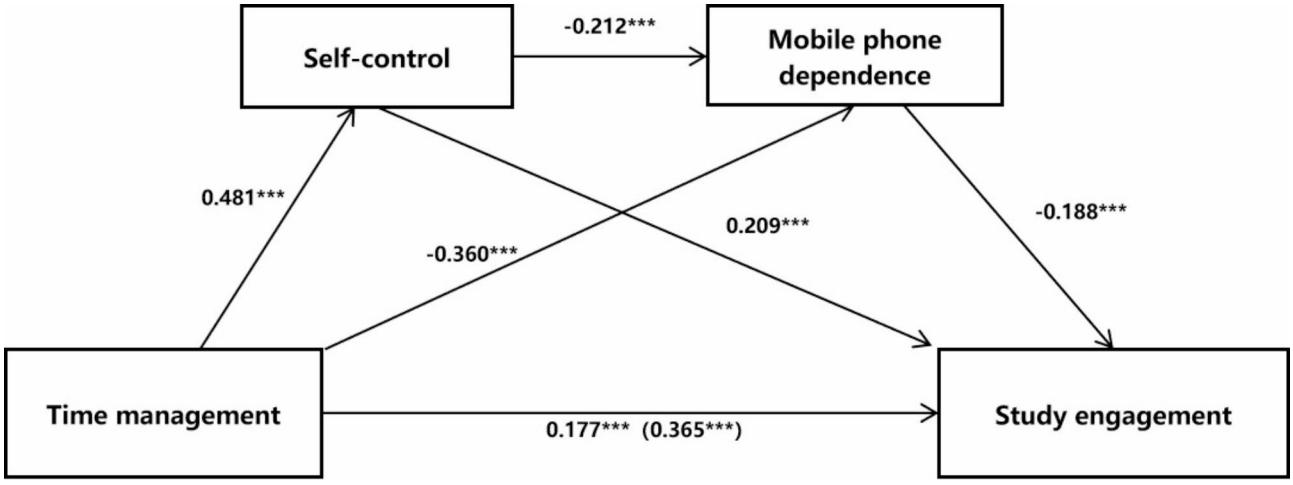

Fig. 1 The chain mediating effects of self-control and mobile phone dependence. *** $P<.001$

self-efficacy and mobile phone dependence, as well as a chain mediation pathway.

Discussion

In this study, time management and study engagement among college students were examined, along with possible mediating factors. The results indicate that time management may influence study engagement by way of self-control and mobile phone dependence, offering theoretical backing for enhancing study engagement.

The relationship between time management and study engagement

This study examined 1,016 Chinese college students using a survey to determine the relationship between time management and study engagement. The results indicated that individuals who excel in time management also exhibit higher levels of study engagement, supporting the validity of Hypothesis 1. The direct effect of time management on study engagement (β = 0.194, 95% CI [0.102, 0.280]) is consistent with previous research. For example, Pan et al. (2011) reported a similar effect size (β = 0.21) in their study on time management and learning adaptability among Chinese university students [7]. Similarly, Zhao et al. (2012) found a moderate positive correlation (r = .34) between time management and study engagement, which aligns with our findings [8]. These comparisons suggest that the effect sizes observed in our study are within the range reported in prior research, further validating the robustness of our results. Time management tendency, considered a multidimensional personality trait, comprises cognitive, emotional, and behavioral sub-dimensions. These dimensions not only reflect an individual's attitude towards time but also indicate how effectively they control and utilize time. Students who exhibit a high propensity for time management are able to effectively prioritize tasks, allocate time efficiently, experience a sense of accomplishment, enhance learning efficacy, and proactively address challenges. Conversely, students with a low inclination towards time management struggle to appreciate the importance of time, lack effective planning skills, exhibit weak control over their learning attitudes, and fail to fully engage in their academic pursuits, resulting in subpar academic performance. The research conducted by Zhao et al. (2012) [48] demonstrated that students who possess proficient time management skills are able to appreciate the importance of time, effectively assess and organize their time, and allocate the majority of their time to essential learning activities [8]. This results in enhanced personal investment of time and energy in learning and practice. Enhancing students' time management and planning capabilities facilitates their accurate and complete allocation of time to significant learning tasks, thereby progressively enhancing their study engagement [9]. Additionally, certain elements of Chinese culture may also contribute to the positive correlation observed between time management and study engagement. In Chinese culture, there is a strong emphasis on the adage "an inch of time is an inch of gold, and an inch of gold cannot buy an inch of time," highlighting the invaluable nature of time. This cultural value instills in students the importance of valuing their time and utilizing it effectively for learning and personal development. Furthermore, the collectivist ethos prevalent in Chinese culture encourages students to prioritize collective interests and educational achievements, thereby motivating them to manage their time more efficiently to enhance both learning efficiency and outcomes. These cultural factors may partly explain why Chinese college students with high time management tendencies show higher levels of study engagement.

Based on the findings of this study, several constructive recommendations are proposed to enhance the relationship between college students' time management and

study engagement. These include enhancing time management education, promoting the use of time management tools, reinforcing students' self-monitoring and feedback mechanisms, fostering a positive learning attitude among students, and establishing a collaborative home-school partnership. By implementing these strategies, colleges and universities can improve students' time management skills and subsequently elevate their level of study engagement.

The mediating effect of self-control

The findings of this research indicate that time management has a significant impact on study engagement, mediated by self-control. The indirect effect of time management on study engagement through self-control (β = 0.110, 95% CI [0.066, 0.158]) is comparable to previous studies. Mercer et al. (2011) found a positive correlation (r = .32) between self-control and study engagement, which is consistent with our findings [19]. Individuals with higher levels of time management tendencies demonstrate a belief in their ability to effectively manage their time, allocate tasks appropriately, and exhibit greater self-control [16].

Self-control has been found to be a significant predictor of study engagement, as evidenced by the positive correlation between levels of self-control and study engagement [34]. This phenomenon can be elucidated through the lenses of volitional control theory and self-regulated learning theory. According to the volitional control theory, successful learning requires not only internal motivation to drive individuals towards their goals, but also the presence of strong willpower to sustain their efforts until the desired outcome is achieved [49]. According to Simons et al. (2004) [50], setting valuable goals can enhance individuals' sense of control and discipline, leading to improved self-control behaviors towards achieving their ultimate objectives as suggested by Miller and Brickman (2004) [51]. Additionally, the self-regulation learning theory underscores the proactive nature of individuals in regulating their behaviors and perceptions to effectively attain their learning objectives. Self-control, a key component of self-regulation, necessitates students to utilize their willpower to manage their actions, sustain focus during learning tasks, and enhance their engagement amidst learning challenges. Consequently, individuals with robust self-control tend to exhibit high levels of mental toughness, enabling them to mitigate the influence of adverse factors on goal attainment and enhance their engagement in learning activities [52].

To enhance students' study engagement and time management skills, it is imperative for educators to focus on fostering students' self-regulation capabilities. Initially, educators can facilitate students' understanding of the significance of self-control through thoughtfully designed curricula and instructional activities, guiding them in acquiring strategies to enhance self-regulation. Furthermore, educators can implement targeted training programs that incorporate practical exercises aimed at strengthening students' self-control. Additionally, the establishment of positive feedback mechanisms can serve as an encouragement for students to further develop their self-regulatory skills.

The mediating effect of mobile phone dependence

This study demonstrates that mobile phone dependence serves as an indirect mediator in the relationship between time management and study engagement among college students, providing support for Hypothesis 3. The indirect effect of time management on study engagement through mobile phone dependence (β = 0.074, 95% CI [0.043, 0.109]) is consistent with prior research. For example, Li et al. (2019) reported a similar indirect effect size (β = 0.08) in their study on mobile phone dependence and academic burnout [32]. Additionally, Huang et al. (2019) found a negative correlation (r = –.31) between mobile phone dependence and study engagement, which aligns with our findings [33]. These comparisons suggest that the mediating role of mobile phone dependence is consistent across studies, further validating our results.

Existing research on Internet addiction indicates that effective time management strategies are important to solve the problem of Internet use. Furthermore, time management tendencies, considered as a dimension of personality traits, are significantly associated with addictive behaviors. Effective time management involves reducing reliance on mobile phones by enhancing self-control, minimizing impulsive phone use, and bolstering self-efficacy. Time management plays an important role in enabling individuals to regulate their behavior and decision-making processes, thereby diminishing their reliance on mobile phones. Additionally, effective time management aids individuals in managing their attention and curbing impulsive mobile phones usage. Moreover, the practice of time management empowers individuals to take charge of their personal and professional responsibilities, fostering a heightened sense of self-efficacy. By successfully managing their time and accomplishing tasks, individuals may experience increased confidence and self-esteem, ultimately reducing their dependence on mobile phones.

The theory of media dependence posits that increased reliance on a medium, such as a mobile phone, leads to a greater influence of the medium on the individual [53]. Higher levels of mobile phone dependence are associated with more pronounced negative effects on the individual, particularly in the context of college students' study engagement. Research has demonstrated that mobile phone dependence is a significant predictor of decreased

study time and effort, aligning with the findings of this study [54]. Excessive reliance on mobile phones among college students can impede study time, disrupt normal work and rest routines, diminish sleep quality [55], deplete energy needed for study engagement, and ultimately decrease overall study engagement. Additionally, mobile phone dependence is associated with heightened risk of negative emotions like depression and anxiety [56], which can further contribute to decreased attention and reduced learning efficacy [57]. Based on the above, mobile phone dependence has a negative impact on individuals' cognition, emotions, and daily learning behaviors, which in turn leads to a decrease in the level of individuals' engagement in learning.

Considering the significant detrimental impact of mobile phone dependency on study engagement, the following recommendations are proposed: Firstly, educational institutions should recognize the issue of mobile phone dependency and incorporate it into the framework of students' mental health education. Secondly, schools and families should collaborate to offer students a greater variety of non-mobile-based entertainment and learning opportunities. For instance, students are encouraged to engage in sports, social events, reading, and other activities that promote physical and mental well-being to enhance their life experiences and interpersonal communication skills, while simultaneously reducing reliance on mobile devices. Furthermore, the development and implementation of time management and mobile usage monitoring tools are effective strategies. Lastly, students exhibiting symptoms of mobile phone dependence should seek professional psychological counseling promptly. Through psychological counseling and behavioral therapy, help students identify and change bad mobile phone use habits, improve self-control ability, so as to restore healthy learning and life status.

The chain mediating effects of self-control and mobile phone dependence

Self-control and mobile phone dependence mediated the chain between time management and study engagement in college students, which tested Hypothesis 4.

Both time management and self-control have a significant impact on teenagers' academic performance. Within the framework of the three-dimensional structure of time management tendency, the dimension of time monitoring, which encompasses activities such as scheduling, goal setting, and time allocation [42], serves as a tangible representation of an individual's self-control capacity in managing time effectively. Numerous studies have confirmed a significant positive relationship between self-control and time management, with findings suggesting that individuals with low self-control tend to exhibit poor time management tendencies as a result of challenges in regulating and restraining their own psychological and behavioral impulses, ultimately leading to decreased investment in learning. This relationship has been supported by previous research [57].

Self-control, as posited by Billieux et al. (2007), is a crucial individual factor impacting mobile phone dependence [58]. This phenomenon can be elucidated through the dual-systems theoretical model and the use-satisfaction theory. The dual-systems theoretical model posits that individuals with higher levels of self-control possess a reflexive system that is sufficiently robust to regulate impulsive behaviors, thereby enabling them to manage their urges to use mobile phones and mitigate problematic usage patterns [59]. Parker and Plank's (2000) use-satisfaction theory suggests that the interactive and convenient nature of mobile phones fulfills an individual's social needs, with lower levels of self-control correlating with increased difficulty in suppressing the impulse to use mobile phones and a heightened likelihood of developing dependence on them [60]. Empirical research has further indicated that an individual's self-control capacity, defined as the ability to resist immediate temptations, suppress inappropriate impulses and behaviors through logical reasoning, and attain objectives in the absence of external limitations, serves as a detrimental predictor of mobile phone dependence [61]. Research has established a correlation between mobile phone dependency and study engagement, particularly among college students. Studies have indicated that the extent of mobile phone dependency among college students is inversely related to their level of study engagement [62]. The abundance of content available on mobile phones serves as an external source of distraction for college students, potentially undermining their academic focus. Failure to effectively manage the balance between mobile phone usage and academic responsibilities may predispose individuals to diminished study engagement.

To tackle this issue, educators and parents may implement a range of strategies aimed at enhancing college students' self-control and time management abilities. Initially, students' time management competencies can be developed through instruction in techniques such as creating study schedules, establishing both short-term and long-term objectives, and prioritizing tasks effectively. Secondly, fostering self-control among students can be facilitated through the establishment of rules and boundaries, the regulation of time spent on mobile devices and the Internet, and the promotion of engagement in sports and social activities. Furthermore, collaboration between educational institutions and families is essential in creating a supportive environment for adolescents, enabling them to receive appropriate guidance and assistance when confronted with temptations and impulses. By employing these strategies, college students

can enhance their ability to manage time and behavior, thereby improving their study engagement.

Limitations

While the study successfully validated its hypotheses, it is important to acknowledge the limitations inherent in its research design. Firstly, while the model validated in this study is grounded in existing research and theoretical frameworks, the use of a questionnaire-based, cross-sectional research design precludes the establishment of definitive causal relationships. Future research could employ longitudinal methodologies to explore the impact of time management on study engagement more thoroughly. Secondly, due to constraints related to time and other objective conditions, this study was limited to a sample of representative undergraduate universities within Shandong Province. Consequently, the sampling scope may not be sufficiently extensive and primarily reflects the local context. The conclusions drawn from this study are not entirely generalizable to other contexts, necessitating the expansion of subsequent research to encompass a broader scope. Furthermore, this investigation focuses on college students to examine the relationship and mechanisms between time management and study engagement. However, additional research is required to ascertain the applicability of these findings to middle and high school students. Lastly, the study controlled for a limited number of extraneous variables, which may have compromised its external validity. Therefore, relevant background factors should be considered in future studies, so as to clarify the relationship between time management and study engagement more clearly.

Conclusion

The findings of the study suggest that time management plays an important role in predicting college students' level of study engagement. Additionally, the results indicate that self-control and mobile phone dependence act as significant mediators in the relationship between time management and study engagement. This study provides further evidence supporting the importance of time management in improving self-control and study engagement, while also decreasing reliance on mobile phones. The findings of this research have the potential to enhance college students' comprehension of the significance of time management, foster awareness of the importance of bolstering self-discipline and diminishing reliance on mobile phones, and ultimately facilitate heightened engagement in study engagement. Consequently, institutions of higher education should implement strategies aimed at enhancing college students' time management skills and self-regulation, reducing their reliance on mobile devices, and thereby fostering increased study engagement and enhancing learning outcomes.

Abbreviations

ATMD	Adolescence time management disposition scale
CSMPDQ	College student mobile phone dependence questionnaire
SCS	Self-control scale
UWES-S	Utrecht work engagement scale-student

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Author contributions

Y.F.: Data analysis and manuscript revision. Q.W.: Data acquisition, drafting and manuscript revision. X.W.: Drafted the manuscript. H.Z.: Drafted the manuscript. J.C.: Drafted the manuscript. H.F.: Data acquisition. Y.Y.: Data acquisition. Y.X.: Data acquisition. W.L.: Design and manuscript revision. N.L.: Study conception, design and manuscript revision. The authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

All participants were provided full information on the study, and provided their informed consent to participate. The research protocol (Code: JNMC-YX-2024-057) obtained approval from the Ethics Committee of Jining Medical University. The study was performed following the standards for medical research involving human subjects recommended by the Declaration of Helsinki for human research.

Consent for publication

No applicable.

Competing interests

The authors declare no competing interests.

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