

## **An Empirical Study on the Influence of Social Media Overload on Learning Engagement**

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**Abstract:** Excessive social media use leading to slow engagement and poor academic performance outlines the urgency in exploring the influence mechanism of social media overload on college students' learning engagement. This study uses a set of 601 samples from undergraduate students from 26 Chinese public colleges and universities. Results show that: (1) Social overload, communication overload, and system feature overload significantly positively impacted ego depletion; (2) Social overload and system feature overload significantly impacted learning engagement; (3) Ego depletion significantly negatively impacted learning engagement, and partially mediated between social media overload and learning engagement. Results herein theoretically expand the ego depletion theory's research scope in information communication technology and enriches research on the influencing factors of learning engagement. Results also provide empirical evidence for the application and management of social media among college students and provide relevant reference value for university administrators and service providers.

**Keywords:** Social media overload, Learning engagement, Ego depletion, Undergraduate students, Structural Equation Modeling (SEM)

## 1. Introduction

Today's college students are "digital natives" who have grown up in the information age and are among the most dominant and active social media users (Zhao et al., 2021). Students now use social media more frequently, making it difficult to draw a line between studies and personal life, and can quickly impact learning engagement (Ding, 2020; Ren & Chen, 2020). Overuse of social media highly likely affects the efficiency and quality of learning engagement, further affecting academic performance. According to the *China Internet Development Report 2022*, 61.2% of social media users are on social media platforms for more than 2 hours daily. As many as 22.8% of users even use social media for more than 6 hours, indicating how widespread excessive social media use is. Social media overuse, also known as social media overload (SMO), can significantly impact an individual's psychology and behaviour (Gissubel et al., 2018; Kalogiannidis et al., 2022). Studies on the impact of social media overuse on learning have shown a significant upward trend in recent years, but are yet to reach any consistent conclusions. Certain influencing factors' mechanisms of action (e.g., learning engagement) may even remain unclear. Learning engagement mainly examines the time, emotional experience, and the cognitive strategy of students' learning engagement in activities, which is an important indicator that affects academic performance. Most scholars also agree that high-quality learning engagement guarantees good academic performance.

An individual's behaviour is affected by both emotion and cognition, and frequent emotion regulation and cognitive processing can lead to ego depletion. Work engagement is characterized by high levels of self-engagement and positive work feelings, which rely more on self-controlled mental resources than on passive work with less energy and attention (Liu, 2022). Individuals with ego depletion lack sufficient psychological resources for self-control to fully mobilize their attention and focus on work, which makes it uncondusive in maintaining good work engagement. Ego depletion has also been shown to be uncondusive to the individual's dedication to work and study, which shows the negative result of low commitment. Many studies have also found the egregious effect of ego depletion, although its occurrence seems to depend on certain conditions (Kühl & Bertrams, 2019). Therefore, following results from studies on social media overload and work engagement in the context of social media, we introduce the mediating variable of ego depletion, thus helping reveal the cognitive mechanism and individual differences of insufficient learning engagement caused by social media overload.

Ego depletion theory is also used widely in studying work stress in organizational management (Cui et al., 2021; Liu, 2022). However, only few studies have used it to explain the relationship between college students users' use of social media and learning engagement, thus presenting a research gap. Moreover, social media, as an educational tool in a broad sense, participation in teaching activities has a positive impact on learning outcomes (Aziz, 2023; Kalogiannidis et al., 2022). These may, in turn and in some cases, affect the time and quality of learning investment, thus either directly or indirectly contributing to poor academic performance (Kühl & Bertrams, 2019). Hence, different scholars have offered different insights into understanding the potential negative impact of the overuse of social media on students. Few scholars have conducted theoretical-based empirical studies on the psychological and behavioural interrelationships caused by social media overload from the perspective of the impact on education (Shi et al., 2020). The lack of research in this field impedes both the high-quality development of higher education and the academic pursuit of college students.

Based on the ego depletion theory, this study takes undergraduate students as the research participants and uses questionnaire survey and structural equation modeling (SEM) to discuss how social media overload affects college students' learning engagement. The study's objectives are twofold: (1) Reveal the direct and indirect impact relationship of social media overload on college students' learning engagement; (2) Verify the mediating effect of ego depletion on social media overload and college students' learning engagement.

The remainder of the study is as follows. Section 2 reviews the development of literature and hypotheses. Methods will be presented in Section 3, while research findings will be presented in Section 4. Section 5 will present the discussion and management implications, followed by the study's conclusions in Section 6.

## **2. Literature Review and Hypothesis Development**

### **2.1. Ego depletion theory**

The ego depletion theory holds that an individual's self-control activities require the consumption of limited mental resources, and its success (or failure) depends on the number of mental resources available (Baumeister et al., 1998). Self-control in previous tasks can also affect subsequent tasks, resulting to the failure in self-control otherwise known as the ego depletion effect. After consuming self-control resources, they can return to their original levels through adequate rest or sleep. The ego depletion effect reduces an individual's control over their attention span and is universal to daily social life over extended periods of time (Lee et al., 2016). For example, there are different types of temptation scenarios and stimuli in the workplace, which can easily cause employees to fall into a state of ego depletion, thus affecting individual work performance. In a state of ego depletion, the individual's desire and ability for self-control are significantly reduced, thereby adversely affecting their work behaviour (Cui et al., 2021), making them devote less effort towards the next task. Similarly, during the same ego depletion context, students with higher exam pressure have more robust ego depletion aftereffects which result in a long-term state of insufficient psychological resources. Many studies on social media overload lack a solid theoretical basis, and the ego depletion theory is promising in providing a robust theoretical method for this study. Said theory helps in further deeply understand the impact mechanism of social media overload on learning engagement, and expands the application scope of ego depletion theory.

### **2.2. Research on social media overload, ego depletion, and learning engagement**

College students rely too much on social media, which can easily lead to social media overload. As a result of the Chinese government blocking some mainstream international social media, local social media platforms have subsequently sprung up and flourished. Currently, mainstream social media include sites such as WeChat, QQ, Weibo, Bilibili, TikTok, Kwai, Zhihu, Douban, and Xiaohongshu, with WeChat and TikTok being typical representatives. Social media is also currently not only a communication tool, it has also become a complete ecological environment for obtaining news, learning, and shopping. Teachers and students in Chinese colleges, regardless of their affairs being public or personal in nature, frequently use social media to communicate. Previous studies have shown that social media overload has different dimensions, including social overload (Maier et al., 2015), information overload (Zhang et al., 2016), communication overload (Karr-Wisniewski & Lu, 2010), and system feature overload (Karr-Wisniewski & Lu, 2010; Lee et al., 2016). Communication and information overload have also been found to increase an individual's social network fatigue, leading to intermittent dropout behaviour. Information overload can also cause individual fatigue and dissatisfaction, both of which reduce users' willingness to continue using (Maier et al., 2015). As a result, social media overload can lead to student ego depletion, in turn affecting learning engagement and learning outcomes.

Ego depletion is the state of self-control depletion where an individual completes a series of self-control behaviours and activities that cause self-control resources to be depleted (Hagger et al., 2010). Some studies believe that self-control tasks reduce glucose levels, and that resource depletion is related to the decline in glucose supply, thereby affecting working memory tasks performance. Gissubel et al. (2018) found that participants in the attrition state performed worse on subsequent tasks in a meta-analysis of 48 meta-analyses on ego depletion in college students. Learning engagement is a positive, fulfilling, learning-related state of mind in which students engage, with Vigor, Dedication, and Absorption being the three core dimensions (Schaufeli et al., 2002). The use of social media not only affects the personal lives of college students, it also correlates with their academic engagement. A meta-

analysis showed that for some scholars there is only a moderate positive correlation between social media use and learning performance (Ren & Chen, 2020). The appropriate use of social media can facilitate knowledge sharing and learning puzzle solving, helping improve academic performance. However, social media overload can also adversely affect students' learning and life leading to effects such as fatigue, burnout, procrastination, and lack of interest in learning. Some scholars have also found that multitasking on social media correlates inversely with academic performance (Ren & Chen, 2020). Therefore, the relationship between social media overload, learning engagement, and ego depletion still needs further exploration.

## **2.3. Hypothesis and Research Models**

### **2.3.1. Social media overload and ego depletion**

Social media overload compresses sleep time, the lack of which can affect the repair of individual ego depletion. Individuals are then simultaneously affected by emotions when making behavioural decisions, and emotional regulation can lead to the occurrence of ego depletion (Inzlicht & Schmeichel, 2012). Both cognitive regulation and attention concentration significantly deplete the mental resources of the individual for self-control, causing the individual to quickly enter a state of ego depletion (Baumeister et al., 1998). In this state of negative emotions, individuals consume a lot of self-control psychological resources to regulate negative emotions which may weaken the ability to self-control and enter a state of ego depletion (Hagger et al., 2010). Following extant studies, the following hypothesis is therefore proposed:

**H1:** Social overload of undergraduate students significantly positively impacts ego depletion.

Cognitive load may occur when the cognitive resources individuals require to process social media information content exceed the range of the total cognitive resources that individuals can effectively process. Many psychological resources must then be consumed for self-regulation, resulting in ego depletion (Giunchiglia et al., 2018). The higher the degree of stress an individual perceives during information processing, the higher the degree of ego depletion (Xia et al., 2020). Heavy study pressure and daily information processing pressure can also bring negative emotions to individuals. Consuming self-control resources for emotional regulation is necessary, therein easily leading to ego depletion (Cui et al., 2021). Therefore, another hypothesis is forwarded herein:

**H2:** Information overload of undergraduate students significantly positively impacts ego depletion.

In the alternating process of social media use and learning activities, media communication frequently interrupts the ongoing learning of college students which may increase self-control and cause ego depletion (Cao & Sun, 2018). The contradiction between social media overload and completing learning tasks causes college students to frequently engage in the self-control of psychological resources, thus making them likely feel exhausted (Lee et al., 2016). Additionally, due to the requirements of learning tasks, most students still have to complete them on time despite the merely short amount of time given to them. This makes it necessary for them to control limited psychological resources, resulting in ego depletion (Baumeister et al., 1998). The study's third hypothesis is thus forwarded as:

**H3:** Communication overload of undergraduate students significantly positively impacts ego depletion.

Users often encounter system feature updates and modifications when using social media. However, having too many complex functions can lead to user fatigue and dissatisfaction (Zhang et al., 2016). Users may also get frustrated and bored when new features added to a package reach a certain point; by then, the marginal utility of new features begins to be negative (Hsi & Potts, 2000). When the constantly updated system features exceeds the scope of the individual's ability to manage and use them effectively, it overloads the system features to the user, which in turn causes ego depletion (Zhang et al., 2016). Hence, the study's fourth hypothesis is as follows:

**H4:** System feature overload of undergraduate students significantly positively impacts ego depletion.

### 2.3.2. Social media overload and learning engagement

Students use social media while learning and alternating multitasking between the two can quickly drain personal control energy (Giunchiglia et al., 2018). Individuals must frequently provide various social supports to their social media friends, and these social supports can bring heavy learning burdens and pressure to individuals (Maier et al., 2015). Because of the social norm of reciprocity, students often constantly check electronic devices such as mobile phones and computers to better keep in touch with friends on social media and ensure that they do not miss messages from friends and respond as soon as possible. It is difficult to guarantee the time invested in learning (LaRose et al., 2014). Some studies have shown that individuals achieve weak connections in social relationships through social overload, acquire personalized knowledge, increase social capital, and significantly positively impact work engagement (Liu, 2022). This leads to the study's fifth hypothesis:

**H5:** Social overload of undergraduate students significantly impacts learning engagement.

Social media is flooded with excessive, repetitive, disparate information from diverse sources that are likely to cause information overload. When the amount of information exceeds a person's cognitive ability, this often leads to the inability of individuals to process the information (Ding, 2020). This information overload also inhibits the positive relationship between academic participation and knowledge acquisition, thereby negatively impacting learning outcomes (Feroz et al., 2021). Information overload can cause individuals wishing to retrieve knowledge over the Internet to have a more negative attitude toward access to knowledge. Moreover, both the timing and frequency of social media users significantly impact students' learning engagement and academic performance (Giunchiglia et al., 2018). However, Liu (2022) showed that information overload positively impacts work engagement. Therefore, another hypothesis is put forward:

**H6:** Information overload of undergraduate students significantly impacts learning engagement.

The blurring effect of social media has made it difficult for students to draw the line between studying and other personal tasks. Too much communication is done through social media, which makes it more challenging to complete learning tasks (Ren & Chen, 2020). Out of their fear of missing out, college students join various social media groups, endure getting bombarded with information, and reluctantly carry out communication behaviour. When students are working on an activity, frequent distractions from the community can distract them from simultaneously multithreading tasks (Brooks & Califf, 2017). To maintain relationships with online friends, students are also forced to participate in too many online communication activities, which can quickly produce communication overload and affect learning engagement (Lee et al., 2016). Therefore, the following hypothesis is forwarded as well:

**H7:** Communication overload of undergraduate students significantly impacts their learning engagement.

Social media is one of the important ways for college students to communicate, and has since become part of their daily studies and lives from their adolescent years (Zhao et al., 2021). Some teacher-student and peer interactions are realized through online course platforms, especially after the COVID-19 pandemic, which seemed to normalize online and offline hybrid teaching. Moreover, system feature updates or complexity that exceed the user's acceptable level of operation can also overload the system functionality (Karr-Wisniewski & Lu, 2010). College students often spend much time familiarizing themselves with new features, which can lead to dissatisfaction with the perceived usefulness and ease of use of social media platforms (Zhang et al., 2016). The burden of overloading system features causes users to experience burnout, ultimately affecting the current progress of learning tasks. Therefore, this study proposes its eighth hypothesis:

**H8:** System feature overload of undergraduate students significantly impacts learning engagement.

### 2.3.3. Ego depletion and learning engagement

Individuals with ego depletion lack sufficient psychological resources to fully mobilize attention to focus on work, which is not conducive to maintaining good work engagement. The higher the degree of ego depletion, the lower the level of work engagement (Lanaj et al., 2014). In a digital media

environment, students can significantly impact academic engagement and intellectual performance by controlling their ego depletion (Vanco & Christensen, 2016). An experimental study of more than 1,000 American college students found that students who were self-depleted and then engaged in controlled writing showed higher error rates and difficulty concentrating (Garrison et al., 2018). Therefore, the research proposes another hypothesis:

**H9:** Ego depletion of undergraduate students has a significantly negative effect on learning engagement.

2.3.4. Ego depletion as a mediator

Social media can be both a tool to promote learning performance and a factor contributing to insufficient learning engagement. Social media overload negatively affects students’ cognition and behaviour, and ego depletion likely plays a mediating role (Zhang et al., 2016). The results of Vanco and Christensen (2016) suggest that an individual’s higher level of media enjoyment in an educational environment significantly predicts their academic performance, wherein ego depletion plays a mediating role. When college students overuse social media, it exceeds their processing capacity, thus resulting in ego depletion and affecting subsequent learning activities (Shi et al., 2020). This therefore leads to the study’s tenth and final hypothesis:

**H10:** Ego depletion of undergraduate students plays a mediating role between social media overload and learning engagement

2.3.5. Research framework

Based on the above theoretical research, this study suggests that using social media beyond the optimal level for college students can lead to social media overload. Essentially, overloads such as social overload, information overload, communication overload, and system feature overload represent that the social support, information volume, and system functions exceed the individual’s capabilities, which increase the work requirements of its responsibilities and consume additional time and resources (Schaufeli et al., 2002). The more effort individuals exert to cope with social media overload, the more resources they also have to consume. If resources cannot be restored in a timely and effective manner, the level of learning engagement is reduced. Hence, this research took the four dimensions of social media overload (social overload, information overload, communication overload, and system feature overload) as its independent variables, learning engagement as the dependent variable, and ego depletion as the mediating variable. The complete research framework is proposed in Figure 1 below.

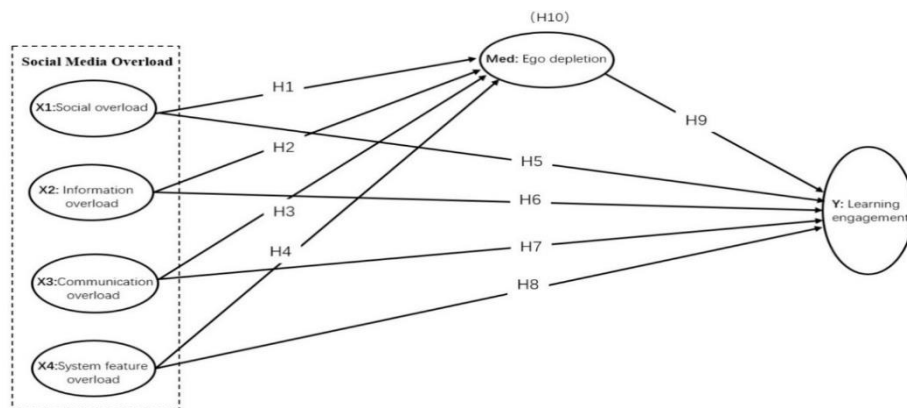


Fig. 1: Research framework

**3. Research Methodology**

**3.1. Population and sampling technique**

The current study took undergraduate students from public colleges and universities in Guangxi Province in mainland China, while the questionnaire and sample data used was extracted from an extensive questionnaire project. According to the statistics of the Ministry of Education and the Guangxi

Department of Education, there are 26 public undergraduate colleges in Guangxi, distributed in most prefecture-level cities in Guangxi, with about 456,015 undergraduate students in total across all institutions. We used relevant scales that are internationally accepted and have been repeatedly verified to form a questionnaire, which was then presented in Chinese. Following the standard back-translation process, we first asked 2 professional English teachers to translate the scale's original English version into Chinese. We then asked two native English university teachers to translate it into English. Several experts involved in the translation completed the revision after numerous discussions on the questionnaire's ambiguities.

### **3.2 Pilot study**

Due to the differences between Chinese and Western cultural backgrounds, some of the questionnaire questions may seem ambiguous for the participants, which made it necessary to conduct a pre-test procedure. The questionnaire had 47 items of observation variables. According to the principle, the pre-test survey's sample size is 3-5 times longer than the questionnaire items, with more than 141 volunteers having the capacity to meet the standards. We conducted a pilot study at two educational institutions: the Youjiang Medical University for Nationalities and the Baise University in Baise City, Guangxi, China. Both colleges are comprehensive universities and medical schools representing undergraduate colleges. 186 valid samples were ultimately obtained by contacting 100 undergraduate students from each college on-site through convenient sampling method and the distribution of online questionnaires.

Data was then ran through SPSS 22 for the scale's item analysis, reliability, and validity analysis. The analysis showed that the reliability of the six scales was from 0.71 to 0.88 which meant that reliability was good, and the factor load of each question was within the normal range of 0.582 to 0.895. Following Church and Waclawski (1998), we reviewed the questionnaire based on clarity, relevance, and specificity. We also modified the presentation of the seven items in the scale, which resulted into the final form of the formal questionnaire.

### **3.3. Sampling and survey process**

The number of formal questionnaires is 5-10 times the sample size and 235-470 samples can meet the requirements. For further accurate sampling, this study referred to Zikmund's (2003) sample calculation formula for social science research and obtained a sample of no less than 384 samples. To ensure the final number of valid samples, considering the questionnaire recovery rate is more than 70% more suitable, this study plans to distribute 800 questionnaires. After allocating samples, this study used quota sampling to investigate students from 26 public undergraduate universities in Guangxi. After the questionnaire was approved by the Institutional Review Board (IRB), the QR code of the online questionnaire was distributed. The participants were encouraged to scan the code to enter the questionnaire page. Those who completed the questionnaire received 3 RMB as incentive.

The study conducted the questionnaire survey in colleges from March 2 to 15, 2023 and originally collected 718 samples, reflecting a recovery rate of 89.75%. Given the inefficiency of this non-face-to-face questionnaire survey, this study took the time spent answering, IP address, respondent's name, reverse question, and demographic information as the screening criteria for the later valid samples and ultimately obtained 601 valid samples.

### **3.4. Instrument**

This paper drew on social overload scales from Guo et al. (2020) and was adjusted according to the research background of this study and has four items. Zhang et al. (2016) developed The Information Overload Scale in four items. Communication overload was measured using the 5-item communication overload scale designed by Lee et al. (2016). The System feature overload Scale was drawn on scales designed by Zhang et al. (2016) with three items. The abovementioned scales were measured using a seven-point Likert scale ranging from 1 (Completely disagree) to 7 (Completely agree). Li et al. (2019)'s ego depletion scale was also adjusted according to the research background of this paper and has five items which were measured using a seven-point Likert scale ranging from 1 (Not at all) to 7 (Always).

The Utrecht Work Engagement Scale measured learning engagement for Students (UWES) (Schaufeli et al., 2002) was also used herein; the scale has been measured many times in China and has relatively good reliability and validity. The learning engagement scale has 17 highly unidimensional items, and should be used as a single dimension in statistical analysis, such as in multiple regression, to avoid multivariate collinearity problems (Schaufeli & Bakker, 2003). The scale was measured using a seven-point Likert ranging from 1 (Not at all) to 7 (Always).

**3.5. Data analysis**

SPSS 22 and AMOS 24 software were used for data analysis work. SPSS mainly did the fundamental data analysis, while AMOS allows for more rigorous structural equation modeling (SEM), can retain the complete information of variables, and can evaluate complex models. First, in SPSS, descriptive statistical analysis and internal consistency reliability analysis of each variable, validity analysis, and correlation analysis between variables were conducted. Second, we tested the fit of latent variables through confirmatory factor analysis (CFA) with maximum likelihood estimation in AMOS. Third, the study used SEM to verify the research model and hypothesis. Finally, we used 5000 subsamples and set a 95% confidence level for the significance of the mediating effect of ego depletion, which mastered the influence path relationships between various variables.

**4. Results**

**4.1 Demographic information**

Statistical information among the 601 participants is shown in Table 1. There were 217 boys (36.1%) and girls (63.9%). 98.3% of students were aged 18-25. The proportions of freshman to fifth-year students were 21.8%, 34.4%, 32.4%, 10.8%, and 0.5%, respectively. Students from science backgrounds and those that were humanities and arts majors comprised 47.9% and 52.1%, respectively. Most students have used social media for over three years (85.7%) and 72.3% had over 100 social media friends. On average, 74.8% of students used more than 120 minutes a day, 31.9% of students used more than 240 minutes, and 17.5% were heavy social media users with more than 360 minutes of daily activity.

Table. 1: Demographic information of participants

Characteristics	Category	Count	Percentage (%)
Gender	Male	217	36.1%
	Female	384	63.9%
Age	<18	5	0.8%
	18-25	591	98.3%
	26-35	5	0.8%
Grade	Freshman	131	21.8%
	Sophomore	207	34.4%
	Junior	195	32.4%
	Senior	65	10.8%
	Fifth	3	0.5%
Major	Science	288	47.9%
	Humanities	313	52.1%
Social media usage history (month)	≤6	8	1.3%
	6-12	11	1.8%
	13-24	24	4.0%
	25-36	43	7.2%
	≥37	515	85.7%
Number of friends on social media	0-100	166	27.6%
	101-200	200	33.3%
	201-300	117	19.5%



	≥301	118	17.3%
Daily usage duration of social media (minutes)	0-60	52	8.6%
	61-90	73	12.1%
	91-120	87	14.5%
	121-180	114	19.0%
	181-240	89	14.8%
	241-300	61	10.1%
	301-360	20	3.3%
	≥361	105	17.5%

Note: N=601.

#### 4.2 Confirmatory factor analysis

The confirmatory factor analysis (CFA) test results of the social media overload measurement model show that:  $\chi^2/df=2.972$ , in the excellent range of 1-3. RMSEA = 0.057, which was in good range of 0.08. GFI=0.939, TLI=0.955, CFI=0.963, which all reached the excellent level of 0.9 or more. Therefore, the CFA model for social media overload has an excellent fit. Additionally, the AVE of social overload=0.540, AVE of information overload=0.611, AVE of communication overload=0.695, AVE of system feature overload=0.455, and values for most dimensions were all greater than 0.5. Moreover, the CR of social media=0.824, CR of information overload=0.862, CR of communication overload=0.919, and the CR of System feature overload=0.713, wherein all dimensions' values were greater than 0.6. The reliability analysis results showed that Cronbach's  $\alpha$  of social overload = 0.822, Cronbach's  $\alpha$  of information overload =0.859, Cronbach's  $\alpha$  of communication overload = 0.918, and Cronbach's  $\alpha$  of system feature overload = 0.719, indicating that the reliability of the four scales were good.

The CFA test results of the ego depletion scale show that  $\chi^2/df= 3.254$ , RMSEA=0.061, GFI=0.994, TLI=0.985, CFI=996, all of which indicate that the model fit was good. AVE=0.597 and CR=0.880 indicate good convergence validity and combinatorial reliability. Cronbach's  $\alpha$  of the ego depletion scale = 0.943 also indicated excellent reliability.

The CFA test results of the learning engagement scale were  $\chi^2/df=4.037$ , RMSEA=0.071, GFI=0.902, TLI=0.932, CFI=943, indicating that the model fit was good, AVE=0.505, CR=0.945, which met the standard. Cronbach's  $\alpha$  of the learning engagement scale = 0.943, thereby indicating excellent reliability.

#### 4.3 Correlation analysis and discriminant validity analysis

Pearson correlation analysis was used and the AVE value was squared to determine the relationship between variables. Table 2 shows that the mean values of all four dimensions of social media are high, and the mean values of ego depletion and learning engagement are relatively low. Most of the variables had significant correlations; specifically, there was a significant positive correlation between the four dimensions of social media overload ( $p < 0.001$ ). There was a significant positive correlation between ego depletion and social media overload ( $p < 0.001$ ) and a significant negative correlation with learning engagement ( $r = -0.274, p < 0.001$ ). There was also a significant positive correlation between learning engagement and social overload ( $r = 0.167, p < 0.001$ ) and information overload ( $r = 0.083, p < 0.05$ ). Learning engagement is not correlated with communication overload and system feature overload, and the influence relationship of various variables must be further tested in structural equation modeling (SEM). In the discriminant validity test, the square root value of AVE in any variables of each variable is greater than the correlation coefficient between the two variables, which meets the criteria for evaluating the validity of the difference and indicated that any two variables have good discrimination validity.

Table 2: Pearson correlation and discriminant validity analysis

	M	SD	SO	IO	CO	FO	ED	LEA
SO	4.732	1.340	0.735					
IO	4.440	1.404	0.434***	0.782				
CO	4.505	1.414	0.354***	0.572***	0.834			
FO	4.805	1.300	0.229***	0.564***	0.528***	0.675		
ED	4.384	1.039	0.145***	0.402***	0.542***	0.422***	0.733	
LEA	4.379	0.909	0.167***	0.083*	-0.010	0.047	-0.274***	0.711

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ , Two-tailed, SO = social overload, IO = information overload, CO = communication overload, FO = system feature overload, ED = ego depletion, LEA = learning engagement. Bolded fonts are AVE root values.

#### 4.4 Common method deviations and normality tests

In questionnaire studies, common method deviations may cause the collected data to be inflated. If the single-way explanatory variation obtained by the last rotation exploratory factor analysis does not exceed 50%, then the common method deviation (CMB) is not severe. The amount of explanation for the first factor in this study is 23.287%, which is much lower than the level of 40% of the common method deviation cut-off proposed by Harman (1976), making it unlikely that the sample data may have a common method bias problem.

We tested each measurement item for normality using skewness and kurtosis. All variables had skewness values between -0.903 and 0.643 and kurtosis values between -1.083 and 1.109— This meant that it met the criteria proposed by Kline (2005) that the absolute value of the univariate skewness coefficient must be within 2, and the absolute value of the kurtosis coefficient within 7. Therefore, the data of each measurement item satisfies the approximately normal distribution, which is suitable for structural equation modeling.

#### 4.5 Structural Equation Modeling path analysis

Confirmatory factor analysis (CFA) results show that the measurement model is acceptable. This paper ran structural equation modeling (SEM) in AMOS to test the goodness-of-fit of the structural model as shown in Table 3.  $\chi^2/df = 2.496$  is at the excellent fitting level ( $0 \leq \chi^2/df \leq 3$ ), the reasonable degree of RMSEA=0.055 is good ( $0 < RMSEA < 0.08$ ). Other indices are above 0.8, of which the IFI, GFI, and TLI indices exceed 0.9 at the good fitting level. Therefore, the structural equation modeling of path analysis of the influencing factors of learning engagement is well adapted. The structural equation modeling is shown in Figure 2.

Table 3: Model fit index

Fit index	$\chi^2/df$	RMSEA	GFI	AGFI	NFI	IFI	CFI	TLI
Proposed value	$\leq 3$	$< 0.08$	$> 0.8$	$> 0.8$	$> 0.8$	$> 0.8$	$> 0.9$	$> 0.9$
Estimated value	2.809	0.055	0.849	0.827	0.872	0.913	0.913	0.906

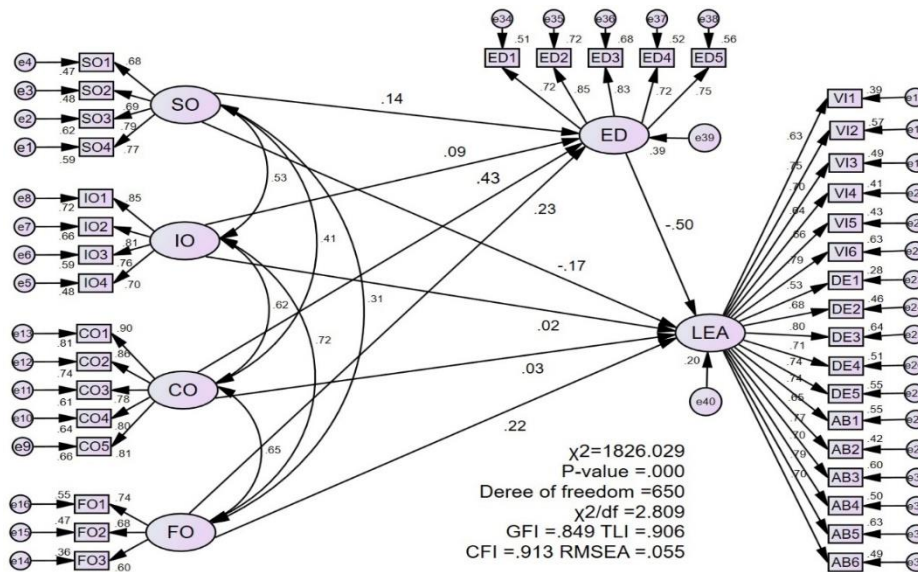


Fig. 2: Result of path coefficients of the final modes

The path’s hypothesis relationship showed the analysis results in Table 4. Social overload significantly and positively impacts ego depletion ( $\beta = 0.136, p < 0.01$ ), Communication overload significantly and positively impacts ego depletion ( $\beta = 0.428, p < 0.001$ ), and System feature overload significantly and positively impacts ego depletion ( $\beta = 0.233, p < 0.01$ ). In contrast, information overload has no regression relationship with ego depletion ( $\beta = 0.090, p > 0.05$ ). So, H1, H3, and H4 are all supported, while H2 is not. Moreover, social overload significantly negatively impacts learning engagement ( $\beta = -0.167, p < 0.01$ ). System feature overload also significantly and positively impacts learning engagement ( $\beta = 0.218, p < 0.01$ ). In contrast, information overload and communication overload have no regression relationship with learning engagement ( $\beta = 0.028, p > 0.05$  and  $\beta = 0.033, p > 0.05$ ), meaning that H5 and H8 are supported, while H6 and H7 are not supported. Also, ego depletion significantly negatively affects learning engagement ( $\beta = -0.503, p < 0.001$ ). Therefore, H9 is supported.

Table. 4: Results of structural model testing

Hypotheses	Path		Estimate	S.E.	C.R.	P	results
H1	SO	→ ED	0.136	0.036	2.619	0.009**	supported
H2	IO	→ ED	0.090	0.051	1.141	0.254	Non-supported
H3	CO	→ ED	0.428	0.037	6.981	***	supported
H4	FO	→ ED	0.233	0.061	2.774	0.006**	supported
H5	SO	→ LEA	-0.167	0.038	-2.912	0.004**	supported
H6	IO	→ LEA	0.028	0.052	0.328	0.743	Non-supported
H7	CO	→ LEA	0.033	0.038	0.487	0.626	Non-supported
H8	FO	→ LEA	0.218	0.063	2.343	0.019*	supported
H9	ED	→ LEA	-0.503	0.061	-7.722	***	supported

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ , SO = social overload, IO = information overload, CO = communication overload, FO = system feature overload, ED = ego depletion, LEA = learning engagement; S.E.= standard error, C.R.= critical ratio.

#### 4.6 Mediation effect test

In the AMOS, we chose the Bootstrap technique, used 5000 subsamples, and numbered each path, including a(a1-a4)\*b and c(c1'-c4'). We examined the mediating role of ego depletion in the influence

of social media overload on learning engagement. We also calculated the total mediating effect of ego depletion on the impact of social media overload on learning engagement and the mediating effect of ego depletion in the impact of social media overload on learning engagement in four dimensions (Social overload, Information overload, Communication overload, and System feature overload). Results are shown in Table 5 below. In the relationship between social media overload and learning engagement, indirect effects of ego depletion ( $\beta = -0.185, p < 0.01$ ), direct effects ( $\beta = 0.294, p < 0.01$ ), and total effects ( $\beta = 0.110, p < 0.05$ ) are significant. Among them, the 95% confidence interval  $[-0.265, -0.125]$  of indirect effects does not contain 0, indicating that the indirect effect is significant. The 95% confidence interval  $[0.022, 0.202]$  of direct effects does not contain 0, indicating that direct effects also be supported. Based on the above results, ego depletion plays a significant partial mediating role in this path, accounting for 38.6% of the effect, so H10 is supported.

Table 5: Bootstrap analysis of mediating effect significance test

Model Path	Parameter	Estimate	BootLLCI (95%)	BootULCI (95%)	P	Proportion of indirect effect
SMO→ED→LEA	indirect effect	-0.185	-0.265	-0.125	0.001**	38.6%
	direct effect	0.294	0.197	0.417	0.001**	
	total effect	0.110	0.022	0.202	0.012*	
SO→ED→LEA	indirect effect	-0.045	-0.006	-0.089	0.025*	29.0%
	direct effect	0.110	0.027	0.187	0.005**	
	total effect	-0.155	-0.069	-0.236	0.001**	
IO→ED→LEA	indirect effect	-0.028	-0.088	0.029	0.308	/
	direct effect	0.017	-0.096	0.117	0.764	
	total effect	-0.011	-0.130	0.111	0.868	
CO→ED→LEA	indirect effect	-0.122	-0.179	-0.079	0.001**	86.5%
	direct effect	0.019	-0.060	0.100	0.633	
	total effect	-0.103	-0.191	-0.022	0.014 *	
FO→ED→LEA	indirect effect	-0.080	-0.156	-0.019	0.014*	34.9%
	direct effect	0.149	0.019	0.285	0.027*	
	total effect	0.069	-0.069	0.216	0.323	

\* $P < 0.05$ , \*\* $P < 0.01$ , SO = social overload, IO = information overload, CO = communication overload, FO = system feature overload, ED = ego depletion, and LEA = learning engagement.

To the analysis of the mediating effect of ego depletion on the four dimensions of social media overload and learning engagement, it showed that the indirect effects ( $\beta = -0.045, p < 0.05$ ), direct effects ( $\beta = 0.110, p < 0.01$ ) and total effect ( $\beta = -0.155, p < 0.01$ ) in the relationship between social overload and learning engagement were significant. The 95% confidence interval did not contain 0, hence ego depletion played a significant part in the mediating effect of the impact of social overload on learning engagement. In the relationship between information overload and learning engagement, indirect effects ( $\beta = -0.028, p > 0.05$ ), direct effects ( $\beta = 0.017, p > 0.05$ ), and total effects ( $\beta = -0.011, p > 0.05$ ) were not significant. The 95% confidence interval contained 0, thus there was no mediating effect in the influence of information overload on learning engagement. In the relationship between communication overload and learning engagement, indirect effects ( $\beta = -0.122, p < 0.01$ ) and total effects ( $\beta = -0.103, p < 0.05$ ) were both significant. The 95% confidence interval did not contain 0, while the direct effect was insignificant ( $\beta = 0.019, p > 0.05$ ). Hence, ego depletion played a full mediating effect in the impact of communication overload on learning engagement. In the relationship between system feature overload and learning engagement, indirect effects ( $\beta = -0.080, p < 0.05$ ) and direct effects ( $\beta = 0.149, p < 0.05$ ) were both significant, but the total effect ( $\beta = 0.069, p > 0.05$ ) was otherwise. The usual reason is that the absolute value of the direct effect (0.149) is greater than the absolute value of the total effect (0.069) due to the opposite signs of direct and indirect effects.

According to MacKinnon (2000), there is a suppression effect, and that ego depletion still has a significant mediating effect.

## **5. Discussion and Implications**

### **5.1 Discussion of the significant results**

Some significant findings have been obtained herein. In terms of social media overload and ego depletion, the study found that social overload significantly positively affects ego depletion, which is consistent with the studies of Inzlicht and Schmeichel (2012), although contrasts the conclusions of Liu (2022). The higher the degree of social overload, the more severe the individual's ego depletion. When an individual's social activities exceed the scope of their ability, it can cause anxiety, restlessness, irritability, and other emotions. The need to consume self-control resources for emotional regulation which results in ego depletion state of communication overload and system feature overload significantly positively affect ego depletion, respectively, which thus coincides with the similar results forwarded by Cao and Sun (2018) and Zhang et al. (2016). All are the same as the results of Liu (2022). The need for a large number of communication and system function update iterations may frequently interrupt the learning tasks at hand of students, this increases the cognitive burden and consuming self-control resources to shift attention from processing overloaded needs to the original learning tasks, resulting in ego depletion. Interestingly, this study's effect of information overload on ego depletion was insignificant, contrasting the findings of Brooks and Califf (2017) and Liu (2022). One reason is that students always search for information and share knowledge through social media, and frequent information acquisition has become the norm, thus resulting in information overload and ego depletion is not significant.

In terms of social media overload and learning engagement, social overload significantly and negatively impacts learning engagement, indicating that excessive social activities affect the time and quality of learning engagement, thus coinciding with the results of Maier et al. (2015). Unlike the findings of Liu (2022), system feature overload significantly positively affects work engagement, indicating that the system function of social media may satisfy students' curiosity. Especially because some social media have added many teaching functions during the COVID-19 pandemic, social media has since become convenient for teachers and students in communicating with their peers, and can promote learning engagement to a certain extent (Aziz, 2023). However, information overload and communication overload did not significantly affect learning engagement, which is consistent with the study of Hwang et al. (2020). This may be because social media is essential for students to access adequate information in today's age of information. Huge information will not completely overwhelm the individual, and it is still possible to focus on the learning task without affecting the individual's current level of learning engagement. Moreover, social media-based communication is the guarantee of cooperative learning, hence it may not have a significant impact on learning engagement.

This study also found that ego depletion significantly negatively affects learning engagement: the higher the degree of ego depletion, the lower the level of learning engagement, similar to Garrison et al. (2018) and Liu (2022). Learning engagement may require draining students' self-control resources to focus on current learning tasks. Students in a state of ego depletion reduce their willingness to exercise self-control subsequently. Therefore, when in said state of ego depletion, college students are unable to fully mobilize self-control and have difficulty concentrating on learning tasks.

More importantly, ego depletion significantly mediated between social media overload and learning engagement, which is similar to the findings of Vanco and Christensen (2016) and Shi et al. (2020) on work engagement. Social overload, Communication overload, and System feature overload may cause individuals to fall into a state of ego depletion, difficulty maintaining self-control, resources, and focus on learning, and may lead to their inability in maintaining a high level of learning engagement. Social media-based communication is also necessary for cooperative learning between students and teachers. Moreover, communication overload does not directly and significantly affect learning engagement, and

instead negatively affects learning engagement through a completely mediating effect of ego depletion. Therefore, although some social media overload does not seem to impact learning engagement negatively, it is mainly through the mediation of ego depletion that negatively affects learning engagement and needs our attention.

With the continuous enrichment of social media functions, there exists a trend of expanding from social to educational tools (Zhao et al., 2021). Social media has thus become an essential platform for knowledge sharing and learning at the individual and organizational levels (Aziz, 2023; Kalogiannidis et al., 2022), especially during the three years of China's COVID-19 pandemic lockdown. The educational function of social media has thus become more prominent. Interestingly, the results of this study contrast the results of work engagement in the workplace, likely because work has the meaning of extraction, and learning has the meaning of absorption, hence the impact of social media overload on work engagement may not be consistent with learning engagement. Our findings are also inconsistent with the case results of some Western studies, which may indicate that Western students focus on talent and personal interest in learning. In contrast, Chinese students believe they can achieve good results if they work hard. Therefore, even if Chinese college students experience social media overload, it still positively impacts learning engagement. This presents a completely novel finding in China's higher education environment.

## **5.2 Implications**

The study's theoretical contributions are four-fold. First, it proposes a research framework based on literature reviews and clarifies the relationship between social media overload and college students' learning engagement. In comparison, social media was created to facilitate communication between people and increase productivity. However, due to people's inappropriate user behaviour, social media's "dark side" has gradually emerged (Shi et al., 2020). The research herein helps elucidate the consequences of poor social media use, providing direct evidence of the impact of social media overload on college students' learning engagement behaviour. Second, this paper proves the mediating role of ego depletion in the influence of social media overload on learning engagement through the theory of ego depletion. Third, it provides a more comprehensive classification of social media overload from four aspects: Social, Information, Communication, and System feature, to improve the understanding of social media overuse behaviour, which enriches the influencing factors of learning engagement in the context of higher education. Finally, this paper bolsters the scholarly significance for the country's research on the influence of social media environmental factors under the influence of Chinese and Western cultures. The atmosphere of higher education in China is somewhat different from that in the West. Results herein confirm that the impact of social media overload on learning engagement is quite different given the cultural context between East and West.

The paper also has several practical contributions. For college administrators and teachers, discussing the impact mechanism of social media overload on learning engagement helps them rethink how to guide college students to use social media effectively, thereby allowing social media's positive role in learning and minimizing the negative impact. Results also help undergraduate students examine their use problems more deeply, thus strengthening their ability to control their psychological resources. When students perceive that social media overload brings discomfort, they can evaluate the situation and take targeted measures. They can also withdraw from some unnecessary online social communities, make delayed replies, or focus on replying to messages reducing the time and energy consumed on social media, thereby mitigating the negative impacts of social media use. For social media service providers and technology developers, the results herein provide a reference for optimizing product features and settings. Social media development teams can limit the time of software use, information presentation, and other aspects to reduce the probability of overuse to a certain extent, thereby preventing more serious social problems.

## 6. Conclusions and Research Limitations

Based on the research results of social media overload on work engagement, this study proposes a research model on the relationship between social media overload and learning engagement. The model adaptability was good, and there was a significant correlation between social media, ego depletion, and learning engagement. Most of the hypotheses were confirmed, especially the significant ego depletion mediation effect. Although the correlation between social media overload and learning engagement is not very strong, it still significantly affects the level of learning engagement through the mediating effect of ego depletion, which warrant further attention by all stakeholders. With the prevalence of social media usage among college students, more in-depth research is needed in the future to study its impact on learning activities.

Although this study has many significant findings, it also has some limitations. First, the data related to college students' social media user behaviour and psychological responses are cross-sectional, which can only be indirectly speculated. Using longitudinal study design in future studies can obtain more direct causal judgments. Second, all data herein were based on participants' self-reported responses, and for negative questions, participants may underestimate their perception when reporting these data. Finally, the independent variables were a variety of social media platforms. We might have different results if we studied social media with different functions and uses (such as WeChat or TikTok) separately.

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