Adult and Higher Education (2022)
Clausius Scientific Press, Canada

DOI: 10.23977/aduhe.2022.040810
ISSN 2523-5826 Vol. 4 Num. 8

A Study On the Impact of Smartphone Use during Short Breaks on Student Engagement

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Keywords: smartphone use, vitality, fatigue, student engagement, conservation of resources theory

Abstract: Extant studies have demonstrated that smartphone addiction plays a negative role on learning. However, the impact of a short-time use of smartphone on learning is largely overlooked. This paper, based on conservation of resources theory, aims to test the mediating roles of vitality and fatigue in the relationship between smartphone use during short breaks and student engagement among Chinese undergraduates. The sample in this study comprises 271 undergraduates in China. The results of the survey reveal that vitality mediates the relationship between smartphone use and student engagement, while the association of smartphone use and fatigue is insignificant, although the negative relation of fatigue on student engagement is tested. The paper shows that a short-time use of smartphone plays a positive role in promoting learning engagement and suggests an appropriate use of smartphone among undergraduates.

1. Introduction

With increasing interest in positive psychology, engagement, an active construct which increases one's well-being, has received accumulated attention. Studies have proved an association between student engagement and academic success-related outcomes [1-3]. What's more, study engagement plays a crucial role in nurturing capabilities of information evaluation and critical thinking which are demanded by the changing economy [4].

However, some limitations in previous research on student engagement should be noted. First, engagement involves an interaction process of the individual with the context [5, 6]. Research on student engagement has mainly focused on school-level factors and classroom context during class time [4]. Studies have paid little attention to the impacts of individual difference variables on engagement [7]. Second, short breaks between classes in college are supposed to counteract fatigue and gain energy for following classes. Although long-term energy plays a significant role in human sustainability, the accumulation of short-term energy replenishment is particularly important since energy is volatile resource [8]. However, research on the expected recovery effect of short breaks has not received enough attention despite the fact that individuals' energy replenishment within a class day is crucial in keeping sustainability and study engagement. Finally, although a plenty of

studies have proved the negative relationship between student engagement and problematic smartphone use (PSU) [9], it is not tested clearly whether smartphone use for a short break have the potential for aiding or impeding the energy replenishment. The mechanism of smartphone use during short breaks within a class day influencing student engagement has remained unclear.

The purpose of the present study is to investigate the impacts of smartphone use during short breaks on student engagement among Chinese undergraduates. Based on corollaries resource gain spirals and resource loss spirals of conservation of resources theory [10], the present study explores two possible but different ways in which smartphone use might influence student engagement. On one hand, gratifications derived from the use of smartphone mobilizes resources and brings energy in its users, which improves student engagement in the following class. On the other hand, resource loss resulted from the use of smartphone worsens undergraduates' energy and causes fatigue, which impedes student engagement in the following class. This study investigates the impacts of smartphone use during short breaks on student engagement among Chinese undergraduates from a balanced perspective.

The present study makes several contributions. First, this study investigates student engagement from the perspective of individual variables. individuals demonstrate variances under the same context since engagement involves an interaction of individuals and the context [5, 6]. Second, since energy is transient and volatile [8], this study focuses on the short-term energy recovery within a class day and its impacts on student engagement rather than the long-term energy recovery after class. Third, this study uses a more balanced perspective to analyze the impacts of smartphone use rather than simply reiterating the long-term negative effects on physical and psychological well-being [11, 12].

2. Theoretical Background and Hypothesis Development

2.1. Smartphone Use for Short Breaks, Vitality, Fatigue and Student Engagement

Short breaks in college are scheduled breaks taken within a class day to counteract fatigue and thus to regain energy resources. Short breaks were positively related to discomfort reduction among computer terminal workers [13]. Smartphone has become its own in terms of communication and rapid access to information. Given the fact that 99.2% of Chinese undergraduates own a smartphone [14], accumulative researches have focused on the relationship between problematic smartphone use (PSU) and academic behavior, mental health and well-being of college students [9]. This effect of short breaks has not been thoroughly investigated when smartphone use is involved, although smartphone use for breaks in workplace has received accumulative attention. Studies on the impacts of smartphone use tend to demonstrate conflicting results [15], but surprisingly little attention has been paid to the role of smartphone use for a short time in hindering or speeding student engagement.

Energy refers to full of vitality and lack of fatigue [16]. Vitality involves the experience of being energetic and vigorous and enthusiastic [17]. Vitality is connected with self-motivation and energy available to self. Fatigue refers to the experience of energy depletion and exhaustion [18]. Within the class context, how student feel after breaks is an important factor in predicting student engagement. Individuals have a plenty of choices on activities they are intend to undertake while taking a short break. The impacts of short breaks on human energy are mixing, and short breaks do not always produce the due positive outcomes. Researches in workplace have demonstrated that some activities during micro-breaks are positively associated with high levels of human resources and post-break resources and some are negatively associated with these resources [19, 20]. Doubts may arise when it comes to the impacts of temporary use of smartphone for short breaks on post-break resources.

Student engagement denotes the degree and emotional quality of students' involvement in learning activities [21]. Student engagement is a multi-dimensional construct and is composed of behavioral, cognitive, and psychological components [22, 23]and related to important academic and social-emotional outcomes [1]. While previous studies on student engagement have mainly focused on school-level factors, classroom context and individual needs, studies on characterizations of students' behavior and feel could facilitate a more comprehensive understanding of engagement [4]. What' more, the work engagement literature identifies personal resources predict individual engagement [24]. The impacts of individual energy in short term settings in a class day on student engagement deserve more attention to fully improve students' commitment to learning.

2.2. Conservation of Resources Theory

To understand the impacts of undergraduates' smartphone use for short breaks on student engagement, we draw upon conservation of resources theory [25], which has been proven valuable in explaining resources lost and regain. Conservation of resources theory holds that people strive to obtain, retain, and protect resources [25]. One of the key principles of conservation of resources theory is that individuals invest resources to recover from resource losses [10] and that stress occurs when individuals fail to gain resources after resource investment [26]. Two of corollaries of conservation of resources are resource gain spirals and resource loss cycles [10]. Resource gain spirals hold that individuals gain more resources out of original resources. Resource loss cycles occur when individuals have fewer resources to compensate for resource loss. Compared with resource loss cycles, the process of gain spirals is slower because individuals value resource loss more than resource gain [10]. Among all resources, energy is deemed to be personal and volatile [8]. Energy management strategies [19], referring to activities that employees engage in to replenish their energy while at work, has been put forward to explain how individuals endeavor to remain energy sustainability in short-time settings. We hold that the concept can be applied to students' energy replenishment during class intervals. Energy management strategies include work-related strategies and micro-break strategies, and not all strategies are positively related with high level of vitality and low level of fatigue [19, 27]. The timing and content of breaks should be taken into consideration when analyzing the impacts of energy management strategies on resource gain and resource loss [28]. With conservation of resources theory, smartphone use for short breaks can be considered as one of energy management strategies to gain resources after resources loss. The resource gain spirals and resource loss spirals offer an explanation for the two possible but different effects of smartphone use during short breaks on student engagement.

2.3. The Mediating Role of Vitality

To test the associations between smartphone use for short breaks and student engagement, the purposes of using smartphone should be taken into consideration. With resource investment principle [10], resources should be invested to protect against resource loss and recover from loss. Smartphone use for short breaks contributes to vitality for undergraduates mainly in two aspects. First, smartphone with hedonic and eudaemonic functions may significantly alleviate perceived boredom in free time [29], thus leading to a temporary detachment from study, which is beneficial for energy recovery. Second, study-related use of smartphone is positively associated with high levels of vitality since the associations of work-related strategies with higher levels of energy in workplace have been proven [19]. The information-seeking viewing of smartphone reflects a goal-oriented use to meet cognitive needs, and a search for solutions for an academic problem might trigger individuals' desire to receive meaningful information and thus smartphone use has become a meaningful way to satisfy individuals' cognitive needs. This satisfaction fuels individuals' energy

and resources to further study. Thus, a temporary detachment from study and cognitive satisfaction resulted from smartphone use contribute to resource recovery during break times.

With corollary of resource gain spirals, resources gained from smartphone use during a short break enable undergraduates to devote themselves to learning in the following class. Although contextual factors are of vital importance in predicting student engagement, individual factors should not be ignored since student engagement involves the interaction of context and individuals [4]. An individual's experience of positive emotions contributes to broaden the individual's thoughts and behavior, leading to accumulation of resources [30,31]. Researches has shown positive emotions are related with higher levels of student engagement [7]. As a positive emotion of human sustainability, vitality plays a role in predicting student engagement. Vitality undergraduates gain through smartphone use during short breaks triggers positive resources in student engagement. Therefore, on the basis of previous analysis, we propose:

Hypothesis 1(H1). Undergraduates' smartphone use for short breaks promotes vitality, which aids student engagement.

2.4. The Mediating Role of Fatigue

With resource investment principle, stress occurs when individuals fail to recover after resource investment [10]. Smartphone use for short breaks leads to fatigue for undergraduates mainly in three aspects. First, many side-effects in using smartphone during short breaks might emerge as it could lead to harms to physical health. Researches have manifested the negative association of smartphone use and physical activity among college students [32], deviating from the original purposes of breaks and leading to the feeling of depletion and fatigue. Second, it is conceivable that undergraduates are vulnerable in developing information overload, especially when the information incoming is not requested [33]. Stress might emerge when undergraduates lost control on the timing and amount of messages and information received [33], thus resulting in the feeling of fatigue. Finally, smartphone use as short breaks would be ineffective if individuals are forced to terminate their short breaks before recovery could occur [34]. Studies have indicated that the completion of the rest break activity ensures positive outcomes [35].The multi-functions of smartphone allows undergraduates to engage with various activities with it and undergraduates who lack the ability of self-control are tend to be so addicted with smartphones that they have to be interrupted. This interruption might cause negative emotions such as fatigue.

With corollary of resource loss cycles, students' failure to gain recovery resources from smartphone use during a short break worsens performances in the following class. Failure to gain resources after investment will lead to stress to individuals, or more serious subsequent resource deterioration and negative outcome will occur [26]. Researches has shown negative emotions are related with lower levels of student engagement [7]. As a negative emotion of human sustainability, fatigue caused by smartphone use during short breaks further depletes resources in student engagement in the following class. Therefore, on the basis of previous analysis, we propose:

Hypothesis 2 (H2). Undergraduates' smartphone use for short breaks results in fatigue, which impedes student engagement.

According to the arguments above, we propose the following theoretical model (Figure 1).

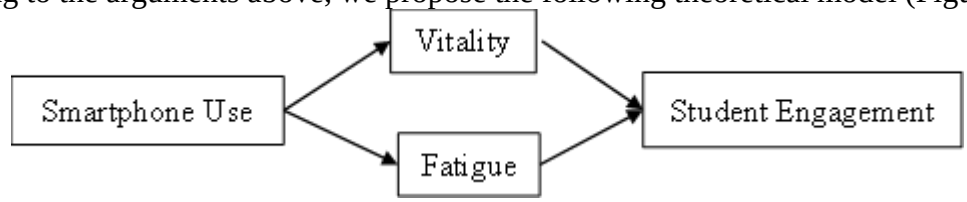

Figure 1: Theoretical Model

3. Materials and Methods

3.1. Sample and Procedures

The data of this study were collected from 271 undergraduates in a college during a time when all students had classes online at home after the outbreak of COVID-19 in China in 2020. Participants completed the questionnaires by recalling their experiences in the past five class days. 330 questionnaires were sent out online, and 295 questionnaires were sent back. 23 questionnaires reported that there was no smartphone use involved during breaks and thus were eliminated. 1 questionnaire was invalid in which the participant chose option 1 for all questions. Thus, we obtained 271 questionnaires (82% valid response rate).

The 271 sample includes freshmen, sophomores and juniors majored in journalism, finance, Chinese, law, accountants, medicine, business English. Among the participants, 22.8% were male and 69.4% were female. The participants aged from 18 to 24. The number of classes the participants had online ranged from 18 to 25 per week. 128(47.2%) participants had classes with computers, while 143(53.8%) participants had classes with smartphones.

3.2. Measures

Smartphone use. We used a modified smartphone use scale based on Uses and Gratifications for the Internet [36]. Currently, most functions of smartphone are realized by internet, thus Uses and Gratifications for the Internet is suitable for testing our hypotheses. The ten items adopted referred to process gratification, content gratification and social gratification when smartphone was used. Sample items were “resources” (process gratifications), “learning” (content gratification) and “chatting” (social gratification). We used a 7-point Likert scale ranging from 1 (extremely unimportant) to 7 (extremely important). In the present study, second-order confirmatory factor analysis demonstrated that the smartphone use scale had a higher-order latent construct overarching three factors ($\chi 2$ (32) = 94.13; TLI = 0.96; CFI = 0.97; RMSEA = 0.08; SRMR = 0.04). Standardized loadings ranged from 0.64 to 0.94. Cronbach’s alpha was 0.92.

Vitality and Fatigue. We used a revised version based on a shortened version of the Profile of Mood States [37]. Sample items were “active” (vitality) and “exhausted” (fatigue). We used a 7-point Likert scale ranging from 1 (extremely disagree) to 7 (extremely agree). Confirmatory factor analysis (CFA) demonstrated that the vitality scale had a one-dimensional structure ($\chi 2$ (2) = 4.26; TLI = 0.99; CFI = 0.997; RMSEA = 0.07; SRMR = 0.01). Standardized factor loadings ranged from 0.80 to 0.95. Cronbach’s alpha was 0.92. Confirmatory factor analysis (CFA) demonstrated that the fatigue scale had a one-dimensional structure ($\chi 2$ (2) = 4.67; TLI = 0.99; CFI = 0.997; RMSEA= 0.07; SRMR = 0.01). Standardized factor loadings ranged from 0.83 to 0.94. Cronbach’s alpha was 0.92.

Student engagement. We used a revised scale based on the student version of engagement scale [38]. We used a 7-point Likert scale ranging from 1 (extremely disagree) to 7 (extremely agree). Student engagement scale included three dimensions: vigor, dedication and absorption. Sample items were “When I’m doing my work as a student, I feel bursting with energy” (vigor), “I find my studies full of meaning and purpose” (dedication) and “Time flies when I am studying” (absorption) In this study, second-order confirmatory factor analysis demonstrated that the student engagement scale had a higher-order latent construct overarching three factors ($\chi 2$ (41) = 106.41; TLI = 0.96; CFI = 0.97; RMSEA = 0.08; SRMR = 0.03). Standardized factor loadings ranged from 0.65 to 0.99. Cronbach’s alpha was 0.94.

4. Results

4.1. Descriptive Analysis

The descriptive results are presented in Table 1. Results show that smartphone use during short breaks was positively associated with both vitality (r=0.19, p<0.01) and student engagement (r=0.31, p<0.01). Vitality was negatively associated with fatigue (r = -0.29, p<0.01), but positively associated with student engagement (r=0.60, p<0.01). Fatigue was negatively associated with student engagement (r =-0.27, p<0.01). Noticeably, the association of smartphone use with fatigue was insignificant (r= 0.67).

Table 1: Means, Standard Deviations, and Correlations for Relevant Variables

variables		Mean	SD	1	2	3
1	Smartphone Use	53.08	9.29			
2	Vitality	12.46	2.98	0.19**		
3	Fatigue	11.25	3.38	0.67	-0.29**	
4	Student Engagement	47.04	11.06	0.31**	0.60**	-0.27**

Note: n=271; **p<0.01, *p<0.05.

4.2. Test of Hypotheses

Regression analysis was used to test the hypotheses in present study. H1 proposed a road to energization: undergraduates' smartphone use for short breaks promotes vitality, which aids student engagement. According to Table 2, undergraduates' using smartphone for short breaks was positively related with vitality (β=0.06, p<0.05). The smartphone use for short breaks was positively related with student engagement (β=0.26, p<0.001). Vitality was positively related with student engagement (β=1.92, p<0.001). According to Table 3, undergraduates' smartphone use for short breaks had a significant direct effect of 0.26(95% CI= [0.15, 0.37]) and a significant indirect effect of 0.12 (95% CI= [0.03, 0.21]) on student engagement through the mediation of vitality. Thus, Hypothesis 1 was supported (see Tables 2 and 3).

Table 2: Mediation effects of Vitality and Fatigue

Predictors	Vitality	Fatigue	Student Engagement
	Model 1	Model 2	Model3
constant	9.18	9.96	14.38
Smartphone Use	0.06^{*}	0.02	0.26^{***}
Vitality			1.92^{***}
Fatigue			-0.45^{**}
R^2	0.04	0.01	0.42
F	10.35^{**}	1.21	63.85^{***}

Note: n=271; *p<0.05, **p<0.01, ***p<0.001.

H2 proposed a road to overload: undergraduates' smartphone use for short breaks results in fatigue, which impedes student engagement. In line with results in Table 1, results in Table 2 show that the association of undergraduates' using smartphone during short breaks with fatigue was not significant, although fatigue was negatively associated with student engagement (β=-0.45, p<0.01). The indirect effect of smartphone use on student engagement through fatigue was -0.01(95%CI= [-0.05, 0.00]), which indicated insignificant indirect effect of fatigue. Thus, Hypothesis 2 was partially supported (see Tables 2 and 3).

Table 3. Direct and Indirect Effect of Smartphone Use on Student Engagement

		Effect	Boot SE	Boot LLCL	Boot ULCI
Direct Effect		0.26	0.06	0.15	0.37
Indirect Effects	Vitality	0.12	0.05	0.03	0.21
	Fatigue	-0.01	0.01	-0.05	0.00

5. Discussion

The present study investigates the effects of using smartphone during short breaks on student engagement in class day among Chinese undergraduates. The results have shown that using smartphone as a short break activates undergraduates' vitality, which is beneficial for students to get engaged in the following class. Individuals use internet or smartphone mainly for entertainment, learning and socializing [39]. Therefore, three functions of smartphone use during short breaks have been tested in this study.

The first function is to satisfy undergraduates' process needs, which means that undergraduates enjoy the process of being serf on line with smartphones. This indicates that changes occur in the nature of leisure in information age and that smartphone is becoming one of sources that provides entertainment and energy for undergraduates. This is in line with previous study which proved that smartphone users achieve flow state while using a smartphone for entertainment, especially when they are bored [29]. The second function is to satisfy undergraduates' content needs, which means that undergraduates search for useful or study-related information with a smartphone. This indicates that smartphone, as a tool, fuels students with useful and latest information in an economical way due to its rapid and easy access to messages all around the world. This is congruent with the study in workplace that energy management strategies related to learning were strongly related to employees' energy [19]. The third function is to satisfy undergraduates' social needs, which means that undergraduates contact with other people via smartphone. This indicates that smartphone serves as a communication tool and facilitates undergraduates keeping in contact with the world. Research has shown that the frequency of smartphone use is associated with the feel of missing out among young adults in China [40], which lent support to social gratification of smartphone use in this study. Individuals with resources are better at solving problems [26], thus students who possess enriched resources would have better performance in class.

The insignificant relationship between smartphone use during short breaks and fatigue in this study demonstrates that short-time smartphone use may be harmless to undergraduates. In this study, among 294 questionnaires we received (one questionnaire is deleted because option 1 was chosen for all questions), only 23 questionnaires reported there was no smartphone use involved during short breaks. This indicates that smartphone use during short breaks is one of preferred activities among undergraduates. Studies have clarified that preferred breaks are related to more resource recovery after the break [20]. The use of smartphone is so common among undergraduates that is has become a ritualized and habitual use, which results in less cognitive overload. Although studies have demonstrated the negative relationship between smartphone use and academic performance [41], this study proves that the temporary use of smartphone during short breaks activates momentary energies among Chinese undergraduates, and thus increase student engagement in the following class. This is partially in accordance with studies on the positive impacts of caffein intake during a rest on counteracting to driver fatigue and thus decreasing risks in driving [28].

Some theoretical contributions could be drawn from this study. First, this study investigates how personal resource in one domain is linked to outcomes in other domains, which enriches the study crossover of engagement in conservation of resources theory [10]. Gratifications in using smartphone during break time provide undergraduates with a sense of energy, which aids student

engagement in study domain. The corollary of resource gain spirals is tested in shorter-term setting of short breaks within a class day. Second, this study offers insights in terms of energy management strategies due to the multi-functions of smartphones. While studies on the side effects of smartphone use are overwhelming, more cautious and reasonable conclusions may be drawn when considering how smartphone fulfills users' needs and thus activates their vitality in their spare time, which enriches the study on possible outcomes when one kind of one energy management strategy is in use. Third, the impacts of individual factors on student engagement are investigated to further study engagement at a micro-level. Student engagement are thoroughly studied from the perspective of contextual levels, such as school-level factors, teacher support, peers, classroom structure, autonomy support and task characteristics. This study proves that personal resource predicts engagement, demonstrating that individual variable plays a role in student engagement.

Practical implications of this study include the use of smartphone during short breaks and students' energy management strategies. First, the temporary use of smartphone during break time plays a positive role in meeting instant satisfactions among Chinese undergraduates and thus foster energy in its users. This implies that using a smartphone for a short time during spare time does good to maintaining energetic for the whole day and thus brings about positive outcomes. What should be noted is that this positive effect of smartphone use exists in short term. Second, this study investigates energy management and student engagement from a micro-perspective. The results show that the short breaks in a class day count in replenishing energy for students. More attention should be paid to the activities undertaken during our spare time in order to have a real good rest and thus a better performance. It is tested in this study that the temporary use of smartphone during short breaks brings about momentary resource replenishment and better performance in study. However, what should be noted is that the impacts of long time use of smartphone on study engagement are not tested. Thus, the positive effect of smartphone use on recovery replenishment should not be exaggerated.

Some limitations should not be ignored in this study. First, this study tested three functions of smartphone use during short breaks, which is not a comprehensive way to understand the multi-functions and gratifications the smartphone could bring about [29]. Second, the data collected in this study was single-sourced and self-reported. Other methods are highly recommended, such as experiment, to further verify the causal relationship between smartphone use and student engagement. Third, a contrasting study is needed to further investigate the impacts of smartphone on student engagement. More convincing results may emerge if an experiment is conducted in which the smartphone use is manipulated.

6. Conclusion

This study, based on conservation of resource theory, investigates the ways in which the smartphone using during short breaks would influence student engagement among Chinese undergraduates. The results of this study indicate that smartphone use during short breaks is positively associated with vitality, which predicts better student engagement in the following class. The road to momentary energization by temporary use of smartphone verifies the gratifications the smartphone could offer and explains the widespread popularity of smartphone among Chinese undergraduates. The positive association of vitality with smartphone use during short breaks with student engagement shows that transient individual variables play a role in predicting engagement, which offers a more comprehensive way to the study of engagement. Future research could continuously analyze how technology impacts on work or study engagement with different participants in different settings, which would contribute to the advancement of conservation of resources theory and psychological study of well-being in information age.

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