Teacher-student relationships and smartphone addiction: the roles of achievement goal orientation and psychological resilience

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Abstract

Smartphone addiction has become an urgent problem for college students. Teacher-student relationships are important factors affecting smartphone addiction, but the mechanism is not clear, and the subjects of the most existing studies are primary and secondary school students. Therefore, this study developed and tested a model of teacher-student relationships and smartphone addiction of college students. It further investigated the mediating effect of achievement goal orientation and the moderating effect of psychological resilience. This study recruited 598 Chinese college students from freshmen to seniors, aging from 17 to 25, with the help of the Teacher-Student Relationships Questionnaire, Achievement Goal Oriented Questionnaire, Psychological Resilience Scale (CD-RISC) and Smartphone Addiction Scale for College Students (SAS-C) questionnaire, which are completed during the period of their computer experiments. The results indicated that, (a) after controlling the factors of gender, age, grade etc., teacher-student relationships exerted negative prediction on smartphone addiction. (b) Achievement goal orientation played a partial mediating role in the relationship between teacher-student relationships and smartphone addiction of college students. (c) The relationship between teacher-student relationships and smartphone addiction was moderated by psychological resilience — for college students with high psychological resilience teacher-student relationships had a more prominent negative effect on smartphone addiction. This study has application value for guiding college students to improve their achievement goals and reduce the tendency of smartphone addiction.

Keywords Achievement goal orientation · College students · Psychological resilience · Smartphone addiction · Teacher-student relationships

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Introduction

Teacher-student relationships are based on the warmth, respect, comfort and emotional support that students perceive from their schoolteachers (Grazia & Molinari, 2020). Because teachers and students interact with each other through direct communication involving emotion, cognition and behavior in bilateral interaction in the education process, teacher-student relationships have a strong impact on students' academic performance and physical and mental health (Liu et al., 2013). For example, students who form positive relationships with their teachers reported a greater sense of belonging and more interest in school (Rey et al., 2007). In contrast, a meta-analysis of 99 articles showed that a negative teacher-student relationship leads to lower academic performance (Roorda et al., 2011). When teacher-student relationships are poor, students are less motivated to participate in learning and subsequently perform worse academically (Park et al., 2012). College is an important period

of life development. Compared with middle school students, in addition to facing academic pressure, college students also experience problems with social interaction and freshmen maladjustment (Lepp et al., 2015). On the one hand, social support of college students from early adolescence is transferred from family to school (Lin & Li, 2005). On the other hand, due to the relatively common migration of college students, the increased physical distance from their families weakens the role of family support, making teacher support more important for these college students (Pan, 2017). Therefore, teachers play a more critical role in the lives of college students (Pianta et al., 2003). Teachers are adults who provide comfort, guidance and support to college students (Wentzel, 2016). Teachers play an important role in the career development of college students supporting their mental health, personal growth and emotional well-being (McGrath & Bergen, 2015).

By June 2021, the number of mobile internet users in China had reached 1.007 billion, with 99.6% of mobile phones users surf the internet, and 29.7% aged 10 to 29 (China Internet Network Information Center, 2021). Smart phones have become an indispensable tool in people's life (Noe et al., 2019). Smart phones are featured by high personality and diversity, meeting people's various life requirements. (Carbonell et al., 2013). However, excessive use of smart phones can cause smartphone addiction (Ahn & Jung, 2016). Smartphone addiction is characterized by symptoms of compulsive behavior, withdrawal, tolerance and deterioration of function (Lopez-Fernandez, 2017). It's an impulse control disorder (Mok et al., 2014). Life styles and learning approaches in college are very different from those in high school. Besides study, college students also need to face more psychological pressure such as interpersonal relationship, life adaptation etc., who often turn to smart phones to relieve the pressure. Studies have shown that the detection rate of smartphone addiction among college students is 25% to 40%, and the average time reached 6 h per day (Wang et al., 2014). Smartphone addiction brought about many problems such as making it difficult for college students to concentrate in class, reducing happiness in life, and even leading to social anxiety, personality disorders, and suicidal tendencies (Billieux et al., 2015; Volkmer & Lermer, 2019). Therefore, smartphone addiction not only harms individual mental health (Błachnio & Przepiorka, 2019), but even threatens the life safety of college students (Hersh et al., 2019).

Studies have shown that the quality of teacher-student relationships is negatively correlated with internet addiction (Wu & Wu, 2014). Positive teacher-student relationships will reduce internet addiction among adolescents (Jin et al., 2014). Existing researches focused mostly on the relationship between teacher-student relationships and internet addiction among primary and middle school students. Since

it is convenient to carry the smart phones and surf the internet (Kim, 2013a, 2013b), more and more college students follow suit. In addition to more pressure from interpersonal relationship and life adaptation for college students, therefore, the research on the relationship between teacher-student relationships and college students' smartphone addiction and its influencing mechanism is of help for college administrators to prevent and intervene college students' smartphone addiction by improving college environment. This study attempts to further explore the influence and mechanism of teacher-student relationships on college students' smartphone addiction on the basis of existing studies.

Teacher-Student Relationships and Smartphone Addiction

First, previous studies have found that warmth and control are important manifestations of good teacher-student relationships (Verschueren & Koomen, 2012). Good teacher-student relationships can not only play an important protective role for students (Rey et al., 2007), but also prevent the maladjustment of students with stressful life affairs, negative emotions and social emotional difficulties. Simultaneously, positive teacher-student relationships can also prevent students with difficult temperament from having maladaptive behavior (such as internet addiction) (Rudasill et al., 2010), thus reducing the occurrence of internet addiction (Wu & Wu, 2014).

Second, according to the stage-environment matching theory, school environment is an important reason for students to have various problems. Hunt (1975) believed that teachers could provide students with emotional needs, thus promoting their better development. It is very important to fit the development needs of college students with the educational environment. When the development trajectory of college students synchronizes with the change trajectory of the college environment they live in, it will produce positive incentive effects. But when these two trajectories are out of sync, there are negative motivational consequences. Good teacher-student relationships are important parts of the college environment, and the quality of teacher-student relationships is related to students' learning motivation. Individuals with poor achievement motivation have lower self-efficacy (Sitzmann & Yeo, 2013), and low self-efficacy as a kind of maladaptive cognition is a proximal factor of pathological internet use (Davis, 2001). Poor teacher-student relationships make students prone to internet addiction (Luthar, 2006). Some studies indicate that when individuals cannot feel the warmth provided by teachers, they will try to turn to the internet for emotional consolation so as to satisfy the feelings they lack in the real world (Fredriksen & Rhodes, 2004). As one of the main carriers of internet use, smart phones are the concentrated reflection of individuals'

excessive internet use (Liu et al., 2017). Studies have pointed out that poor teacher-student relationships are risk factors for internet addiction (Li et al., 2013), which are also one of the reasons for teenagers' problematic mobile phone use (Zhen et al., 2019). Students with poor teacher-student relationships have a higher degree of smartphone addiction (Lai et al., 2020). Therefore, poor teacher-student relationships may lead to smartphone addiction.

However, previous studies focused mainly on internet addiction or mobile phone addiction among primary and secondary school students. As mentioned above, college students are a group with high incidence of smartphone addiction, and the prevalence rate of smartphone addiction is 25%– 40%(Wang et al., 2014). Therefore, it is particularly important to study the relationship between teacher-student relationships and college students' smartphone addiction and its influencing mechanism.

The Mediating Role of Achievement Goal Orientation

According to the achievement goal theory, people's achievement goals and goal orientation are based on their belief in the nature of their ability (Button et al., 1996). The perception of security influences achievement goals (Rusk & Rothbaum, 2010). According to attachment theory, when individuals experience secure attachment, they interact effectively with their environment in the way they wish (Cassidy, 1999). Teachers can provide students with the ability to provide emotional support and support their functioning as a basis for their safety (Pianta, 1994). Therefore, a good teacher-student relationship enables students to regard teachers as objects of attachment; thus, students can obtain more emotional support and a stronger sense of security from this relationship which improves their achievement goal orientation (Thijs & Koomen, 2008).

In addition, school culture is an important factor affecting the orientation of students' achievement goals. Construction of identity is related to the environment in which learning takes place. In a good learning environment, language learning could establish a preferred social identity that may provide individuals with the opportunity to learn different language skills through immersion programs or direct practices (Tadayon & Khodi, 2016). In the context of classroom instruction, the goal systems of students and teachers interact to develop complex relationships and influence students' goal orientation (Deemer, 2004). Teachers are one of the most important factors influencing students' motivation. The stronger teachers' sense of responsibility personality is, the richer students' intrinsic motivation knowledge is. (Khalilzadeh & Khodi, 2021). Having positive teacher-student relationships will improve students' motivation and their academic performance (Lamb, 2017). Maulana et al.

(2013) believed that a good teacher-student relationship has a positive impact on students' behavior, thus improving students' learning ability and academic performance. A positive teacher-student relationship helps to cultivate students' interest in learning and encourages their active participation in the teaching process (Little & Kobak, 2003), while a negative teacher-student relationship may cause students to lose motivation to attend class (Maulana et al., 2013). Furthermore, a good teacher-student relationship will not only affects students' relationships with their peers, which in turn affects their self-esteem and learning ability, but also affects their achievement goal orientation (Jerome & Pianta, 2008).

Davis(2001) proposed a cognition-behavior model suggesting that the causes related to pathological internet use are divided into two aspects: proximal factors and distal factors. Proximal refers to the degree to which one perceives one's surroundings in a proper paradigm, and distal refers to accidents in life and one's personal predisposition. Individuals with poor achievement goals have lower self-efficacy (Sitzmann & Yeo, 2013). As a kind of maladaptive cognition, low self-efficacy is a proximal factor of pathological internet use (Davis, 2001). A study showed that students with inadequate mastery of goals in an achievement goal orientation are prone to mobile phone dependence (Yang & Xu, 2018). On the one hand, impaired limbic system function, which is associated with learning motivation and inhibition, can lead to internet addiction (Nie et al., 2016). On the other hand, in order to obtain more educational opportunities, students strive to achieve academic success. When their development needs for competence, intimacy and autonomy are not met, students may feel dissatisfied with school and retreat, which may lead to excessive use of the internet (Ryan & Deci, 2000).

The Moderating Role of Psychological resilience

Studies have shown that teachers are one of the important sources of students' academic pressure. Teachers exert academic pressure on students on the basis of teacher-student relationships (Lee & Larson, 2000). The tendency to have high personal achievement expectations is one of the main sources of students' learning pressure (Ang et al., 2009). Internet addicts tend to use the internet as a mechanism to cope with pressure. For example, internet addicts use the internet to escape from reality when they are under extreme pressure (Whang et al., 2003). Studies have also shown that stress is closely related to substance addiction and behavioral addiction. The higher the pressure an individual faces is, the higher the tendency for internet addiction is (Jun & Choi, 2015). Resilience, the personal quality that allows a person to thrive under adversity, refers to the ability to cope with negative experiences, such as acute stress, trauma or adversity. Resilience is what keeps a person mentally healthy

(Choi et al., 2015; Connor & Davidson, 2003). That is, individuals can cope with the pressure caused by achievement goals through high levels of resilience (Fergus & Zimmerman, 2005). When faced with adverse situations, students with stronger psychological resilience have more internal resources to cope with stress and more positive attitudes. Thus, they are less addicted to using the internet to cope with painful emotions (Li et al., 2010). That is, individuals with higher psychological resilience can handle stress and successfully reduce their negative psychological outcomes (e.g., mobile phone addiction) (Steinhardt & Dolbier, 2008).

In addition, Kumpfer (1999) proposed a theoretical model of individual-process-environmental resilience in which psychological resilience consists of external environmental factors, internal factors of psychological resilience, and mediating mechanisms interacting with the external environment. Among them, the internal factors of resilience include an individual's adaptation to the external environment and the process of actively changing the external environment. When an individual encounters a stressor or challenge, the individual and the environment interact with each other, and internal resilience factors (including cognitive, emotional, mental, physical and behavioral) come into play to help the individual successfully cope with maladjustment. As mentioned above, teacher-student relationships create academic pressure on students (Lee & Larson, 2000). Internal psychological resilience factors can reduce risk factors (mobile phone addiction) and promote individual healthy development.

Statement of Problem

Based on previous studies, it was found that although previous studies on teacher-student relationships and internet addiction or mobile phone addiction were carried out, the research objects mainly focused on primary and secondary school students. With the prevalence of smartphone addiction, college students become the high risk group of smartphone addiction. Therefore, the study on the influence of teacher-student relationships on college students' smartphone addiction is well worth discussing.

Second, although existing studies have discussed the influence mechanism of teacher-student relationships on mobile phone addiction, but most are conducted from the perspective of external environment, and there is a lack of research on the influence mechanism from the perspective of individual intrinsic motivation. Therefore, this study attempts to explore the mediating mechanism from the perspective of intrinsic learning motivation, and explore when the influencing mechanism becomes stronger or weaker.

To sum up, this paper puts forward the following questions:

1. What is the predictive effect of teacher-student relationships on college students' smartphone addiction?
2. How do teacher-student relationships affect college students' smartphone addiction through intrinsic learning motivation?
3. When does the influence of teacher-student relationships on college students' smartphone addiction become stronger or weaker?

The Present Research Questions

On the basis of previous studies, this paper proposes a hypothetical model (see Fig. 1). In this model, the mediating effects of achievement goal orientation and the moderating effects of psychological resilience were tested. This model deepens the direct relationship between teacher-student relationships and college students' smartphone addiction. It could answer not only how teacher-student relationships affect smartphone addiction, but also when the effect becomes stronger or weaker. Specifically, this study proposes the following hypotheses:

Hypothesis 1. Teacher-student relationships are negatively related to smartphone addiction.
Hypothesis 2. Achievement goal orientation mediates the relationship between teacher-student relationships and smartphone addiction.
Hypothesis 3. Psychological resilience moderates the relationship between teacher-student relationships and smartphone addiction.

Fig. 1 The hypothetical model

Methods

Participants

Convenient sampling method was adopted to select subjects. Students from freshmen to seniors were recruited from four universities in Hunan province and Anhui Province. Participants had to have used a smartphone. The research protocol was approved by the ethics Research Committee of the university where the investigator worked. Informed consent from students was obtained before collecting data. A well-trained graduate student in psychology introduces the principles of voluntary participation and confidentiality when students do computer experiments. Data was collected by filling out questionnaires on the spot. To ensure the validity of the questionnaire, the questionnaire was filled in anonymously, which takes about 10 min. After completing the questionnaire, each student received a small gift to show our gratitude. First, the graduate student presented instructions to the participants, stated the purpose of the test, showed how to answer the questions, and introduced the principle of anonymity. Second, the participants were asked to fill in the questionnaire truthfully. Third, blank questionnaires, regular answers and abnormal questionnaires were removed to obtain the data of this study. 632 paper questionnaires were distributed and 598 valid questionnaires were collected with an effective rate of 94.62%. The participants were from 17 to 25 years old ($M = 19.97$; $SD = 1.50$). There were 307 male students (51.34%) and 291 female students (48.66%). There were 319 freshmen (53.34%), 126 sophomores (21.07%), 101 juniors (16.89%) and 52 seniors (8.70%). Additionally, 308 participants (51.51%) were liberal arts students and 290 participants (48.49%) were science and engineering students.

Measures

Teacher-Student Relationships Questionnaire This questionnaire, compiled by Pianta (1994) and revised by Zou et al. (2007), contained 23 questions (e.g., "The relationship between my teacher and I is close and warm"), including 4 dimensions: intimacy, conflict, support and satisfaction. All items were rated by students on a 5-point scale ranging from 1 (not at all) to 5 (absolutely). The average scores were calculated, with higher scores reflecting more better teacher-student relationships. This questionnaire has shown good reliability and validity in Chinese college students (Zhang et al., 2013). In this study, the Cronbach's α of the scale was 0.74.

Achievement Goal Oriented Questionnaire This questionnaire, compiled by Button et al. (1996) and translated and revised by Xu et al. (2000), was adopted. It has 12 questions in total (e.g., "I am willing to take tasks that impart me new knowledge"), including two dimensions: mastery goals and achievement goals. The students were asked on a 5-point scale from 1 (very inconsistent) to 5 (very consistent). The average scores were calculated, with higher scores represent higher achievement goals. This questionnaire has shown good reliability and validity in Chinese college students (Xu et al., 2000). In this study, the Cronbach's α of this scale was 0.73.

Psychological Resilience Scale (CD-RISC) This scale, compiled by Connor and Davidson (2003), translated and revised by Yu and Zhang (2007), was adopted. It has 25 questions in total (e.g., "I will not be discouraged by failures"), including 3 dimensions: tenacity, self-reliance and optimism. The students were asked on a 5-point scale from 1 (very inconsistent) to 5 (very consistent). The average scores were calculated, with higher scores reflecting higher psychological resilience levels. This questionnaire has shown good reliability and validity in Chinese college students (Jia & Wang, 2018). In this study, the Cronbach's α of this scale was 0.81.

Smartphone Addiction Scale for College Students (SAS-C) This scale, compiled by Su et al. (2014) was adopted. It has a total of 22 questions (e.g., "The procrastination caused by playing with my smartphone caused me a lot of trouble"), including 6 dimensions: withdrawal behavior, highlighting behavior, social comfort, negative influence, app use and app updates. Items were assessed on a 5-point scale that ranged from 1 (strongly disagree) to 5 (strongly agree). The average scores were calculated, with higher scores indicating higher levels of smartphone addiction. This questionnaire has shown good reliability and validity in Chinese college students (Su et al., 2014). In this study, the Cronbach's α of this scale was 0.90.

Data Analysis

Data were analysed by using SPSS version 26.0. First, descriptive statistics and Pearson correlations between variables were calculated. Second, Model 4 in the PROCESS macro developed by Hayes (2013) was used to analyse the mediating effect of achievement goal orientation on teacher-student relationships and smartphone addiction. Third, Model 1 and Model 5 in the PROCESS macro developed by Hayes (2013) were used to analyse the moderating effect of psychological resilience on the relationship between teacher-student relationships and smartphone addiction.

Results

Pre-analysis

First, as the missing values accounted for less than 5% and the missing value was a variable of the scoring type, the missing values were replaced by means of average.

Second, by drawing scatter plot (see Fig. 2), In Fig. 2, all scatter points are approximately elliptic, indicating an approximately linear relationship between independent variable and dependent variable. In the elliptic scatter plot, the tilt direction of the long axis of the ellipse is high on the left and low on the right, indicating that they are negatively correlated.

Third, before correlation analysis, it is generally necessary to check the normality of data distribution. Skewness and kurtosis tests are used to test the normal distribution of data (Kim, 2013a, b; West et al., 1995). The skewness and kurtosis values of each variable were shown in Table 1. According to West et al. (1995) and Kim (2013a, b), when the absolute value of skewness is less than 2 and the absolute value of kurtosis (minus 3) is less than 7, the data can be considered to be approximately normal distribution. Therefore, teacher-student relationships, achievement goal orientation, psychological resilience and smartphone addiction were all normally distributed.

Fourth, outlier test was carried out. The variables were standardized and then judged to be outliers based on the standard score. In general, values with the absolute values of Z greater than or equal to 3.29 are considered outliers (Tabachnick & Fidell, 2013). According to this principle, outliers whose absolute value of Z are greater than or equal to 3.29 were removed.

Table 1 Skewness and kurtosis of variables ($N = 598$)

variables	skewness	kurtosis (-3)
Teacher-student relationships	-0.11	0.09
Achievement goal orientation	0.71	1.12
Psychological resilience	-0.18	-0.10
Smartphone addiction	-1.53	2.25

Kurtosis is the result after subtracting 3

Common method bias

We use Harman's single-factor method to test common method bias. The results showed that there were 23 factors with eigenvalues greater than 1, and the variance explained by the first factor was 10.79%, less than the critical standard of 40%. This result indicated that there was no serious common method bias in the data in this study.

Descriptive statistics and correlation analysis

Table 2 presents the means, standard deviations and correlation matrix of the main variables in this study. The results showed that teacher-student relationships were significantly positively correlated with achievement goal orientation, significantly positively correlated with psychological resilience, and significantly negatively correlated with smartphone addiction. Achievement goal orientation was significantly positively correlated with psychological resilience and significantly negatively correlated with smartphone addiction. There was a significant negative correlation between psychological resilience and smartphone addiction.

Fig. 2 The scatter diagram
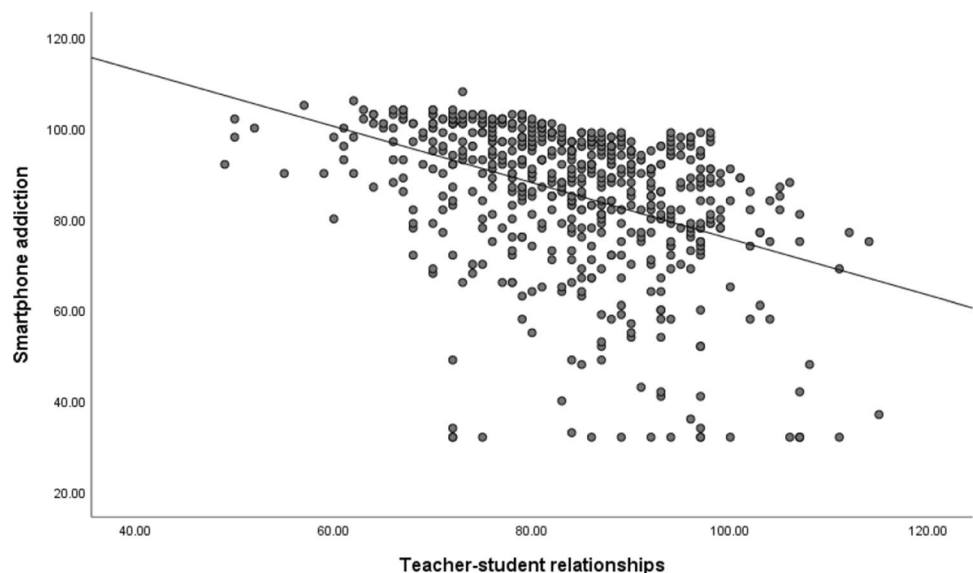
Testing for Mediation

First, all variables were standardized, and gender was coded with dummy variables (0 for males and 1 for females). Second, Model 4 in the PROCESS macro developed by Hayes (2013) was used to test the mediation effect. In data analysis, gender, age, grade, major category and family location were included as control variables.

As shown in Table 3, teacher-student relationships significantly negatively predicted smartphone addiction ($\beta = $-0.38, $p < 0.001$), teacher-student relationships significantly positively predicted achievement goal orientation ($\beta = 0.36$, $p < 0.001$), and achievement goal orientation significantly negatively predicted smartphone addiction ($\beta = $-0.17, $p < 0.001$). The mediation analysis showed that achievement goal orientation mediated the influence of teacher-student relationships on smartphone addiction. The mediating effect was -0.06, and its 95% Bootstrap confidence interval was [-0.10, -0.03], accounting for 16.64% of the total effect.

Testing for Moderation

According to the moderation model testing method recommended by Wen and Ye (2014), factors such as gender, age, grade, major category and family location were controlled. The PROCESS program developed by Hayes (2013) was used to test the moderation model.

The analysis results are as follows (see Table 4 for details). First, Eq. 1 tested the relationship between teacher-student relationships and smartphone addiction and examined whether the total effect was regulated by psychological resilience. The results showed that teacher-student relationships had a significant effect on the prediction of smartphone addiction ($\beta = $-0.34, $p < 0.001$), and the interaction term between teacher-student relationships and psychological resilience had a significant effect on the prediction of smartphone addiction ($\beta = $-0.08, $p < 0.05$). Then, examine whether the direct path of achievement goal orientation mediating the relationship between teacher-student relationships and

Table 2 Means, standard deviations and correlations of the variables

	M	SD	1	2	3	4
1 Teacher-student relationships	3.65	0.47	1			
2 Achievement goal orientation	3.17	0.53	0.35**	1		
3 Psychological resilience	3.86	0.45	0.23**	0.28**	1	
4 Smartphone addiction	3.89	0.74	-0.41**	-0.29**	-0.26**	1

$*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 3 Testing the mediation effect of teacher-student relationships on SA

Independent variables	Equation 1: SA			Equation 2: AGO			Equation 3: SA		
	β	SE	t	β	SE	t	β	SE	t
Teacher-student relationships	-0.38	0.04	-9.94***	0.36	0.04	9.20***	-0.32	0.04	-7.87**
AGO							-0.17	0.04	-4.43***
R^2	0.21			0.14			0.23		
F	15.14***			9.63***			15.98***		

AGO: Achievement goal orientation; *SA*: Smartphone addiction

Table 4 The moderating effect of psychological resilience

Independent variables	Equation 1: SA			Equation 2: AGO			Equation 3: SA		
	β	SE	t	β	SE	t	β	SE	t
T-S relationships	-0.34	0.04	-8.87***	0.36	0.04	9.20***	-0.30	0.04	-7.41***
Psychological resilience	-0.15	0.04	-4.05***				-0.12	0.04	-3.21**
T-S relationships × Psychological resilience	-0.08	0.03	-2.61*				-0.07	0.03	-2.25*
AGO							-0.14	0.04	-3.49***
R^2	0.24			0.14			0.25		
F	14.98***			9.63***			15.03***		

T-S relationships: Teacher-student relationships; *AGO*: Achievement goal orientation; *SA*: Smartphone addiction

smartphone addiction was moderated by psychological resilience. In Eq. 2, teacher-student relationships significantly positively predicted achievement goal orientation ($\beta = 0.36$, $p < 0.001$). In Eq. 3, achievement goal orientation had a significant predictive effect on smartphone addiction ($\beta = -0.14$, $p < 0.001$). Teacher-student relationships predicted smartphone addiction significantly ($\beta = -0.30$, $p < 0.001$). The interaction term between teacher-student relationships and psychological resilience had a significant predictive effect on smartphone addiction ($\beta = -0.07$, $p < 0.05$). The model estimation results verified that achievement goal orientation played a mediating role in the relationship between teacher-student relationships and smartphone addiction, and the direct path of the mediation pathway (teacher-student relationships and smartphone addiction) was moderated by psychological resilience.

Furthermore, the relation between teacher-student relationships and smartphone addiction at two different levels of psychological resilience (1 *SD* below the mean and 1 *SD* above the mean) is presented in Fig. 3. The figure shows that teacher-student relationships exerts significantly negative prediction on smartphone addiction at the low level (1 *SD* below the mean) ($\beta_{\text{simple}} = -0.22$, $t = -4.16$, $p < 0.001$), while teacher-student relationships had a stronger negative predictive effect on smartphone addiction at the high level (1 *SD* above the mean) ($\beta_{\text{simple}} = -0.37$, $t = -7.32$, $p < 0.001$).

Discussion

In this study, college students were selected as research objects. A moderated mediation model was constructed to investigate the influence of teacher-student relationships on smartphone addiction, the mediating role of achievement goal orientation and the moderating role of psychological resilience on the mediation process (the direct path).
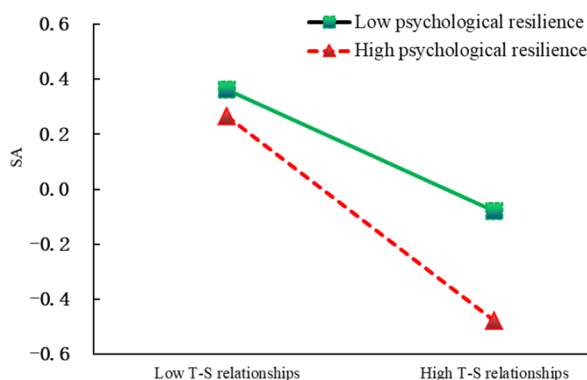

Fig. 3 The moderating effect of psychological resilience on the relationship between T-S relationships and SA. T-S relationships: Teacher-student relationships SA: Smartphone addiction

Teacher-Student Relationships and Smartphone Addiction

This study found that teacher-student relationships can significantly negatively predict smartphone addiction. This finding verifies stage-environment matching theory, according to which students' development has two tracks. One is students' growth, and the other is environmental changes throughout school. When these two trajectories are synchronized, a positive motivational outcome occurs, meaning that the environment both responds to the changing needs of the individual and provides a stimulus that drives continued positive growth. Therefore, teacher-student relationships, as an important factor of the school environment in college, needs to be synchronized with students' development in order to support their development, thus reducing negative effects on their motivation and decreasing the possibility of smartphone addiction.

This study's results are consistent with existing research results, and the protective effect of teacher-student relationships against mobile phone addiction is empirically supported (Jia et al., 2017). Mobile phone addiction can be considered a compensatory response of college students to psychological insecurity when their teacher-student relationships are poor (Kardefelt-Winther, 2014). College students with poor relationships between teachers and students find it difficult to get help from teachers, so they seek mobile internet access to compensate for their psychological insecurity (Verschueren & Koomen, 2012). Combining attachment theory and social control theory, this study supports two important functions of a good teacher-student relationship—warmth and control—which contribute to increase psychological security and thus reduce the risk of mobile phone addiction (Yang et al., 2016). This study enriches the research on the influence of teacher-student relationships on smartphone addiction from an empirical perspective.

The Mediating Role of Achievement Goal Orientation

This study reveals that teacher-student relationships may impact smartphone addiction through the mediating effect of achievement goal orientation. This finding validates the attachment theory. That is, teachers are the main evaluators of students' academic performance in a dependency relationship, and students have a strong need for teachers' recognition and attention. Students in this kind of relationship are sensitive to their teachers' evaluation, and they also want their teachers to pay more attention to them. Therefore, their reliance on teachers may motivate students to prove their learning ability in order to gain the respect of teachers (Wentzel, 1999).

This study's results are in agreement with the previous research results. Studies have found that students with a high affinity for teachers show more positive emotional and behavioral investment in school (Furrer & Skinner, 2003). Good teacher-student relationships can promote classroom participation and confidence and academic achievement (Doll et al., 2004; Pianta, 1999). When students believe that their teachers pay attention to them, provide them with emotional and academic support, look forward to seeing them, and provide them constructive feedback, students' motivation and participation are enhanced (Davis, 2003). Compared with negative teacher-student relationships, positive teacher-student relationships show more intrinsic motivation (Urdan & Schoenfelder, 2006). Students who trust their teachers are generally more motivated to study (Martin & Dowson, 2009), and thus participate in classroom activities more actively (Claessens et al., 2017).

This study also supports the cognitive-behavioral model in which students with poor achievement goal orientation have a lower sense of self-efficacy (Sitzmann & Yeo, 2013), which is a proximal factor of pathological internet use. According to the cognitive-behavioral model, problematic internet use is influenced by adverse tendencies (individual predisposition) and life events (stressors). When teacher-student relationships are flawed, students' goal orientation is affected (Deemer, 2004), thus, acadimic pressure increases, resulting in mobile phone addiction (Yang & Xu, 2018). This study is consistent with previous research. People with lower achievement goals have a higher degree of internet addiction (Niemz et al., 2005). Furthermore, smartphone addiction, which has similar symptoms and behavioral defects to internet addiction, is also more serious (Jeong et al., 2016).

The Moderating Role of Psychological resilience

This study found that psychological resilience moderated the relationship between teacher-student relationships and smartphone addiction. Specifically, the relationship between teacher-student relationships and smartphone addiction depends on the level of psychological resilience. As shown in Fig. 3, teacher-student relationships have a significant negative effect on smartphone addiction at a low level of psychological resilience, while a high level of psychological resilience effectively enhances this effect — the degree of smartphone addiction decreases even more.

This study is consistent with the previous research results. First, teachers exert academic pressure on students through the teacher-student relationship (Lee & Larson, 2000). Poorer academic performance was associated with higher perceived stress (Keech et al., 2018). Furthermore, individuals with a high level of psychological resilience can deal with stress, and students with strong resilience are less addicted to using the internet to cope with painful emotions

when facing adverse situations (Li et al., 2010). This study validated the theoretical model of individual-process-environment psychological resilience. Negative teacher-student relationships can bring about increased stress. Psychological resilience can help individuals cope with maladjustment (mobile phone addiction) when their achievement goals are insufficient. Psychological resilience reflects the individuals' ability to resist pressure and cope. The specific performance is that individuals focus on goals and planning. Individuals with clear goals may be able to deal with stressors purposefully and in a planned way due to their high level of psychological integration. Goal-focused individuals are more positive and more effectively protected from the impact of distractions on their lives. Therefore, such individuals are less likely to become addicted to mobile phones. In addition, psychological resilience is a protective factor against general addiction (Fadardi et al., 2010). Compared with individuals with poor psychological resilience, those with high psychological resilience are less likely to immerse themselves in virtual networks. One possible explanation is that resilience reflects a person's ability to cope with stress, which has been found to be associated with addiction (Cleck & Blendy, 2008).

Limitations, Future Directions, and Implications

There are several limitations in this study, which can be further studied in the future. First, in terms of the mediating mechanism, this study found that achievement goal orientation has a partial mediating effect. This means that there may be other mediating variables that can be investigated in future studies. Second, in different stages of university studies, the relationship between teachers and students presents different developmental characteristics. It develops and changes continuously through continuous interaction between teachers and students (Sang, 2021). The relationship between teacher-student relationships and smartphone addiction may change over the course of students' years at university, which future research may examine using systemic verification and longitudinal studies. Researchers can examine the relationships between the variables in more detail and try to carry out effective interventions for groups with different stages of smartphone addiction groups. Furthermore, the effect of these interventions can be tested.

This study has theoretical and practical significance despite these limitations. This study enriches the application of attachment theory to the internet environment. From a practical point of view, as internet use continues to increase, poor teacher-student relationships will drive individuals to compensate for a lack of emotional support through smartphones. Increased psychological resilience can effectively mitigate this trend. This research result has significance for college students.

The results of this study support the understanding of the mechanism driving smartphone addiction among college students. This study has practical significance for the prevention of smartphone addiction in the following aspects. First, attention should be given to the importance of teacher-student relationships. College students need to strengthen their communication with their teachers. They need to actively interact with teachers during classroom instruction and communicate with teachers after class to strengthen teacher-student relationships. Then, they will reduce their possibility of smartphone addiction. College teachers also need to actively interact with students in class. New flipped classroom and hybrid teaching methods can be used in class. Online teaching methods such as network classrooms can be used to actively communicate with students after class. College students can be guided to use smartphones for pre-class previews and after-class reviews. Second, college counselors and teachers can teach students to plan their future careers through courses such as career planning to improve their achievement goals. College students should set and plan for their goals and make continuous efforts to reduce their dependence on smartphones. Third, universities should pay attention to college students' mental health education and improve their psychological resilience. When the achievement goals of college students are insufficient, they should adjust their attitude, improve their self-confidence, and communicate with counselors and teachers in a timely fashion in order to effectively reduce the possibility of smartphone addiction.

Conclusion

(a) After controlling the factors of gender, age, grade etc., teacher-student relationships exerted negative prediction on smartphone addiction.

(b) Achievement goal orientation played a partial mediating role in the relationship between teacher-student relationships and smartphone addiction of college students.

(c) The relationship between teacher-student relationships and smartphone addiction was moderated by psychological resilience — for college students with high psychological resilience teacher-student relationships had a more prominent negative effect on smartphone addiction.

Declarations

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