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# The effects of online game addiction on reduced academic achievement motivation among Chinese college students: the mediating role of learning engagement

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**Introduction:** The present study aimed to examine the effects of online game addiction on reduced academic achievement motivation, and the mediating role of learning engagement among Chinese college students to investigate the relationships between the three variables.

**Methods:** The study used convenience sampling to recruit Chinese university students to participate voluntarily. A total of 443 valid questionnaires were collected through the Questionnaire Star application. The average age of the participants was 18.77 years old, with 157 males and 286 females. Statistical analysis was conducted using SPSS and AMOS.

**Results:** (1) Chinese college students' online game addiction negatively affected their behavioral, emotional, and cognitive engagement (the three dimensions of learning engagement); (2) behavioral, emotional, and cognitive engagement negatively affected their reduced academic achievement motivation; (3) learning engagement mediated the relationship between online game addiction and reduced academic achievement motivation.

## KEYWORDS

college students, online game addiction, learning engagement, reduced academic achievement motivation, online games

## 1. Introduction

Online games, along with improvements in technology, have entered the daily life of college students through the popularity of computers, smartphones, PSPs (PlayStation Portable), and other gaming devices. Online game addiction has recently become a critical problem affecting college students' studies and lives. As early as 2018, online game addiction was officially included in the category of "addictive mental disorders" by the World Health Organization (WHO), and the International Classification of Diseases (ICD) was updated specifically to include the category of "Internet Gaming Disorder" (IGD). Prior research investigating Chinese college students' online game addiction status mostly comprised regional small-scale studies. For example, a study on 394 college students in Chengde City, Hebei province, China showed

that the rate of online game addiction was about 9% (Cui et al., 2021). According to the results of an online game survey conducted by China Youth Network (2019) on 682 Chinese college students who played online games, nearly 60% of participants played games for more than 1 h a day, over 30% stayed up late because of playing games, over 40% thought that playing games had affected their physical health, over 70% claimed that games did not affect their studies, and over 60% had spent money on online games. This phenomenon has been exacerbated by the fact that smartphones and various portable gaming devices have become new vehicles for gaming with the development of technology. The increase in the frequency or time spent on daily gaming among adolescents implies a growth in the probability of gaming addiction, while an increase in the level of education decreases the probability of gaming addiction (Esposito et al., 2020; Kesici, 2020). Moreover, during the COVID-19 pandemic, adolescents' video game use and the severity of online gaming disorders increased significantly (Teng et al., 2021).

A large body of literature on the relationship between problematic smartphone use and academic performance has illustrated the varying adverse effects of excessive smartphone obsession (Durak, 2018; Mendoza et al., 2018; Rozgonjuk et al., 2018). These effects are manifested in three critical ways: first, the more frequently cell phones are used during study, the greater the negative impact on academic performance and achievement; second, students are required to master the basic skills and cognitive abilities to succeed academically, which are negatively affected by excessive cell phone use and addiction (Sunday et al., 2021); third, online game addiction negatively affects students' learning motivation (Demir and Kutlu, 2018; Eliyani and Sari, 2021). However, there is currently a lack of scientifically objective means of effective data collection regarding online game addiction among college students in China, such as big data. Hong R. Z. et al. (2021) and Nong et al. (2023) suggested that the impact of addiction on students' learning should be explored more deeply.

Since the 1990s, learning engagement has been regarded as a positive behavioral practice in learning in Europe and the United States, and plays an important role in the field of higher education research (Axelson and Flick, 2010). Recently, studies on learning engagement among college students have also been a hot topic in various countries (Guo et al., 2021). According to Fredricks et al. (2004), learning engagement includes three dimensions: behavioral, emotional, and cognitive.

The concept of behavioral engagement encompasses three aspects: first, positive behavior in the classroom, such as following school rules and regulations and classroom norms; second, engagement in learning; and third, active participation in school activities (Finn et al., 1995). Emotional engagement refers to students' responses to their academic content and learning environment. The emotional responses to academic content include students' emotional responses such as interest or disinterest in learning during academic activities (Kahu and Nelson, 2018), while the emotional responses to the learning environment refer to students' identification with their peers, teachers, and the school environment (Stipek, 2002). Cognitive engagement is often associated with internal processes such as deep processing, using cognitive strategies, self-regulation, investment in learning, the ability to think reflectively, and making connections in daily life (Khan et al., 2017). Cognitive engagement emphasizes the student's investment in learning and self-regulation or strategies.

According to Yang X. et al. (2021), learning engagement refers to students' socialization, behavioral intensity, affective qualities, and use

of cognitive strategies in performing learning activities. Besides, Kuh et al. (2007) argued that learning engagement was "the amount of time and effort students devote to instructional goals and meaningful educational practices." Learning engagement is not only an important indicator of students' learning process, but also a significant predictor of students' academic achievement (Zhang, 2012). It is also an essential factor in promoting college students' academic success and improving education quality.

As one of the crucial components of students' learning motivation (Han and Lu, 2018), achievement motivation is the driving force behind an individual's efforts to put energy into what he or she perceives to be valuable and meaningful to achieve a desired outcome (Story et al., 2009). It can be considered as achievement motivation when an individual's behavior involves "competing at a standard of excellence" (Brunstein and Heckhausen, 2018). Students' achievement motivation ensures the continuity of learning activities, achieving academic excellence and desired goals (Sopiah, 2021). Based on the concept of achievement motivation, academic achievement motivation refers to the mental perceptions or intentions that students carry out regarding their academic achievement, a cognitive structure by which students perceive success or failure and determine their behavior (Elliot and Church, 1997). Related research also suggests that motivation is one variable that significantly predicts learning engagement (Xiong et al., 2015).

Therefore, it is worthwhile to investigate the internal influence mechanism of college students' online game addiction on their reduced academic achievement motivation and the role of learning engagement, which is also an issue that cannot be ignored in higher education research. The present study explored the relationship between online game addiction, learning engagement, and reduced academic achievement motivation among college students by establishing a structural equation model (SEM) to shed light on the problem of online game addiction among college students.

## 2. Research model and hypotheses

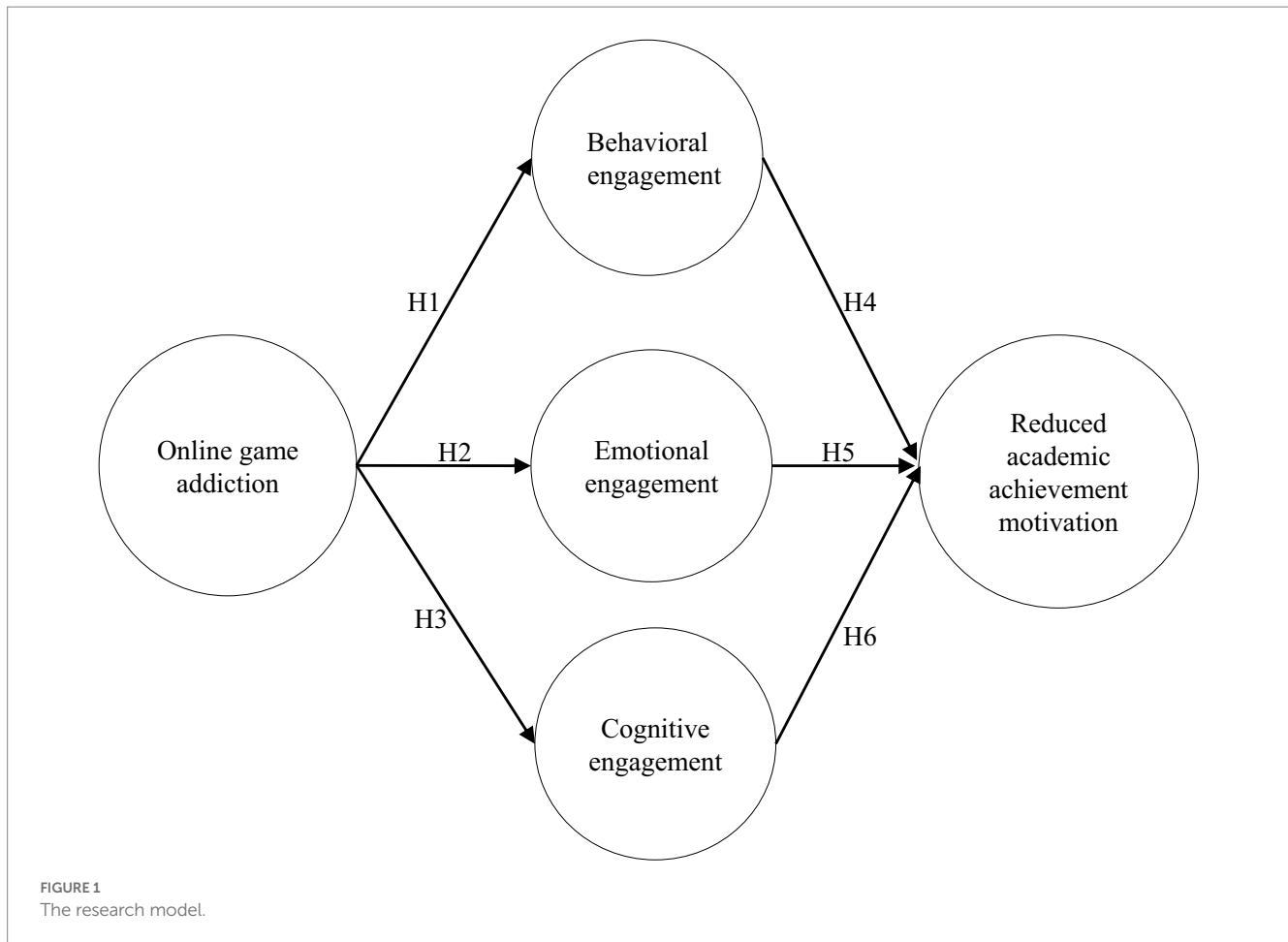
### 2.1. Research model

Previous research usually regarded learning engagement as a variable of one or two dimensions, and scholars tend to favor the dimension of behavioral engagement. However, other ignored dimensions are inseparable parts of learning engagement (Dincer et al., 2019). In a multi-dimensional model, the mutual terms of each dimension form a single composite structure. Therefore, the present study took the structure proposed by Fredricks et al. (2004) as a reference, divided learning engagement into behavioral, emotional, and cognitive dimensions as mediating variables, and explored the relationship between online game addiction, learning engagement, and reduced academic achievement motivation. The research frame diagram is shown in Figure 1.

### 2.2. Research questions

#### 2.2.1. The relationship between online game addiction and learning engagement

Learning engagement has been viewed as a multidimensional concept in previous studies. Finn (1989) proposed the participation-identification model to make pioneering progress in learning



engagement study. [Schaufeli et al. \(2002\)](#) suggested that learning engagement was an active, fulfilling mental state associated with learning. [Chapman \(2002\)](#) pointed out affective, behavioral, and cognitive criteria for assessing students' learning engagement based on previous research. [Fredricks et al. \(2004\)](#) systematically outlined learning engagement as an integration of behavioral, emotional, and cognitive engagement. The updated International Classification of Diseases [[World Health Organization \(WHO\), 2018a,b](#)] specifies several diagnostic criteria for gaming addiction, including the abandonment of other activities, the loss of interest in other previous hobbies, and the loss or potential loss of work and social interaction because of gaming. Past studies have shown the adverse effects of excessive Internet usage on students' learning. Short video addiction negatively affects intrinsic and extrinsic learning motivation ([Ye et al., 2022](#)). Students' cell phone addiction negatively affects academic commitment, academic performance, and relationship facilitation, all of which negatively affect their academic achievement ([Tian et al., 2021](#)). The amount of time spent surfing the Internet and playing games has been identified to negatively affect students' cognitive ability ([Pan et al., 2022](#)). College students' cell phone addiction, mainly reflected in cell phone social addiction and game entertainment addiction, has also been noted to impact learning engagement; specifically, the higher the level of addiction, the lower the learning engagement ([Qi et al., 2020](#)). [Gao et al. \(2021\)](#) also showed that cell phone addiction among college students could negatively affect their learning engagement. [Choi \(2019\)](#) showed that excessive use of cell

phones might contribute to smartphone addiction, which also affects students' learning engagement. Accordingly, the following three research hypotheses were proposed.

- H1:* Online game addiction negatively affects behavioral engagement.
- H2:* Online game addiction negatively affects emotional engagement.
- H3:* Online game addiction negatively affects cognitive engagement.

### 2.2.2. The relationship between learning engagement and reduced academic achievement motivation

Achievement motivation is people's pursuit of maximizing individual value, which embodies an innate drive, including the need for achievement, and can be divided into two parts: the intention to succeed and the intention to avoid failure ([McClelland et al., 1976](#)). On this basis, [Weiner \(1985\)](#) proposed the attributional theory of achievement motivation, suggesting that individuals' personality differences, as well as the experience of success and failure, could influence their achievement attributions and that an individual's previous achievement attributions would affect his or her expectations and emotions for the subsequent achievement behavior while expectations and emotions could guide motivated behavior. [Birch and Ladd \(1997\)](#) indicated that behavioral engagement involved positive

behavioral attitudes such as hard work, persistence, concentration, willingness to ask questions, and active participation in class discussions to complete class assignments. Students' attitudes toward learning are positively related to achievement motivation (Bakar et al., 2010). Emotional engagement involves students' sense of identity with their peers, teachers, and the school environment (Stipek, 2002). Students' perceptions of the school environment influence their achievement motivation (Wang and Eccles, 2013). Cognitive engagement encompasses the ability to use cognitive strategies, self-regulation, investment in learning, and reflective thinking (Khan et al., 2017). Learning independence and problem-solving abilities predict student motivation (Saeid and Eslaminejad, 2017). Hu et al. (2021) indicated that cognitive engagement had the most significant effect on students' academic achievement among the learning engagement dimensions, and that emotional engagement was also an important factor influencing students' academic achievement. Therefore, the following three research hypotheses were proposed:

*H4: Behavioral engagement significantly and negatively affects the reduced academic achievement motivation.*

*H5: Emotional engagement significantly and negatively affects the reduced academic achievement motivation.*

*H6: Cognitive engagement significantly and negatively affects the reduced academic achievement motivation.*

### 2.2.3. The relationship between online game addiction, learning engagement, and reduced academic achievement motivation

Past studies have demonstrated the relationship between online game addiction and students' achievement motivation. For example, a significant negative correlation between social network addiction and students' motivation to progress has been reported (Haji Anzehai, 2020), and a significant negative correlation between Internet addiction and students' achievement motivation has been reported (Cao et al., 2008). Students addicted to online games generally have lower academic achievement motivation because they lack precise academic planning and motivation (Chen and Gu, 2019). Yayman and Bilgin (2020) pointed out a correlation between social media addiction and online game addiction. Accordingly, there might be a negative correlation between online game addiction and academic achievement motivation among college students.

Students addicted to online games generally have lower motivation for academic achievement because they lack precise academic planning and learning motivation (Chen and Gu, 2019). Similarly, Haji Anzehai (2020) reported a significant negative correlation between social network addiction and students' motivation to progress.

Learning engagement is often explored as a mediating variable in education research. Zhang et al. (2018) found that learning engagement was an essential mediator of the negative effect of internet addiction on academic achievement in late adolescence and is a key factor in the decline in academic achievement due to students' internet addiction. Li et al. (2019) noted that college students' social networking site addiction significantly negatively affected their learning engagement, and learning engagement mediated the relationship between social networking addiction and academic

achievement. Accordingly, the following research hypothesis was proposed.

*H7: Learning engagement mediates the relationship between online game addiction and reduced academic achievement motivation.*

## 3. Research methodology and design

### 3.1. Survey implementation

The present study employed the Questionnaire Star application for online questionnaire distribution. Convenience sampling was adopted to recruit Chinese college students to participate voluntarily. The data were collected from October 2021 to January 2022 from a higher vocational college in Shandong province, China. Participants were first- and second-year students. According to Shumacker and Lomax (2016), the number of participants in SEM studies should be approximately between 100 and 500 or more. In the present study, 500 questionnaires were returned, and 443 were valid after excluding invalid responses. The mean age of the participants was 18.77 years. There were 157 male students, accounting for 35.4% of the total sample, and 286 female students, accounting for 64.6%.

### 3.2. Measurement instruments

The present empirical study employed quantitative research methods by collecting questionnaires for data analysis. The items of questionnaires were adapted from research findings based on corresponding theories and were reviewed by experts to confirm the content validity of the instruments. The distributed questionnaire was a Likert 5-point scale (1 for *strongly disagree*, 2 for *disagree*, 3 for *average*, 4 for *agree*, and 5 for *strongly agree*). After the questionnaire was collected, item analysis was conducted first, followed by reliability and validity analysis of the questionnaire constructs using SPSS23 to test whether the scale met the criteria. Finally, research model validation was conducted.

#### 3.2.1. Online game addiction

In the present study, online game addiction referred to the addictive behavior of college students in online games, including mobile games and online games. The present study adopted a game addiction scale compiled by Wu et al. (2021) and adapted the items based on the definition of online game addiction. The adapted scale had 10 items. Two examples of the adapted items in the scale were: "I will put down what should be done and spend my time playing online games" and "My excitement or expectation of playing an online game is far better than other interpersonal interactions."

#### 3.2.2. Learning engagement

In the present study, learning engagement included students' academic engagement in three dimensions: behavioral, emotional, and cognitive. The learning engagement scale compiled by Luan et al. (2020) was adapted based on its definition. The adapted scale had 26 questions in three dimensions: behavioral, emotional, and cognitive engagement. Two examples of the adapted items in the scale are: "I like to actively explore unfamiliar things when I am doing my homework" and "I will remind myself to double-check the places where I tend to make mistakes in my homework."

### 3.2.3. Reduced academic achievement motivation

Reduced academic achievement motivation in the present study refers to the reduction in college students' intrinsic tendency to enjoy challenges and achieve academic goals and academic success. The achievement motivation scale developed by Ye et al. (2020) was adapted to measure reduced academic achievement motivation. The adapted scale had 10 items. Two examples of the adapted items in the scale are: "Since playing online games, I do not believe that the effectiveness of learning is up to me, but that it depends on other people or the environment" and "Since I often play online games, I am satisfied with my current academic performance or achievement and do not seek higher academic challenges."

## 4. Results and discussion

### 4.1. Internal validity analysis of the measurement instruments

In the present study, item analysis was conducted using first-order confirmatory factor analysis (CFA), which can reflect the degree of measured variables' performance within a smaller construct (Hafiz and Shaari, 2013). The first-order CFA is based on the streamlined model and the principle of independence of residuals. According to Hair et al. (2010) and Kenny et al. (2015), it is recommended that the value of  $\chi^2/df$  in the model fitness indices should be less than 5; the root mean square error of approximation (RMSEA) value should be greater than 0.100; the values of the goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) should not be lower than 0.800; the factor loading (FL) values of the constructs should also be greater than 0.500. Based on the criteria above, the items measuring the online game addiction construct were reduced from 10 to seven; the items measuring the behavioral engagement construct were reduced from nine to six; the items measuring the emotional engagement construct were reduced from nine to six; the items measuring the cognitive engagement construct were reduced from eight to six; and the items measuring the reduced academic achievement motivation construct was reduced from 10 to six, as shown in Table 1.

### 4.2. Construct reliability and validity analysis

In order to determine the internal consistency of the constructs, the reliability of the questionnaire was tested using Cronbach's  $\alpha$  value. According to Hair et al. (2010), a Cronbach's  $\alpha$  value greater than

0.700 indicates an excellent internal consistency among the items, and the constructs' composite reliability (CR) values should exceed 0.700 to meet the criteria. In the present study, the Cronbach's  $\alpha$  values for the constructs ranged from 0.911 to 0.960, and the CR values ranged from 0.913 to 0.916, which met the criteria, as shown in Table 2.

In the present study, convergent validity was confirmed by two types of indicators, FL and average variance extracted (AVE). According to Hair et al. (2011), an FL value should be greater than 0.500, and items with an FL value less than 0.500 should be removed; and AVE values should be greater than 0.500. In the present study, the FL values of the constructs ranged from 0.526 to 0.932, and the AVE values ranged from 0.600 to 0.805; all dimensions met the recommended criteria, as shown in Table 2.

According to Awang (2015) and Hair et al. (2011), the square root of the AVE of each construct (latent variable) should be greater than its correlation coefficient values with other constructs to indicate the ideal discriminant validity. The results of the present study showed that the three constructs of online game addiction, learning engagement, and reduced academic achievement motivation had good discriminant validity in the present study, as shown in Table 3.

### 4.3. Correlation analysis

Pearson's correlation coefficient is usually used to determine the closeness of the relationship between variables. A correlation coefficient greater than 0.8 indicates a high correlation between variables; a correlation coefficient between 0.3 and 0.8 indicates a moderate correlation between variables; while a correlation of less than 0.3 indicates a low correlation. Table 4 shows the Correlation Analysis results. Online game addiction was moderately negatively correlated with behavioral engagement ( $r = -0.402$ ,  $p < 0.001$ ), moderately negatively correlated with emotional engagement ( $r = -0.352$ ,  $p < 0.001$ ), slightly negatively correlated with cognitive engagement ( $r = -0.288$ ,  $p < 0.001$ ), and slightly positively correlated with reduced academic achievement motivation ( $r = 0.295$ ,  $p < 0.001$ ). Behavioral engagement was moderately positively correlated with emotional engagement ( $r = 0.696$ ,  $p < 0.001$ ), moderately positively correlated with cognitive engagement ( $r = 0.601$ ,  $p < 0.001$ ), and moderately negatively correlated with reduced academic achievement motivation ( $r = -0.497$ ,  $p < 0.001$ ). Emotional engagement was moderately positively correlated with cognitive engagement ( $r = 0.787$ ,  $p < 0.001$ ) and moderately negatively correlated with reduced academic achievement motivation ( $r = -0.528$ ,  $p < 0.001$ ). Cognitive engagement was

TABLE 1 First-order confirmatory factor analysis.

Model fitness	Threshold value	Online game addiction	Behavioral engagement	Emotional engagement	Cognitive engagement	Reduced academic achievement motivation
$\chi^2$	-	39.900	29.200	31.600	36.9	15
$df$	-	14	9	9	9	9
$\chi^2/df$	<5	2.850	3.324	3.511	4.100	1.667
RMSEA	<0.100	0.065	0.071	0.075	0.084	0.039
GFI	>0.800	0.975	0.977	0.977	0.973	0.989
AGFI	>0.800	0.949	0.947	0.947	0.937	0.974

TABLE 2 Construct reliability and validity of constructs.

Variables	M	SD	$\alpha$	FL	CR	AVE
Online game addiction	1.828	0.900	0.911	0.700–0.841	0.913	0.600
Behavioral engagement	4.160	0.879	0.904	0.526–0.903	0.914	0.646
Emotional engagement	3.869	0.904	0.955	0.784–0.910	0.956	0.783
Cognitive engagement	3.891	0.877	0.960	0.779–0.932	0.961	0.805
Reduced academic achievement motivation	2.248	1.080	0.954	0.704–0.920	0.950	0.759

M = mean; SD = standard deviation;  $\alpha$  = Cronbach's  $\alpha$ ; FL = factor loading; CR = composite reliability; AVE = average variance extracted.

TABLE 3 Discriminant validity analysis.

Variables	1	2	3	4	5
Online game addiction	(0.775)				
Behavioral engagement	−0.402	(0.804)			
Emotional engagement	−0.352	0.696	(0.885)		
Cognitive engagement	−0.288	0.601	0.787	(0.897)	
Reduced academic achievement motivation	0.295	−0.497	−0.528	−0.503	(0.971)

The square roots of AVE values are in parentheses, and the other values are Pearson correlation coefficients.

TABLE 4 Correlation analysis.

Variables	1	2	3	4	5
1. Online game addiction	1				
2. Behavioral engagement	−0.402***	1			
3. Emotional engagement	−0.352***	0.696***	1		
4. Cognitive engagement	−0.288***	0.601***	0.787***	1	
5. Reduced academic achievement motivation	0.295***	−0.497***	−0.528***	−0.503***	1

moderately negatively correlated with reduced motivation for academic achievement ( $r = -0.528, p < 0.001$ ).

### 4.4. Analysis of fitness of the measurement model

According to Hair et al. (2010) and Abedi et al. (2015), the following criteria should be met in the analysis for measurement model fitness: the ratio of chi-squared and degree of freedom ( $\chi^2/df$ ) should be less than 5; the root mean square error of approximation (RMSEA) should not exceed 0.100; the goodness of fit index (GFI), adjusted goodness of fit index (AGFI), normed fit index (NFI), non-normed fit index (NNFI), comparative fit index (CFI), incremental fit index (IFI) and relative fit index (RFI) should be higher than 0.800; and the parsimonious normed fit index (PNFI) and the parsimonious fitness of fit index (PGFI) should be higher than 0.500. The model fitness indices in the present study were  $\chi^2 = 1434.8, df = 428, \chi^2/df = 3.352, RMSEA = 0.073, GFI = 0.837, AGFI = 0.811, NFI = 0.899, NNFI = 0.920, CFI = 0.927, IFI = 0.927, RFI = 0.890, PNFI = 0.827, and PGFI = 0.722$ . The results were in accordance with the criteria, indicating a good fitness of the model in the present study (Table 5).

TABLE 5 Direct effects analysis.

Path	$\beta$
Online game addiction → Behavioral engagement	−0.486***
Online game addiction → Emotional engagement	−0.430***
Online game addiction → Cognitive engagement	−0.370***
Online game addiction → Reduced academic achievement motivation	0.19**
Behavioral engagement → Reduced academic achievement motivation	−0.238***
Emotional engagement → Reduced academic achievement motivation	−0.221**
Cognitive engagement → Reduced academic achievement motivation	−0.265***

\*\* $p < 0.01, ***p < 0.001$ .

### 4.5. Validation of the research model

Online game addiction had a negative effect on behavioral engagement ( $\beta = -0.486; t = -9.143; p < 0.001$ ). Online game addiction had a negative effect on emotional engagement ( $\beta = -0.430; t = -8.054; p < 0.001$ ). Online game addiction had a negative effect on cognitive engagement ( $\beta = -0.370; t = -7.180; p < 0.001$ ). Online game addiction had a positive effect on reduced academic achievement motivation ( $\beta = 0.19; t = -2.776; p < 0.01$ ). Behavioral engagement had a negative

effect on reduced academic achievement motivation ( $\beta = -0.238$ ;  $t = -3.759$ ;  $p < 0.001$ ). Emotional engagement had a negative effect on reduced academic achievement motivation ( $\beta = -0.221$ ;  $t = -2.687$ ;  $p < 0.01$ ), and cognitive engagement had a negative effect on reduced academic achievement motivation ( $\beta = -0.265$ ;  $t = -3.581$ ;  $p < 0.01$ ), as shown in Figure 2; Table 6.

Cohen's  $f^2$  is an uncommon but valuable standardized effect size measure that can be used to assess the size of local effects (Selya et al., 2012). When  $f^2$  reaches 0.02 it represents a small effect size, 0.150 represents a medium effect size, and 0.350 represents a high effect size (Hair et al., 2014). The explanatory power of online game addiction on behavioral engagement was 23.6%, and  $f^2$  was 0.309. The explanatory power of online game addiction on emotional engagement was 18.5%, and  $f^2$  was 0.227. The explanatory power of online game addiction on cognitive engagement was 13.7%, and  $f^2$  was 0.159. The explanatory power of behavioral, emotional, and cognitive engagement on reduced academic achievement

motivation was 23.9%, and  $f^2$  was 0.314. Figure 2 illustrates the above findings.

### 4.6. Indirect effects analysis

Scholars are often interested in whether variables mediate the association between predicting and outcome variables. Therefore, mediating variables can partially or entirely explain the association (Hwang et al., 2019). In research fields such as psychology and behavior, where the research situation is often more complex, multiple mediating variables are often required to clearly explain the effects of the independent variables on the dependent variables (MacKinnon, 2012). Scientific quantitative research requires tests of confidence interval (CI; Thompson, 2002), and the standard value of the test numbers is often determined by 95% CI (Altman and Bland, 2011). CI value not containing 0 indicates the statistical

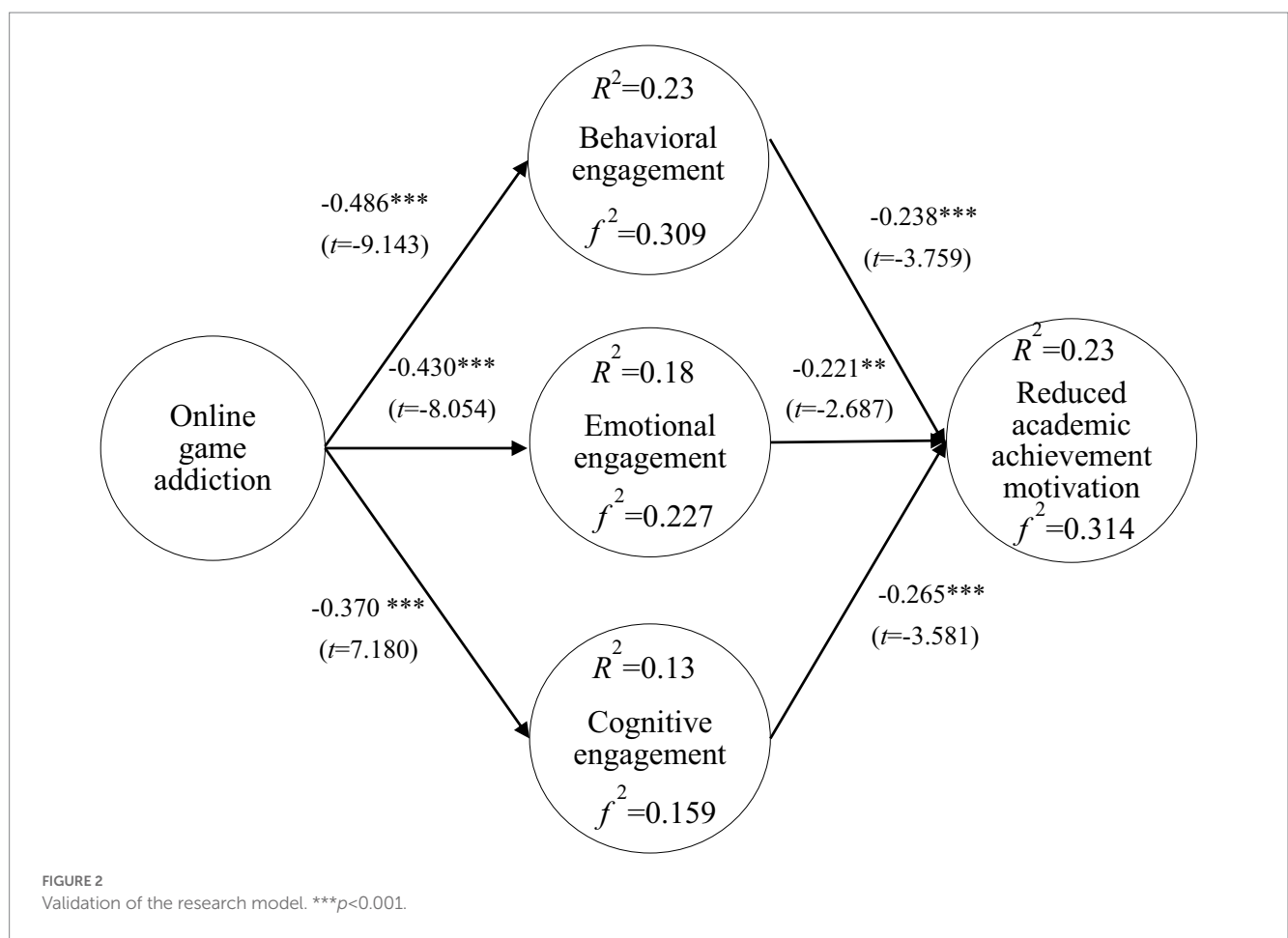


TABLE 6 Indirect effects analysis.

Path	$\beta$	95% CI
Online game addiction → Behavioral engagement → Reduced academic achievement motivation	0.230**	[0.150, 0.300]
Online game addiction → Emotional engagement → Reduced academic achievement motivation	0.209**	[0.130, 0.290]
Online game addiction → Cognitive engagement → Reduced academic achievement motivation	0.170**	[0.100, 0.250]

\*\* $p < 0.01$ .

significance of the analysis results (Nakagawa and Cuthill, 2007). According to the statistical results shown in Table 4, behavioral engagement significantly positively mediated the relationship between online game addiction and reduced academic achievement motivation with a path coefficient of 0.230 and 95% CI ranging from 0.150 to 0.300 (excluding 0),  $p < 0.01$ ; emotional engagement positively mediated the relationship between online game addiction and reduced academic achievement motivation with a path coefficient of 0.209, 95% CI ranging from 0.130 to 0.292 (excluding 0),  $p < 0.01$ ; cognitive engagement positively mediated the relationship between online game addiction and reduced academic achievement motivation with a path coefficient of 0.170, 95% CI ranging from 0.100 to 0.250 (excluding 0),  $p < 0.01$ , as shown in Table 6.

## 4.7. Discussion

### 4.7.1. Analysis of the relationship between online game addiction and learning engagement

Online game addiction is often negatively associated with students' learning. For example, the problematic use of short videos was reported as negatively affecting students' behavioral engagement, while behavioral engagement positively affected students' emotional and cognitive engagement (Ye et al., 2023). Meral (2019) highlighted that students' learning attitudes and academic performance had a negative relationship with students' addiction to online games. Demir and Kutlu (2018) found that online game addiction negatively affects students' learning motivation. As the level of students' game addiction increased, the level of their communication skills decreased (Kanat, 2019). Furthermore, Tsai et al. (2020) pointed out a negative correlation between online game addiction and peer relationships as well as students' learning attitudes. According to the results of the research model validation, it can be observed that: online game addiction negatively affected behavioral engagement, emotional engagement, and cognitive engagement. Therefore, it can be stated that online game addiction had significant and negative effects on all dimensions of learning engagement.

Online game addiction in the present study included aspects of computer game addiction and mobile phone game addiction. The results of the present study are consistent with the findings of Gao et al. (2021), Choi (2019), and Qi et al. (2020), who pointed out that college students' addiction to cell phones negatively affected their learning engagement.

### 4.7.2. Analysis of the relationship between learning engagement and reduced academic achievement motivation

For technology education in higher education, students' intrinsic motivation for academic study predicts their learning engagement (Dunn and Kennedy, 2019). In addition, learning engagement is positively correlated with academic achievement (Fredricks and McColskey, 2012). Based on the research model validation results, behavioral, emotional, and cognitive engagement all negatively affected reduced academic achievement motivation. The findings are consistent with Hu et al.'s (2021) study which

pointed out that cognitive engagement in the learning engagement dimension had the most significant effect on students' academic achievement, and that emotional engagement was also an essential factor influencing students' academic achievement. Lau et al. (2008) showed that achievement motivation positively predicted cognitive engagement in the learning engagement dimension. Mih et al. (2015) noted that achievement motivation positively predicted behavioral and emotional engagement in the learning engagement dimension. The present study supported the above discussion by confirming the association between learning engagement and reduced academic achievement motivation.

### 4.7.3. Analysis of the mediating role of learning engagement

According to the indirect effects analysis results of the present study, learning engagement negatively mediated the relationship between online game addiction and reduced academic achievement motivation. The findings support Haji Anzehai's (2020) conclusion that social network addiction negatively correlated with students' motivation to progress (Haji Anzehai, 2020). It is also consistent with the findings of Chen and Gu (2019) that students addicted to online games generally had lower academic achievement motivation due to a lack of precise academic planning and motivation. Cao et al. (2008) found a significant negative correlation between Internet addiction and students' achievement motivation. Similarly, Zhang et al. (2018) explored the intrinsic influencing mechanism of students' Internet addiction on academic achievement decline in their late adolescence by identifying learning engagement as the important mediating variable. Li et al. (2019) proposed that social networking site addiction among college students significantly negatively affected learning engagement and that learning engagement mediated the relationship between social network addiction and students' academic achievement. The present study findings also support the discussion above.

## 5. Conclusion and suggestions

### 5.1. Conclusion

Currently, the problem of online game addiction among college students is increasing. The relationship between online game addiction, learning engagement, and reduced academic achievement motivation still needs to be explored. The present study explored the relationships between the three aforementioned variables by performing SEM. The results of the study indicated that: (1) online game addiction negatively affected behavioral engagement; (2) online game addiction negatively affected emotional engagement; (3) online game addiction negatively affected cognitive engagement; (4) behavioral engagement negatively affected reduced academic achievement motivation; (5) emotional engagement negatively affected reduced academic achievement motivation; (6) cognitive behavioral engagement negatively affected reduced academic achievement motivation; (7) learning engagement mediated the relationship between online game addiction and reduced academic achievement motivation.



According to the research results, when college students are addicted to online games, their learning engagement can be affected, which may decrease their behavioral, emotional, and cognitive engagement; their academic achievement motivation may be further reduced and affect their academic success or even prevent them from completing their studies. The mediating role of learning engagement between online game addiction and reduced academic achievement motivation indicates that reduced academic achievement motivation influenced by online game addiction could be prevented or weakened by enhancing learning engagement.

## 5.2. Suggestions

Universities and families play a crucial role in preventing online game addiction among college students. One of the main reasons college students play online games may be that they lack an understanding of other leisure methods and can only relieve their psychological pressure through online games (Fan and Gai, 2022). Therefore, universities should enrich college students' after-school leisure life and help them cultivate healthy hobbies and interests. Besides, a harmonious parent-child relationship positively affects children's learning engagement (Shao and Kang, 2022). Parents' stricter demands may aggravate children's game addiction (Baturay and Toker, 2019). Therefore, parents should assume a proper perspective on the rationality of gaming and adopt the right approach to guide their children.

One key factor influencing the quality of higher education is students' learning engagement. The integration of educational information technology has disrupted traditional teaching methods. This trend has accelerated in the context of COVID-19. College students' growth mindset can impact their learning engagement through the role of the perceived COVID-19 event strength and perceived stress (Zhao et al., 2021). Moreover, students' self-regulated learning and social presence positively affect their learning engagement in online contexts (Miao and Ma, 2022). Students' liking of the teacher positively affects their learning engagement (Lu et al., 2022). Their perceived teacher support also positively affects their learning engagement (An et al., 2022). Hence, educators should focus on teacher support and care in the teaching and learning process.

Students' motivation for academic achievement can often be influenced by active interventions. Cheng et al. (2022) noted that the cumulative process of students gaining successful experiences contributed to an increased sense of self-efficacy, motivating them to learn. Zhou (2009) illustrated that cooperative learning motivated students' academic achievement. In addition, Hong J. C. et al. (2021) showed that poor parent-child relationships (such as the behavior of "mama's boy" in adults) had a negative impact on students' academic achievement motivation, and they concluded that cell phone addiction was more pronounced among students with low academic achievement motivation. Hence, enhancing students' academic achievement motivation also requires family support.

## 5.3. Research limitations and suggestions for future research

Most of the past studies on the impact of online game addiction on academics have used quantitative research as the research method. The

qualitative research approach regarding students' online game addiction should not be neglected. By collecting objective factual materials in the form of qualitative research such as interviews a greater understanding of students' actual views on games and the psychological factors of addiction can be achieved. Therefore, future studies could introduce more qualitative research to study online game addiction.

To pay attention to the problem of students' online game addiction, universities and families should not wait until they become addicted and try to remedy it, but should start to prevent it before it gets to that stage. In terms of developing students' personal psychological qualities, students' sensation-seeking and loneliness can significantly affect their tendency to become addicted to online games (Batmaz and Çelik, 2021). Adolescents' pain intolerance problems can also contribute to Internet overuse (Gu, 2022). Emotion-regulation methods affect the emotional experience and play a vital role in Internet addiction (Liang et al., 2021). In this regard, it is necessary to pay attention to students' mental health status and to guide them to establish correct values and pursue goals through psychological guidance and other means.

In addition to individual factors, different parenting can considerably impact adolescents. Adolescents who tend to experience more developmental assets are less likely to develop IGD (Xiang et al., 2022a), and external resources can facilitate the development of internal resources, discouraging adolescents from engaging in IGD (Xiang et al., 2022b). Relevant research indicates that the most critical factor in adolescents' game addiction tendency comes from society or their parents rather than being the adolescents' fault (Choi et al., 2018). Adolescents who tend to be addicted to online games may have discordant parent-child relationships (Eliseeva and Krieger, 2021). Better father-child and mother-child relationships predict lower initial levels of Internet addiction in adolescents (Shek et al., 2019). Family-based approaches such as improved parent-child relationships and increased communication and understanding among family members can be a direction for adolescent Internet addiction prevention (Yu and Shek, 2013).

At the school level, a close teacher-student relationship is one of the main factors influencing students' psychological state. Students' participation in and control over the teaching and learning process as well as their closeness to teachers can increase their satisfaction and thus enhance their learning-related well-being (Yang J. et al., 2021). More school resources can lead to higher adolescent self-control, attenuating students' online gaming disorders (Xiang et al., 2022c).

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements. Written informed consent was not obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

## Author contributions

R-QS, and J-HY: concept and design and drafting of the manuscript. R-QS, and J-HY: acquisition of data and statistical analysis. G-FS, and J-HY: critical revision of the manuscript. All authors contributed to the article and approved the submitted version.

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## References

- Abedi, G., Rostami, F., and Nadi, A. (2015). Analyzing the dimensions of the quality of life in hepatitis B patients using confirmatory factor analysis. *Global J. Health Sci.* 7, 22–31. doi: 10.5539/gjhs.v7n7p22
- Altman, D. G., and Bland, J. M. (2011). How to obtain the confidence interval from a p value. *Br. Med. J.* 2011:343. doi: 10.1136/bmj.d2090
- An, F., Yu, J., and Xi, L. (2022). Relationship between perceived teacher support and learning engagement among adolescents: mediation role of technology acceptance and learning motivation. *Front. Psychol.* 13:992464. doi: 10.3389/fpsyg.2022.992464
- Awang, Z. (2015). *SEM made simple, a gentle approach to learning structural equation modeling*. MPWS Rich Publication. Bangi.
- Axelson, R. D., and Flick, A. (2010). Defining student engagement. *Change* 43, 38–43. doi: 10.1080/00091383.2011.533096
- Bakar, K. A., Tarmizi, R. A., Mahyuddin, R., Elias, H., Luan, W. S., and Ayub, A. F. M. (2010). Relationships between university students' achievement motivation, attitude and academic performance in Malaysia. *Procedia Soc. Behav. Sci.* 2, 4906–4910. doi: 10.1016/j.sbspro.2010.03.793
- Batmaz, H., and Çelik, E. (2021). Examining the online game addiction level in terms of sensation seeking and loneliness in university students. *Addicta* 8, 126–130. doi: 10.5152/ADDICTA.2021.21017
- Baturay, M. H., and Tokar, S. (2019). Internet addiction among college students: some causes and effects. *Educ. Inf. Technol.* 24, 2863–2885. doi: 10.1007/s10639-019-09894-3
- Birch, S., and Ladd, G. (1997). The teacher-child relationship and children's early school adjustment. *Journal of School Psychology* 35, 61–79. doi: 10.1016/S0022-4405(96)00029-5
- Brunstein, J. C., and Heckhausen, H. (2018). “Achievement motivation,” in *Motivation and action*. eds. J. Heckhausen and H. Heckhausen (New York, NY: Springer), 221–304.
- Cao, H., Cao, P., Wang, P., and Wang, X. H. (2008). An exploration of the interrelationship between internet addiction and achievement motivation among middle school students. *J. Beijing Youth Polit. College* 2008, 31–38.
- Chapman, E. (2002). Alternative approaches to assessing student engagement rates. *Pract. Assess. Res. Eval.* 8:13. doi: 10.7275/3e6e-8353
- Chen, C. G., and Gu, X. Q. (2019). The impact of online games on students' subject literacy and social inclusion - an analysis based on PISA 2015 test data from four Chinese provinces and cities. *Open Educat. Res.* 25, 73–87. doi: 10.13966/j.cnki.kfyyj.2019.05.008
- Cheng, B. J., Chen, P., and Chen, Y. S. (2022). The influence of academic achievement motivation on technical learning engagement of students with specialization in physical education faculty: the mediating role of self-efficacy. *J. Southwest Univ.* 47, 96–106. doi: 10.13718/j.cnki.xsxb.2022.04.014
- China Youth Network (2019). *Survey on online games for college students*. Available at: [http://edu.youth.cn/jyxx/jyxxw/201904/t20190415\\_11926323.htm](http://edu.youth.cn/jyxx/jyxxw/201904/t20190415_11926323.htm)
- Choi, S. (2019). Relationships between smartphone usage, sleep patterns and nursing students' learning engagement. *J. Korean Biol. Nurs. Sci.* 21, 231–238. doi: 10.7586/jkbn.2019.21.3.231
- Choi, C., Hums, M. A., and Bum, C. H. (2018). Impact of the family environment on juvenile mental health: eSports online game addiction and delinquency. *Int. J. Environ. Res. Public Health* 15:2850. doi: 10.3390/ijerph15122850
- Cui, J., Yang, K. B., Yang, Q. Y., Liu, Y., Zhao, R. J., Wu, W., et al. (2021). Psychological influences of online game addiction among college students in Chengde

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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- City. *Chin. J. Drug Depend* 30, 296–300+305. doi: 10.13936/j.cnki.cjdd1992.2021.04.011
- Demir, Y., and Kutlu, M. (2018). Relationships among Internet addiction, academic motivation, academic procrastination and school attachment in adolescents. *Int. Online J. Educat. Sci.* 10, 315–332. doi: 10.15345/iojes.2018.05.020
- Dincer, A., Yeşilyurt, S., Noels, K. A., and Vargas Lascano, D. I. (2019). Self-determination and classroom engagement of EFL Learners: a mixed-methods study of the self-system model of motivational development. *SAGE Open* 9:215824401985391. doi: 10.1177/2158244019853913
- Dunn, T. J., and Kennedy, M. (2019). Technology enhanced learning in higher education; motivations, engagement and academic achievement. *Comput. Educ.* 137, 104–113. doi: 10.1016/j.compedu.2019.04.004
- Durak, H. Y. (2018). Investigation of nomophobia and smartphone addiction predictors among adolescents in Turkey: demographic variables and academic performance. *Soc. Sci. J.* 56, 492–517. doi: 10.1016/j.soscij.2018.09.003
- Eliseeva, M. I., and Krieger, E. E. (2021). The peculiarities of parent-child relationship among teenagers who are addicted to online games. *Psychol. Educat. Stud.* 13, 51–67. doi: 10.17759/psyedu.2021130304
- Eliyani, E., and Sari, N. F. (2021). The effect of online game activities on student learn motivation. *Jurnal Pelita Pendidikan* 9, 65–70. doi: 10.24114/jpp.v9i2.23843
- Elliot, A. J., and Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. *J. Pers. Soc. Psychol.* 72, 218–232. doi: 10.1037/0022-3514.72.1.218
- Esposito, M. R., Serra, N., Guillari, A., Simeone, S., Sarracino, F., Continisio, G. I., et al. (2020). An investigation into video game addiction in pre-adolescents and adolescents: a cross-sectional study. *Medicina* 56:221. doi: 10.3390/medicina56050221
- Fan, H., and Gai, X. Y. (2022). A survey study on contemporary college students' leisure activities and online gaming behavior. *Campus Life Mental Health* 20, 12–16. doi: 10.19521/j.cnki.1673-1662.2022.01.002
- Finn, J. D. (1989). Withdrawing from school. *Rev. Educ. Res.* 59, 117–142. doi: 10.3102/00346543059002117
- Finn, J. D., Pannozzo, G. M., and Voelkl, K. E. (1995). Disruptive and inattentive-withdrawn behavior and achievement among fourth graders. *Elem. Sch. J.* 95, 421–434. doi: 10.1086/461853
- Fredricks, J. A., Blumenfeld, P. C., and Paris, A. H. (2004). School engagement: potential of the concept, state of the evidence. *Rev. Educ. Res.* 74, 59–109. doi: 10.3102/00346543074001059
- Fredricks, J. A., and McColskey, W. (2012). “The measurement of student engagement: a comparative analysis of various methods and student self-report instruments,” in *Handbook of research on student engagement* (New York, NY: Springer), 763–782.
- Gao, B., Zhu, S. J., and Wu, J. L. (2021). The relationship between cell phone addiction and learning engagement among college students: the mediating role of self-control and the moderating role of core self-evaluation. *Psychol. Dev. Educ.* 37, 400–406. doi: 10.16187/j.cnki.issn1001-4918.2021.03.11
- Gu, M. (2022). Understanding the relationship between distress intolerance and problematic internet use: the mediating role of coping motives and the moderating role of need frustration. *J. Adolesc.* 94, 497–512. doi: 10.1002/jad.12032
- Guo, J. P., Liu, G. Y., and Yang, L. Y. (2021). Mechanisms and models influencing college students' learning engagement - a survey based on 311 undergraduate higher education schools. *Educ. Res.* 42, 104–115.

- Hafiz, B., and Shaari, J. A. N. (2013). "Confirmatory factor analysis (CFA) of first order factor measurement model-ICT empowerment in Nigeria," in *International Journal of Business Management and Administration*. 2, 81–88.
- Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2010). *Multivariate data analysis (7th)*. New York: Pearson Prentice Hall.
- Hair, J. F., Hult, T. M., Ringle, C. M., and Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Thousand Oaks, CA: SAGE.
- Hair, J. F., Ringle, C. M., and Sarstedt, M. (2011). PLS-SEM: indeed a silver bullet. *J. Mark. Theory Pract.* 19, 139–152. doi: 10.2753/MTP1069-6679190202
- Haji Anzehai, Z. (2020). Correlation between self-efficacy and addiction to social networks with the motivation of academic achievement in high school students in Tehran. *J. Health Promot. Manag.* 9, 72–86.
- Han, J., and Lu, Q. (2018). "A correlation study among achievement motivation, goal-setting and L2 learning strategy in EFL context," in *English Language Teaching*. 11, 5–14.
- Hong, J. C., Ye, J. N., Ye, J. H., Wang, C. M., and Cui, Y. T. (2021). Perceived helicopter parenting related to vocational senior high school students' academic achievement and smartphone addiction. *J. Res. Educat. Sci.* 66, 1–33. doi: 10.6209/JORIES.202112\_66(4).0001
- Hong, R. Z., Ye, J. N., Ye, J. H., Wang, C. M., and Cui, Y. T. (2021). A study on the correlation between "mummy's boys" behavior awareness, academic achievement motivation and cell phone addiction among technology-based high school students. *J. Educat. Sci. Res.* 66, 1–33. doi: 10.6209/JORIES.202112\_66(4).0001
- Hu, Q. Z., Wang, L. Y., and Gao, S. B. (2021). The effect of physics teacher trainees' learning engagement on academic achievement. *Higher Educat. Sci.* 2021, 53–60.
- Hwang, M. Y., Hong, J. C., Ye, J. H., Wu, Y. F., Tai, K. H., and Kiu, M. C. (2019). Practicing abductive reasoning: the correlations between cognitive factors and learning effects. *Comput. Educ.* 138, 33–45. doi: 10.1016/j.compedu.2019.04.014
- Kahu, E. R., and Nelson, K. (2018). Student engagement in the educational interface: understanding the mechanisms of student success. *High. Educ. Res. Dev.* 37, 58–71. doi: 10.1080/07294360.2017.1344197
- Kanat, S. (2019). The relationship between digital game addiction, communication skills and loneliness perception levels of university students. *Int. Educ. Stud.* 12, 80–93. doi: 10.5539/ies.v12n11p80
- Kenny, D. A., Kaniskan, B., and McCoach, D. B. (2015). The performance of RMSEA in models with small degrees of freedom. *Sociol. Methods Res.* 44, 486–507. doi: 10.1177/0049124114543236
- Kesici, A. (2020). The effect of conscientiousness and gender on digital game addiction in high school students. *J. Educ. Fut.* 18, 43–53. doi: 10.30786/jef.543339
- Khan, A., Ahmad, F. H., and Malik, M. M. (2017). Use of digital game based learning and gamification in secondary school science: the effect on student engagement, learning and gender difference. *Educ. Inf. Technol.* 22, 2767–2804. doi: 10.1007/s10639-017-9622-1
- Kuh, G. D., Kinzie, J., Cruce, T., Shoup, R., and Gonyea, R. M. (2007). *Connecting the dots: multi-faceted analyses of the relationships between student engagement results from the NSSE, and the institutional practices and conditions that foster student success*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- Lau, S., Liem, A. D., and Nie, Y. (2008). Task- and self-related pathways to deep learning: the mediating role of achievement goals, classroom attentiveness, and group participation. *Br. J. Educ. Psychol.* 78, 639–662. doi: 10.1348/000709907X270261
- Li, Y., Yao, C., Zeng, S., Wang, X., Lu, T., Li, C., et al. (2019). How social networking site addiction drives university students' academic achievement: the mediating role of learning engagement. *J. Pac. Rim Psychol.* 13:e19. doi: 10.1017/prp.2019.12
- Liang, L., Zhu, M., Dai, J., Li, M., and Zheng, Y. (2021). The mediating roles of emotional regulation on negative emotion and internet addiction among Chinese adolescents from a development perspective. *Front. Psych.* 12:608317. doi: 10.3389/fpsyg.2021.608317
- Lu, L., Zhang, L., and Wang, L. (2022). The relationship between vocational college students' liking of teachers and learning engagement: a moderated mediation model. *Front. Psychol.* 13:998806. doi: 10.3389/fpsyg.2022.998806
- Luan, L., Hong, J. C., Cao, M., Dong, Y., and Hou, X. (2020). Exploring the role of online EFL learners' perceived social support in their learning engagement: a structural equation model. *Interact. Learn. Environ.* 31, 1703–1714. doi: 10.1080/10494820.2020.1855211
- MacKinnon, D. P. (2012). *Introduction to statistical mediation analysis*. New York: Routledge.
- McClelland, D. C., Atkinson, J. W., Clark, R. A., and Lowell, E. L. (1976). *The achievement motive*. Appleton-Century-Crofts, New York.
- Mendoza, J. S., Pody, B. C., Lee, S., Kim, M., and McDonough, I. M. (2018). The effects of cellphones on attention and learning: the influence of time, distraction, and nomophobia. *Comput. Hum. Behav.* 86, 52–60. doi: 10.1016/j.chb.2018.04.027
- Meral, S. A. (2019). Students' attitudes towards learning, a study on their academic achievement and internet addiction. *World J. Educat.* 9, 109–122. doi: 10.5430/wje.v9n4p109
- Miao, J., and Ma, L. (2022). Students' online interaction, self-regulation, and learning engagement in higher education: the importance of social presence to online learning. *Front. Psychol.* 13:815220. doi: 10.3389/fpsyg.2022.815220
- Mih, V., Mih, C., and Dragoş, V. (2015). Achievement goals and behavioral and emotional engagement as precursors of academic adjusting. *Procedia Soc. Behav. Sci.* 209, 329–336. doi: 10.1016/j.sbspro.2015.11.243
- Nakagawa, S., and Cuthill, I. C. (2007). Effect size, confidence interval and statistical significance: a practical guide for biologists. *Biol. Rev.* 82, 591–605. doi: 10.1111/j.1469-185X.2007.00027.x
- Nong, W., He, Z., Ye, J.-H., Wu, Y.-F., Wu, Y.-T., Ye, J. N., et al. (2023). The relationship between short video flow, addiction, serendipity, and achievement motivation among Chinese vocational school students: the post-epidemic era context. *Healthcare* 11:462. doi: 10.3390/healthcare11040462
- Pan, Y., Zhou, D., and Shek, D. T. L. (2022). Participation in after-school extracurricular activities and cognitive ability among early adolescents in China: moderating effects of gender and family economic status. *Front. Pediatr.* 10:839473. doi: 10.3389/fped.2022.839473
- Qi, H. Y., Liu, J. H., Hou, Y. H., Fan, W. F., Hou, J. P., and Wang, X. Y. (2020). The effect of cell phone addiction types on college students' learning engagement. *Health Prot. Promot.* 2020, 88–91. doi: 10.3969/j.issn.1671-0223(x).2020.05.023
- Rozgonjuk, D., Saal, K., and That, K. (2018). Problematic smartphone use, deep and surface approaches to learning, and social media use in lectures. *Int. J. Environ. Res. Public Health* 15:92. doi: 10.3390/ijerph15010092
- Saeid, N., and Eslamnejad, T. (2017). Relationship between student's self-directed-learning readiness and academic self-efficacy and achievement motivation in students. *Int. Educ. Stud.* 10, 225–232. doi: 10.5539/ies.v10n1p225
- Schaufeli, W. B., Martinez, I. M., Pinto, A. M., Salanova, M., and Bakker, A. B. (2002). Burnout and engagement in university students: a cross-national study. *J. Cross-Cult. Psychol.* 33, 464–481. doi: 10.1177/0022022102033005003
- Selya, A. S., Rose, J. S., Dierker, L. C., Hedeker, D., and Mermelstein, R. J. (2012). A practical guide to calculating Cohen's  $f^2$ , a measure of local effect size, from PROC MIXED. *Front. Psychol.* 3:111. doi: 10.3389/fpsyg.2012.00111
- Shao, Y., and Kang, S. (2022). The link between parent-child relationship and learning engagement among adolescents: the chain mediating roles of learning motivation and academic self-efficacy. *Front. Educat.* 7:854549. doi: 10.3389/educ.2022.854549
- Shek, D. T., Zhu, X., and Dou, D. (2019). Influence of family processes on internet addiction among late adolescents in Hong Kong. *Front. Psych.* 10:113. doi: 10.3389/fpsyg.2019.00113
- Shumacker, R. E., and Lomax, R. G. (2016). *A beginner's guide to structural equation modeling (4th)*. New York, NY: Routledge.
- Sopiah, C. (2021). The influence of parenting style, achievement motivation and self-regulation on academic achievement. *Turk. J. Comput. Math. Educ.* 12, 1730–1742. doi: 10.17762/turcomat.v12i10.4635
- Stipek, D. (2002). "Good instruction is motivating" in *Development of achievement motivation*. eds. A. Wigfield and J. Eccles (San Diego, CA: Academic Press)
- Story, P. A., Hart, J. W., Stasson, M. E., and Mahoney, J. M. (2009). Using a two-factor theory of achievement motivation to examine performance-based outcomes and self-regulatory processes. *Personal. Individ. Differ.* 46, 391–395. doi: 10.1016/j.paid.2008.10.023
- Sunday, O. J., Adesope, O. O., and Maarhuus, P. L. (2021). The effects of smartphone addiction on learning: a meta-analysis. *Comput. Hum. Behav. Rep.* 4:100114. doi: 10.1016/j.chbr.2021.100114
- Teng, Z., Pontes, H. M., Nie, Q., Griffiths, M. D., and Guo, C. (2021). Depression and anxiety symptoms associated with internet gaming disorder before and during the COVID-19 pandemic: a longitudinal study. *J. Behav. Addict.* 10, 169–180. doi: 10.1556/2006.2021.00016
- Thompson, B. (2002). What future quantitative social science research could look like: confidence intervals for effect sizes. *Educ. Res.* 31, 25–32. doi: 10.3102/0013189X031003025
- Tian, J., Zhao, J. Y., Xu, J. M., Li, Q. L., Sun, T., Zhao, C. X., et al. (2021). Mobile phone addiction and academic procrastination negatively impact academic achievement among Chinese medical students. *Front. Psychol.* 12:758303. doi: 10.3389/fpsyg.2021.758303
- Tsai, S. M., Wang, Y. Y., and Weng, C. M. (2020). A study on digital games internet addiction, peer relationships and learning attitude of senior grade of children in elementary school of Chiayi county. *J. Educat. Learn.* 9, 13–26. doi: 10.5539/jel.v9n3p13
- Wang, M. T., and Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: a longitudinal study of school engagement using a multidimensional perspective. *Learn. Instr.* 28, 12–23. doi: 10.1016/j.learninstruc.2013.04.002
- Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychol. Rev.* 92, 548–573. doi: 10.1037/0033-295X.92.4.548
- World Health Organization (WHO) (2018a). *Inclusion of "gaming disorder" in ICD-11*. Available at: <https://www.who.int/news/item/14-09-2018-inclusion-of-gaming-disorder-in-icd-11>
- World Health Organization (WHO) (2018b). *WHO releases new international classification of diseases (ICD11)*. Available at: <https://www.who.int/news/item/18-06-2018-who-releases-new-international-classification-of-diseases-icd-11>

- Wu, Y.-T., Hong, J.-C., Wu, Y.-F., and Ye, J.-H. (2021). eSport addiction, purchasing motivation and continuous purchasing intention on eSport peripheral products. *Int. J. e-Education e-Business e-Management e-Learning* 11, 21–33. doi: 10.17706/ijeeec.2021.11.1.21-33
- Xiang, G. X., Gan, X., Jin, X., and Zhang, Y. H. (2022a). The more developmental assets, the less internet gaming disorder? Testing the cumulative effect and longitudinal mechanism during the COVID-19 pandemic. *Curr. Psychol.* 1–12, 1–12. doi: 10.1007/s12144-022-03790-9
- Xiang, G. X., Gan, X., Jin, X., Zhang, Y. H., and Zhu, C. S. (2022b). Developmental assets, self-control and internet gaming disorder in adolescence: testing a moderated mediation model in a longitudinal study. *Front. Public Health* 10:808264. doi: 10.3389/fpubh.2022.808264
- Xiang, G. X., Li, H., Gan, X., Qin, K. N., Jin, X., and Wang, P. Y. (2022c). School resources, self-control and problem behaviors in Chinese adolescents: a longitudinal study in the post-pandemic era. *Curr. Psychol.* 1–13, 1–13. doi: 10.1007/s12144-022-04178-5
- Xiong, Y., Li, H., Kornhaber, M. L., Suen, H. K., Pursel, B., and Goins, D. D. (2015). Examining the relations among student motivation, engagement, and retention in a MOOC: a structural equation modeling approach. *Glob. Educ. Rev.* 2, 23–33.
- Yang, J., Peng, M. Y. P., Wong, S., and Chong, W. (2021). How E-learning environmental stimuli influence determinates of learning engagement in the context of COVID-19? SOR model perspective. *Front. Psychol.* 12:584976. doi: 10.3389/fpsyg.2021.584976
- Yang, X., Zhang, M., Kong, L., Wang, Q., and Hong, J. C. (2021). The effects of scientific self-efficacy and cognitive anxiety on science engagement with the “question-observation-doing-explanation” model during school disruption in COVID-19 pandemic. *J. Sci. Educ. Technol.* 30, 380–393. doi: 10.30773/pi.2020.0034
- Yayman, E., and Bilgin, O. (2020). Relationship between social media addiction, game addiction and family functions. *Int. J. Evaluat. Res. Educat.* 9, 979–986. doi: 10.11591/ijere.v9i4.20680
- Ye, J. H., Wang, C. M., and Ye, J. N. (2020). An analysis of the relationship between achievement motivation, learning engagement and continuous improvement attitudes of technical vocational college students. *J. Natl. Taichung Univ. Sci. Technol.* 7, 1–20. doi: 10.6902/JNTUST.202012\_7(2).0001
- Ye, J. H., Wu, Y. F., Nong, W., Wu, Y. T., Ye, J. N., and Sun, Y. (2023). The association of short-video problematic use, learning engagement, and perceived learning ineffectiveness among Chinese vocational students. *Healthcare* 11:161. doi: 10.3390/healthcare11020161
- Ye, J. H., Wu, Y. T., Wu, Y. F., Chen, M. Y., and Ye, J. N. (2022). Effects of short video addiction on the motivation and well-being of Chinese vocational college students. *Front. Public Health* 10:847672. doi: 10.3389/fpubh.2022.847672
- Yu, L., and Shek, D. T. L. (2013). Internet addiction in Hong Kong adolescents: a three-year longitudinal study. *J. Pediatr. Adolesc. Gynecol.* 26, S10–S17. doi: 10.1016/j.jpag.2013.03.010
- Zhang, N. (2012). A review of Chinese domestic and international research on learning engagement and its school influences. *Psychol. Res.* 5, 83–92.
- Zhang, Y., Qin, X., and Ren, P. (2018). Adolescents’ academic engagement mediates the association between internet addiction and academic achievement: the moderating effect of classroom achievement norm. *Comput. Hum. Behav.* 89, 299–307. doi: 10.1016/j.chb.2018.08.018
- Zhao, H., Xiong, J., Zhang, Z., and Qi, C. (2021). Growth mindset and college students’ learning engagement during the COVID-19 pandemic: a serial mediation model. *Front. Psychol.* 12:621094. doi: 10.3389/fpsyg.2021.621094
- Zhou, H. (2009). The effect of cooperative learning in basketball teaching on social behavior and academic achievement motivation. *Zhejiang Sport Sci.* 31, 109–112.