



ARTICLE

How Autonomy Support Environment Influences Student Online Game Addiction: The Mediating Roles of Academic Motivation and Academic Perseverance

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ABSTRACT

Background: Online game addiction has become a serious global public health problem among adolescents. However, its influencing factors and mediating mechanisms remain ambiguous. **Methods:** The present study adopted stratified random sampling to collect 6146 junior high school student samples in mainland China. We used regression analysis, and Bootstrap mediation test through SPSS 26.0 and AMOS 24.0 to reveal the tendency of students' online game addiction with different background characteristics and whether autonomy support from parents and teachers can effectively reduce online game addiction. **Results:** The results showed that parental ($\beta = -0.112, p < 0.001$) and teacher ($\beta = -0.225, p < 0.001$) autonomy support were conducive to reducing students' online game addiction. Academic perseverance ($\beta = -0.080, 95\% \text{ CI} = [-0.103, -0.058]$) and academic motivation ($\beta = -0.073, 95\% \text{ CI} = [-0.095, -0.052]$) partially mediated the relationship between autonomy support and online game addiction. **Conclusion:** This result provides a theoretical basis for educational interventions. It suggests that strengthening autonomy support could enhance students' academic perseverance and motivation and further reduce online game addiction. This study utilized a cross-sectional research design, making it difficult to determine the causal relationship between autonomy support environment and online game addiction.

KEYWORDS

Online game addiction; autonomy support; academic perseverance; academic motivation; junior high school students; mediation

Introduction

In recent years, with the rapid development of Internet technology, online games have gradually become a way of leisure and entertainment for young people. However, the excessive use of online games, especially the problem of online game addiction, has become one of the hot issues of social concern. Online game addiction is characterized by individuals' excessive use of online games and their inability to control their online behaviors, which ultimately leads to serious impairment of psychological and social functions

[1]. Several studies have shown that online gaming addictive behavior not only affects adolescents' academic performance [2,3] but is also associated with a wide range of psychologically problematic in adolescents, including more mental health problems [4–6], higher levels of social anxiety [7] and depression [8], and interpersonal difficulties [9]. According to the “need-satisfaction theory”, when adolescents' psychological needs are not met in real life, they tend to seek pleasure, comfort, and fulfillment in virtual online worlds, which may lead to a vicious cycle of addiction [10]. In this context, it is important to explore



how to effectively prevent and reduce adolescents' addictive behaviors in online games.

The negative effects of adolescent online game addiction have caused extensively exploration, and past studies have found that family and school education are environmental predictors that cannot be ignored [1,11,12]. Previous studies showed that autonomy-supportive environments, deserve continued academic attention for their impact on students' physical and mental health and delinquent behaviors [13,14]. According to self-determination theory, autonomy support plays an important role in promoting an individual's intrinsic motivation and psychological well-being [15]. Autonomy support refers to significant others (e.g., parents and teachers) enhancing an individual's experience of autonomy by encouraging autonomous choices, providing emotional support, and respecting the individual's perspective as they grow and develop [16]. Academic motivation and academic perseverance are two important psychological variables that play a key role in adolescents' schooling and life. It has been shown that autonomy support from parents and teachers can significantly increase adolescents' academic motivation and academic perseverance [17,18], which may further contribute to the reduction of their online gaming addictive behaviors [19,20]. Academic motivation refers to an individual's source of motivation and drive in learning activities, while academic perseverance refers to the quality of persistence that an individual exhibits in the face of learning difficulties and frustrations.

However, there are fewer studies on the relationship between parental and teacher autonomy support and adolescent online game addiction. Yu et al. [21] based on a sample of 356 junior high school students in China and found that teacher autonomy support was effective in meeting the students' basic psychological needs, thereby reducing problematic online game use. Kaya et al. identified that providing some autonomy support helps to prevent online game addiction [10]. However, the relationship between parental and teacher autonomy support and adolescents' online game addiction has not been fully explored. Further, there is a lack of further exploration on the mediating mechanism of how parental and teacher autonomy support reduces students' online game addiction. Therefore, based on a large-sample survey of 6146 junior high school students and empirical analyses, the purpose of this study is to explore whether autonomy support from parents and teachers can effectively reduce junior high school students' online game addictive behaviors and the mediating role of academic motivation and academic perseverance in the process. The significance of this study is not only to fill the gaps in the existing literature, but also reveal the key roles of parents and teachers in preventing and intervening in online game addiction, providing theoretical support and empirical evidence for family and school educational policy and practice.

Parent and teacher autonomy support and online game addiction

The third addition to the 2013 Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) includes online

game addiction and online gaming disorder, with online gaming disorder being defined as "persistent and repetitive use of the Internet to participate in gaming, usually with other players, that results in severe impairment or distress" [22,23]. Online game addiction is characterized by loss of control over online use, increased frequency and time spent online, inability to exercise control over online behaviors, negative emotions while playing online games as well as continuing to play despite negative consequences [24,25]. Excessive use of online games increases the risk of mood disorders, obsessive-compulsive thinking, and social problems among secondary school students [26]. Karaca et al. reported that online game addiction is very prevalent among secondary school students [27], and Keser et al. study of 12–15-year-olds found that 16.8% of the students believed that they are having a problem with online game addiction [28]. Taylan indicated that 28.5% of secondary school students were at risk of Internet addiction [29]. It has been studied that students from different regions have different tendencies towards Internet addiction or net addiction [30,31]. More and more international studies have explored online game addiction and related mental health problems [32], which implies that a large number of adolescents are suffering from online game addiction. In a word, online game addiction has become a social problem, and it is necessary to explore the influencing factors of online game addiction in middle school students.

Parental autonomy support can have an impact on the development of psychological and behavioral problems in adolescents, including addiction to online games. Parental autonomy support refers to the ability of parents to respect their children's autonomy, feelings and acceptance of their children's feelings and thoughts, support the development of their children's autonomy and independence, reduce ordering and authoritarianism, and provide their children with information and assistance to encourage their children's self-determined choices and decisions [16]. According to Self-determination theory [33], individuals are naturally autonomous and develop corresponding psychological needs [34]. Self-determination theory emphasizes the importance of matching the family environment with the adolescent's basic psychological needs (autonomy, relationships, and competence). When parental support for autonomy cannot meet the adolescent's basic psychological needs, it may lead to physical or psychological problems (e.g., online game addiction) [15]. Younger adolescents are at a stage where they are exploring their identity and values, and thus middle school students are more dependent on parental support and guidance in developing cognitive autonomy [35].

Parental autonomy support is reflected in the extent to which parents encourage their children to express themselves and participate in the decision-making process, which is conducive to fostering a sense of self-determination and independent decision-making in adolescents [36]. Parents engage in autonomy support when they encourage their children to take the initiative rather than merely conform to external demands [37]. Several studies have found that parental psychological control is associated with the emergence of externalizing problem behaviors in

adolescents, such as aggression, substance abuse, and addictive behaviors [38], whereas parental autonomy support has a protective effect on the development of externalizing problem behaviors in adolescents and is more likely to promote the development of good psychological adjustment and reduce online game addiction in adolescents [39]. For instance, parental autonomy support was found to reduce smartphone dependence and real-world and cyberspace bias among middle school students [40].

Teacher autonomy support refers to helping students develop independent thinking, problem solving, and self-management skills by providing resources, guidance, and encouragement, and giving students the opportunity to solve problems independently and make choices when they encounter difficulties [41]. Teacher autonomy support is emphasized in self-determination theory as an interpersonal behavior provided by teachers during the teaching and learning process to identify, nurture, and build students' intrinsic motivational resources [15]. Teacher autonomy support aims to fulfill students' need for autonomy by providing them with choices, appreciating their perspectives, and encouraging their autonomy [42]. Teacher autonomy support can help increase student engagement in the classroom [43]. It has been shown that teacher autonomy support is beneficial in alleviating depressive symptoms in middle school students [44], teachers with autonomy support can energize students and increase their positive energy [45], and the more satisfied students are with their teachers [46], and the more perceived teacher autonomy support, the more likely they are to be less likely to be addicted to online gaming [47], which contributes to lowering online use barriers [48]. In addition, when students' autonomy is satisfied with teacher support, their motivation to learn will become stronger and they will be more engaged in learning [49], thus it can be hypothesized that teacher autonomy support may be effective in reducing the probability of online game addiction. Therefore, this study proposes the research hypothesis:

Hypothesis 1. Parental autonomy support is negatively related to online game addiction.

Hypothesis 2. Teacher autonomy support is negatively related to online game addiction.

The mediating role of academic motivation

Academic motivation is a multidimensional construct that includes internal and external drivers of learning, self-concepts about the ability to learn, and the value placed on knowledge [50]. Students who are academically motivated are more likely to perform well academically, have less school-related anxiety, and exhibit positive attitudes toward learning [51]. According to cognitive evaluation theory, autonomy support plays an active and critical role in fostering intrinsic motivation in a variety of life situations. When the three innate psychological needs (competence, autonomy, and relatedness) are met, it enhances human self-stimulation and intrinsic motivation [52]. At the same time, middle school students are in the midst of adolescence, which is a particularly volatile motivational stage [53], and without the support and assistance of their

parents as well as their teachers' students can lack motivation to learn [54].

Parental autonomy support significantly and positively affects students' motivation for academic autonomy, while academic motivation is negatively related to Internet use and online game addiction [55]. When students' needs for autonomy (e.g., independent inquiry, participation in their favorite science and technology activities, etc.) are met with teacher support, students' interest and motivation to learn increase [56,57], and they become more engaged and active in their learning [49,58], which reduces the probability of students' online game addiction. In a longitudinal study of Chinese middle school students alone, teacher autonomy support was found to significantly reduce online game addiction while directly enhancing school engagement and interest in learning [21]. Therefore, this study hypothesized:

Hypothesis 3. Academic motivation mediates the relationship between parental autonomy support and online game addiction.

Hypothesis 4. Academic motivation mediates the relationship between teacher autonomy support and online game addiction.

The mediating role of academic perseverance

Academic perseverance is the quality of being able to sustain effort and persistence in the face of difficulties and setbacks, and it is the ability of students to persist in their academic activities in the face of difficulties and obstacles that impede the achievement of their goals [59], as well as sustained enthusiasm, effort, and perseverance towards long-term goals [60]. Academic perseverance is one of the most important factors in adolescents' academic success [61]. Student academic perseverance can greatly enhance students' self-assessment practices and production of learning outcomes [62].

One manifestation of online game addiction is students' inability to control playing online games [63], which is a sign of lack of perseverance and self-control. Students with lower academic persistence and responsibility are more likely to be addicted to online games [64]. Enhanced academic perseverance makes adolescents more inclined to invest more time and effort in their academics, reducing the likelihood that they will become addicted to online games [65]. In contrast, adolescents with stronger academic perseverance are more able to manage their time and energy effectively and engage in other extracurricular activities, avoiding overindulgence in online games [66]. It has been found that elementary and middle school students who receive a high level of autonomy support from their parents prefer and are able to persevere in school [34], and that perseverance serves as a buffer between parental attachment and Internet use, helping to reduce Internet use problems [67]. Meanwhile, adolescents' perseverance can be developed through teachers' encouragement and support in the classroom [68], and teachers' classroom engagement, encouragement, and support are positively correlated with students' perseverance [69]. Therefore, this study hypothesized:

Hypothesis 5. Academic perseverance mediates the relationship between parental autonomy support and online game addiction.

Hypothesis 6. Academic perseverance mediates the relationship between teacher autonomy support and online game addiction.

The model of study

To validate the above hypotheses, this study employed autonomy support as the independent variable, online game addiction as the dependent variable, academic perseverance and academic motivation as the mediating variable. The hypothesized model of the study is depicted in Fig. 1.

Materials and Methods

Participants

The population of this study was derived from a survey of junior high schools in Suzhou, Jiangsu Province, Mainland China. The principle of stratified random sampling was adopted to select schools with different academic reputations in Suzhou, and a total of eleven junior high schools were selected, with proportional sampling based on the number of students enrolled in each school. These 11 schools, which represent different levels of prestige in the city, were sampled proportionally to the size of the student body enrolled in that junior high school and comprised both the first and second grades; the third grade did not participate in this survey because students had to sit for the Scholastic Level Examination. The study obtained the consent of the Suzhou Education Quality Monitoring Centre to assist us in distributing the questionnaires, a total of 8063 electronic questionnaires were distributed to junior high school students. The questionnaire survey was conducted in October 2023, lasting approximately one month. All the students surveyed were informed that their answers were anonymous and that they could not proceed until they had given informed consent. The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Suzhou Education Quality Monitoring Center (Ethical review number SZKT2023-LLSC03). All participants signed the informed consent in this study.

To ensure the accuracy of the participant's response, first, we inserted two lie detector questions in the questionnaire (inserted in the text and at the end of the text, the question

“Please select the value of 2” and “Please select the value of 4” respectively with the options are 1–5 values, as a way to identify whether the students are serious about answering the question. Students who answered wrongly in these two questions were excluded. Second, we examined the duration time of filling out the questionnaire to screen effective samples. Specifically, we randomly selected 20 students on the spot to fill out the questionnaire. It was found that the average time to finish the questionnaire in the range of 3–8 min. So, the samples are to be excluded in the range beyond this duration. In the end, after screening the samples, we obtained 6146 valid questionnaires, with a 76% effective recovery rate.

As for the distribution of the sample, there were 3079 (50.1%) male students and 3067 (49.9%) female students; 2398 (39.0%) students whose families were in urban areas and 3748 (61.0%) students who were in the rural areas; 5367 (87.3%) students whose parents were present, and 779 (12.7%) students whose parents were absent for a long period of time. A total of 3,485 students (56.7%) were in Grade 7, and 2661 students (43.3%) were in Grade 8. The detailed demographic characteristics of the sample can be found in Table 1.

Materials

Parental autonomy support and teacher autonomy support

Referring to the Parental Autonomy Support Scale developed by Bai et al. [70], which consists of 4 items, the sample is titled “Within certain limits, my parents allow me to spend my time freely”. The scale is scored on a 5-point Likert scale (completely disagree = 1, completely agree = 5). The Teacher Autonomy Support Scale developed by Williams et al. was translated and adapted to the Chinese context and finalized into five questions [71]. The sample question is “Does my teacher know about our learning status when he/she teaches us”. The reliability and validity results of confirmatory factor analysis indicate that the standardized factor loading of all items was significant <0.001 , $std = 0.832-0.906$, $SMC = 0.692-0.821$, parental autonomy support scale's CR value was 0.925, AVE value was 0.756. The teacher autonomy support scale's CR value was 0.948, AVE value was 0.784.

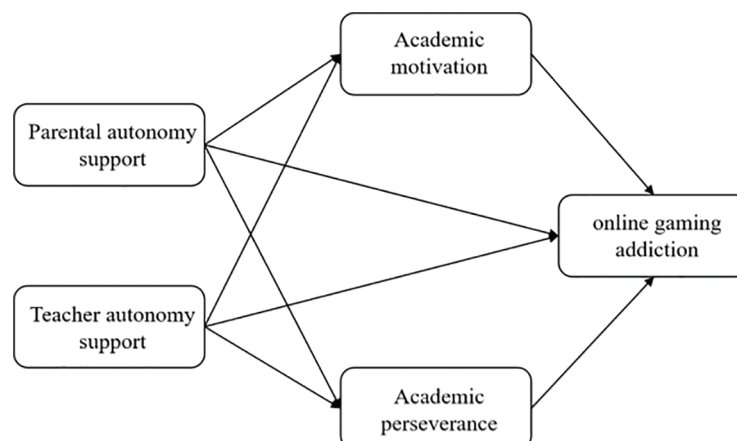


FIGURE 1. Hypothetical model.

TABLE 1

Demographic characteristics of the sample

	N	%
Gender		
Female	3067	50.1%
Male	3079	49.9%
Age		
12 years old	1198	19.5%
13 years old	2013	32.8%
14 years old	1507	24.5%
15 years old	987	16.1%
Others	441	7.2%
Region		
Rural	3748	61.0%
Urban	2398	49.0%
Parental accompaniment		
Parental absence	5367	87.3%
Not parental absence	779	12.7%
Grade levels		
Grade 7 (First Year of Junior High)	3485	56.7%
Grade 8 (Second Year of Junior High)	2661	43.3%

Online game addiction

The scale measures refer to Van Rooij et al.'s [20] and Lemmens et al.'s [72] scales on online game addiction, both of which have also been used in China [73]. Our measurement items consisted of five measurement items, two of which were about the frequency and duration of weekly online gaming in Van Rooij et al. [20]. The reason for choosing to measure the frequency and duration of weekly online game is that an increase in the frequency and duration of online game implies an increase in online game addiction, and the frequency of weekly online gaming is usually positively correlated with game addiction [74]. Thus, the frequency and duration of online game play per week among secondary school students was chosen as one of measurements of online game addiction. The item was: "In the past month, on average, how many times per week have you played online games?" The options included 0, 1–2 times, 3–4 times, 5–6 times, and every day. The higher the frequency, the more serious the addiction to online games. The item of the game duration is "In the past month, how many hours per week, on average, have you spent gaming?" Besides, other three items were derived from the measurement questions in Lemmens et al. [72] with high factor loadings on measurement items such as "Have you felt bad when you were unable to play?" These three items were measured on a Likert 5-point scale: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), and 5 (very often). Among them, due to the differences in the types of the two types of test items, we standardized the scale. The item measuring the frequency of online gaming was already on a five-point scale (0-every day), so no further processing was

required. The time spent on online gaming was a continuous variable, and we divided it into five equal parts based on its distribution, thus forming a five-point scale. This allows it to be homogenized and matched with the five-point Likert scale. The reliability and validity results of confirmatory factor analysis indicate that, the standardized factor loading of all items was significant ($p < 0.001$, std = 0.754–0.870), SMC = 0.569–0.757, CR value was 0.904, AVE value was 0.655.

Academic perseverance

Referenced the Academic Perseverance Scale for 15-year-old adolescents from the Programme for International Student Assessment (PISA) test [75], the PISA test has a good cross-cultural dimension as it covers various countries around the world. The scale includes 4 measurement items, sample questions such as "I persisted in studying when the course was difficult." The scale is scored on a 5-point Likert scale (completely disagree = 1, completely agree = 5). The scale has also been widely validated [76]. The reliability and validity results of confirmatory factor analysis indicate that, the standardized factor loading of all items was significant ($p < 0.001$, std = 0.877–0.944), SMC = 0.769–0.891, CR value was 0.953, AVE value was 0.835.

Academic motivation

We referenced the engagement scale designed by Fang et al. [77], which includes dimensions of motivation and engagement, and we used mature measurement items about motivation. The scale includes 6 measurement items, Sample questions such as "I feel happy when I am fully engaged in learning." The scale is scored on a 5-point Likert scale (completely disagree = 1, completely agree = 5). The reliability and validity results of confirmatory factor analysis indicate that the standardized factor loading of all items was significant ($p < 0.001$, std = 0.786–0.878), SMC = 0.618–0.771, CR value was 0.927, and AVE value was 0.678.

Control variables

Since students' online game addiction may be influenced by a variety of factors, especially in terms of individual characteristics [78,79]. These individual characteristic variables include gender, region of residence, whether the individual is an only child, and whether the parents are present with the child for extended periods. These individual characteristic factors may cause students to develop online game addiction and need to be used as control variables and characteristic variables worth analyzing. Therefore, the study selected students' gender, whether students are only children, parental absence and region as control variables.

Reliability and validity testing of confirmatory factor analysis

The scale reliability, component reliability (CRs), convergent validity, and discriminant validity were tested by validated factor analysis (CFA). The results of the validated factor analysis are shown in Tables 2 and 3. In all measurement models, the factor loadings of the measurement items for each dimension were positive and significant ($Z > 1.96$). For each dimension, the standardized factor loadings for all measurements were greater than 0.7. The values of the

TABLE 2

Confirmatory factor analysis

Dim	Item	Z	Item reliability		CR	AVE
			Std	SMC		
Academic motivation	6	67.384–77.680	0.786–0.878	0.618–0.771	0.927	0.678
Academic perseverance	4	82.191–82.134	0.877–0.944	0.769–0.891	0.953	0.835
Parental autonomy support	4	83.860–97.210	0.832–0.905	0.692–0.819	0.925	0.756
Teacher autonomy support	5	95.218–97.427	0.864–0.906	0.746–0.821	0.948	0.784
Online game addiction	5	64.123–71.234	0.754–0.870	0.569–0.757	0.904	0.655

multiple squared correlation coefficient (SMC) were greater than 0.5, the mean component reliability (SMC) for each dimension was greater than 0.9, and the lowest AVE value for convergent validity was greater than 0.6. All the indicators reached the recommended values for the statistic [80,81].

In addition, the AVE square root values (bold italicized numbers) for each variable are much higher than the correlation coefficients between the variables (see Table 2), indicating that the scale has good discriminant validity. Therefore, the model has good item reliability, constitutive reliability and discriminant validity, and its measures better reflect the characteristics of the measured variables. To simply show the model fit indices, representative indices (χ^2/Df , GFI, CFI, TLI and RMSEA) would be selected to report. The model yielded satisfactory model fit indices: $\chi^2/Df = 4.985$, GFI = 0.902, CFI = 0.908, TLI = 0.907, RMSEA = 0.073. Measurement model has a good fit [82,83]. In addition, the Mardia's coefficient of multivariate kurtosis (393.723) was $< p + 2$ ($p =$ the number of observed variables = 24) = 624 [84]. These findings confirmed the univariate and multivariate normal distribution of the data.

Data analysis

The analysis software of this study used SPSS 26.0 and AMOS 24.0. Firstly, we analyzed the Cronbach's alpha coefficients of each scale by using SPSS 26.0 software to test the reliability of each scale, and we used the standardized factor loadings, component reliabilities, and mean squared extractions to

test the convergent validity of each scale by AMOS 24.0. Then, we used the AVE's square root of the variable and the relationship between the correlation coefficients between the variables to test the discriminant validity of each scale. In the empirical results section, we first analyzed whether there were significant differences in the scores of students with different family background characteristics on each variable through descriptive statistics and independent samples t -tests. The significance test's first significance level is set at $p < 0.05$.

On the basis of research Hypotheses 1 and 2, we established the model of the influence of parental autonomy support and teacher autonomy support on junior high school students' online game addiction respectively, and controlled the parent level variables and family characteristics variables that might interfere with the relationship between parental autonomy support and teacher autonomy support and online game addiction, forming the following Models (1) and (2), which we analyzed using SPSS 26.0 software. And the expression of the specific measurement model is given:

$$Y = \beta_0 + \beta_1 PA_{support} + \beta_2 C_{ji} + \mu_i$$

$$Y = \beta_0 + \beta_1 TA_{support} + \beta_2 C_{ji} + \mu_i$$

$$Y = \beta_0 + \beta_1 PA \times TA_{support} + \beta_2 C_{ji} + \mu_i$$

Y represents the degree of online games per week. $PA_{support}$ represents the degree of autonomy support from the student's parents. $TA_{support}$ implies the degree of teacher autonomy support for students. $PA \times TA_{support}$ represents two types of autonomously supported interactions. C_{ji} is a set of control variables. β_0 is the constant term of the model. μ_i is the residual term of the model.

Then, based on research hypotheses 3-hypothesis 6, we analyzed the mediating effects of academic motivation and academic perseverance on middle school students' online game addiction. We used the bias-corrected nonparametric percentile Bootstrap method to estimate the mediating effect, and 5000 iterations using AMOS 24 software to obtain 95% confidence intervals for the mediating effect value estimates. Thus, we tested the mediating role of academic perseverance and academic motivation between parental autonomy support and teacher autonomy support and online game addiction.

TABLE 3

Descriptive statistics and square root of AVE (N = 6146)

Variables	1	2	3	4
Parental autonomy support	0.869			
Teacher autonomy support	0.589***	0.885		
Academic perseverance	0.498***	0.599***	0.913	
Academic motivation	0.510***	0.618***	0.611***	0.823
M	4.16	4.23	4.12	3.80
SD	0.97	0.92	0.91	0.97

Note: *** $p < 0.001$.

Results

Common method variance test

To evaluate common method bias, Harman's single-factor test was employed, utilizing SPSS software for exploratory factor analysis on all items of the scale. By applying the criterion of eigenvalues greater than 1 before rotation, the first factor was analyzed to determine if it accounted for less than 40% of the total variance explained. The analysis revealed five factors with eigenvalues exceeding one. The first factor accounted for 32% of the total variance, which is below the 40% threshold. This indicates that common method bias is not a significant concern in the data.

Analysis of differences among junior high school students with different characteristics

Table 4 demonstrates the distribution of parental autonomy support, teacher autonomy support, academic perseverance, academic motivation, and online game addition of junior high school students with different characteristics. The results found that in terms of gender, females felt significantly higher family autonomy support and self-academic motivation than males, while online game addiction was significantly lower than males ($p < 0.05$). Only children perceived significantly higher parental autonomy support, teacher autonomy support, and academic perseverance and academic motivation than non-only children, and the risk of online game addiction was significantly lower than that of non-only children ($p < 0.01$). In terms of parental accompaniment, students whose parents were present perceived significantly higher levels of parental autonomy support, teacher autonomy support, as well as academic perseverance and academic motivation than those whose parents were absent for a long period, and the risk of

online game addiction was significantly lower than that of students whose parents were absent for a long period ($p < 0.01$). In addition, urban students perceived significantly higher levels of parental autonomy, teacher autonomy, and academic perseverance and motivation than rural students, and the risk of online game addiction was significantly lower than that of rural students ($p < 0.05$).

Besides, we counted the average weekly game time of the subject samples and found that the average weekly online game time of the subject samples was 3.62 h, with 410 (6.3%) playing more than 16 h per week, 105 (1.7%) playing more than 32 h per week, and only 36.4% of the students did not play online games, and 95 (1.5%) of the students play online games more than 40 h per week.

The effect of autonomy support on students' online game addiction

The effects of parental and teacher autonomy support on middle school students' online game addiction were tested based on a regression model. The results showed (Table 5) that in Model 1, controlling for other variables, the effect of parental autonomy support on middle school students' online game addiction was significantly negative ($\beta = -0.112$, $p < 0.001$), which indicated that the higher the level of parental autonomy support received by the students, the lower the risk of their online game addiction. In Model 2, controlling for other variables, the effect of teacher autonomy support on middle school students' online game addiction is significantly negative ($\beta = -0.225$, $p < 0.001$), suggesting that the higher the degree of teacher autonomy support students receive, the lower their risk of online game addiction. Thus, Hypotheses 1 and 2 were supported.

In order to test whether there is an interactive reinforcement effect between parental and teacher autonomy

TABLE 4

Mean differences in the work status of rural teachers with different background

Variables	Types	Parental autonomy support	Teacher autonomy support	Academic perseverance	Academic motivation	Online game addiction
Gender	Male (N = 3079)	4.14 (0.96)	4.24 (0.95)	4.12 (0.96)	3.86 (1.00)	2.02 (1.00)
	Female (N = 3067)	4.18 (0.98)	4.22 (0.89)	4.11 (0.86)	3.75 (0.94)	1.74 (0.90)
	T	-1.75*	-0.805	-0.331	-4.35***	-11.48***
The only child	No (N = 3859)	4.12 (0.97)	4.20 (0.92)	4.08 (0.91)	3.76 (0.97)	1.92 (0.98)
	Yes (N = 2287)	4.23 (0.98)	4.27 (0.92)	0.17 (0.91)	3.88 (0.97)	1.83 (0.94)
	T	-4.11***	-2.87**	-3.60***	-4.67***	3.51***
Parents	Not Parental absence (N = 5367)	4.17 (0.96)	4.25 (0.90)	4.04 (0.89)	3.82 (0.97)	1.87 (0.95)
	Parental absence (N = 779)	4.07 (1.02)	4.08 (1.02)	3.95 (1.00)	3.67 (1.01)	1.99 (1.08)
	T	2.70**	4.30***	5.06***	4.24***	-3.16**
Regions	Rural (N = 3748)	4.19 (0.99)	4.28 (0.93)	4.14 (0.94)	3.83 (0.99)	1.86 (0.98)
	Urban (N = 2398)	4.10 (0.93)	4.15 (0.90)	4.07 (0.87)	3.77 (0.93)	1.92 (0.94)
	T	3.66***	5.34***	3.14**	2.67**	-2.22*

Note: Standard deviations in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

TABLE 5

The effect of autonomy support on online game addiction in middle school students

Variables	Model 1	Model 2	Model 3
Parental autonomy support	-0.112*** (0.012)		-0.033 (0.039)
Teacher autonomy support		-0.225*** (0.013)	-0.221*** (0.038)
Male	0.295*** (0.0224)	0.294*** (0.024)	0.273*** (0.024)
Only child	-0.101*** (0.025)	-0.099*** (0.025)	-0.101*** (0.025)
Parental absence	0.095** (0.037)	0.071* (0.036)	0.070* (0.035)
Urban family	-0.035*** (0.025)	-0.018 (0.025)	-0.018*** (0.025)
Parental autonomy support × Teacher autonomy support			0.029** (0.009)
Constants	2.284*** (0.067)	2.745*** (0.068)	2.716*** (0.072)
Adj-R ²	0.038	0.071	0.072

Note: (1) *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$; (2) Introducing control variables as dummy variables; (3) Gender: "female" as control sample; "non-only child" as control sample for only child; Parental status with "Both parents present" as control sample; "Rural households" as control sample of households.

support on reducing middle school students' addiction to online gaming, we added an interaction variable between parental autonomy support and teacher autonomy support. Model 3, we incorporate both parent autonomy support, teacher autonomy support, and the interaction term between the two. Controlling for other variables, the effect of teacher autonomy support on junior high school students' online game addiction was significantly negative ($\beta = -0.221$, $p < 0.001$), and parental autonomy support was instead no longer significant in the model ($\beta = -0.033$, $p > 0.05$), but the interaction term of parental autonomy support and teacher autonomy support was significant. This may be due to the fact that in the regression model, teacher autonomy support and parent autonomy support have a mutually reinforcing effect, i.e., although the effect of parent autonomy support is not significant in the total model, parent autonomy support and teacher autonomy support have a mutually reinforcing effect on reducing students' addiction to online games, which is more helpful in reducing the probability of students' addiction to online games.

Analysis of the control variables revealed that male students were at greater risk of online game addiction compared to female students ($\beta = 0.273$, $p < 0.001$). Only children were at less risk of online game addiction than non-only children ($\beta = -0.101$, $p < 0.001$). Students with two or one absent parents were at greater risk of online game addiction than those with both parents ($\beta = 0.070$, $p < 0.05$). Students from urban families were at less risk of game addiction than students from rural families ($\beta = -0.018$, $p < 0.001$).

The mediating role of academic perseverance and academic motivation

To test the mechanism of action of autonomy support on reducing students' online game addiction, based on the previous literature review and theoretical analysis, the study selected academic perseverance and academic motivation as the mediating variables, and used the bias-corrected nonparametric percentile Bootstrap method to test the

mediating effects and estimated the 95% confidence intervals of the mediating effects (see Table 6). The results showed that the mediating effects of academic motivation ($\beta = -0.073$, 95% CI = [-0.095, -0.052]) and academic perseverance ($\beta = -0.080$, 95% CI = [-0.103, -0.058]) in the pathway of parental autonomy support on online gaming addiction reached statistical significance, and Hypotheses 3 and 5 were supported. In addition, the results of the comparison of the two mediating effects ($\beta = -0.006$, 95% CI = [-0.459, 0.033]) were not significant, i.e., there was no significant difference in the extent of the mediating effect between the two.

In the pathway of teacher autonomy support on online gaming addiction, the mediating effects of academic motivation ($\beta = -0.065$, 95% CI = [-0.092, -0.035]) and academic perseverance ($\beta = -0.078$, 95% CI = [-0.106, -0.050]) reached statistical significance, and Hypotheses 4 and 6 were supported. In addition, the results of the comparison of the two mediating effects ($\beta = -0.13$, 95% CI = [-0.065, 0.036]) were not significant, i.e., there was no significant difference in the degree of mediation between the two.

Discussion

Different characteristics of students to online game addiction

The findings suggest that there are differences in the degree of online game addiction among students with different background characteristics, which is consistent with previous studies [73,78,85]. Online game addiction is significantly lower in girls than in boys. According to Smith et al. [86], this may be attributed to males are more motivated than females to use the Internet and they are more likely to enjoy the stimulation of rewarding incentives gained in online games. Only child has a significantly lower risk of online game addiction than non-only children. This may be because there is a huge burden of family education in China, and multiple-child families may distract parents' educational attention, resulting in parents not being able to support each child's educational autonomy sufficiently.

TABLE 6

Results of parallel mediated effects of academic perseverance and academic motivation

Mediation effect test	Estimate	Bootstrap SE	Z-test	95% CI	
				Lower	Upper
Parental autonomy support → online game addiction					
Total effect	-0.113	0.013	-8.692	-0.138	-0.088
Direct effect	0.040	0.015	2.667	0.0103	0.067
Total indirect effect	-0.153	0.106	-1.443	-0.174	-0.133
Academic motivation indirect effect	-0.073	0.011	-6.636	-0.095	-0.052
Academic perseverance indirect effect	-0.080	0.012	-6.667	-0.103	-0.058
Comparative mediation effect	-0.006	0.02	-0.335	-0.459	0.033
Teacher autonomy support → online game addiction					
Total effect	-0.228	0.013	-17.538	-0.253	-0.202
Direct effect	-0.086	0.017	-5.059	-0.119	-0.052
Total indirect effect	-0.142	0.014	-10.143	-0.170	-0.115
Academic motivation indirect effect	-0.065	0.015	-4.333	-0.092	-0.035
Academic perseverance indirect effect	-0.078	0.015	-5.200	-0.106	-0.050
Comparative mediation effect	-0.130	0.026	-5.000	-0.065	0.036

The risk of online game addiction among students with long-term parental presence was significantly lower than that of students with long-term parental absence, which may be because the lack of parental education may lead to a sense of loneliness and thus addiction to online gaming [79]. Miao et al. [87] study also showed that low parental educational involvement is an adolescent online game addiction risk factor. Rural students are at greater risk of online game addiction, which is consistent with the findings of Li et al. [88] that there is a huge gap between urban and rural educational environments in China. Families in rural areas relatively are lacking in educational resources and advanced educational philosophy, and the lack of cultural capital of parents may lead to children's online game addiction [89].

We counted the average weekly online game time of our sample, and the average weekly online game time was 3.62 h, with 410 people (6.3%) playing more than 16 h per week and 105 people (1.7%) playing more than 32 h per week. According to a previous study, those at high risk of online game addiction were found to play more than 16.06 h per week on average [90]. This suggests that a certain percentage of Chinese junior high school students tend to become addicted to online games. According to the 52nd "Statistical Report on China's Internet Development" released by China Internet Network Information Center (CNNIC), China's netizens reach 1.079 billion in 2023, with 13.9% of them aged 10–19 years old, and the number of youth netizens is nearly 200 million. These results indicate that the current situation of Chinese junior high school students' addiction to online games is serious, and excessive playing of online games can lead to game disorders, become irresponsible and impulsive [91]. Apparently, alleviating

adolescents' addiction to online games is a major challenge in the basic education stage.

The relationship between parental and teacher autonomy support and students' online games addiction

Our study also found that parental and teacher autonomy support was significantly negatively related to students' online game addiction, and teacher autonomy support was more important. In other words, creating a favorable autonomy-supportive environment at both school and home can help to reduce the probability of students' addiction to online games. Previous studies have shown that the educational environment at home and school may be an important factor influencing students' online game addiction [87,92]. Since Chinese adolescents spend most of the daytime in school. They often experience high levels of academic performance expectations and suffer from academic stress. When there is a negative relationship with teachers, they may feel more stressed, resulting in utilizing Internet games as a coping method to vent their stress [87].

Whereas positive parental educational support may motivate adolescents to utilize the Internet in an appropriate and favorable way [93]. Good relationship between parents and effective parenting can provide a stable and healthy environment for growing up in and prevent them from engaging in risky behaviors, including excessive use of the Internet [87]. Some studies analyzed from the psychological need satisfaction perspective, which promotes positive behaviors and reduces various types of addictive behaviors among adolescents by facilitating students' multiple need satisfaction with autonomy support from parents and teachers [94]. This is consistent with Deci et al. self-determination theory [15], which states that when

individuals feel a sense of autonomy and competence, they are more likely to engage in positive, intrinsically motivated activities rather than become addicted to external stimuli such as online games.

Providing emotional support and understanding through the establishment of autonomy-supportive environment help students build intrinsic motivation and self-regulation, thus reducing the risk of online gaming addiction [95]. In the absence of autonomy-supportive environments, adolescents tend to become addicted to online games to fulfill their interpersonal needs and emotional support because the virtual online world can provide a happier environment for adolescents to avoid painful family conflicts [96].

The mediating role of academic motivation and academic perseverance

First, the study supported the mediating role of academic motivation and academic perseverance in the relationship between parental autonomy support and students' online game addiction. From the perspective of academic motivation, when parents respect their children's choices, encourage self-determination, and provide emotional support, children are more likely to be intrinsically interested in learning [16]. Further, motivation has been a strong factor in online game addiction in previous studies [97]. Intrinsic motivation leads to active exploration and engagement in learning activities, increasing learning efficiency and performance [98]. When students become more academically engaged, the risk of gaming Internet addiction may subsequently decline. From the perspective of academic perseverance, parental autonomy support comes with more solution strategies and a positive mindset when students suffer from academic difficulty, which enhances their academic perseverance. Subsequently, students' academic anxiety and stress are reduced, and they do not need to escape from the reality of academic obstacles, thus reducing gaming Internet addiction.

Second, we also indicated the mediating role of academic motivation and academic perseverance in the relationship between teacher autonomy support and students' online game addiction. Regarding to the mediating role of academic motivation, adolescents with higher teacher autonomy support and basic psychological needs satisfaction were intrinsically motivated to be engaged in their academics and to be more involved in school activities. Enhanced school experiences and positive goal pursuits protected these adolescents from becoming addicted to online games [21,99,100]. As for academic perseverance, teacher autonomy support helps students feel a sense of control over their own learning process. This sense of control enables students to better cope with challenges and setbacks, thereby increasing their resilience and persistence.

In summary, autonomy support environment students maintain academic motivation and perseverance when they encounter challenges so that they are not attracted to online games, which also enhances students' academic performance [101–103].

Educational Implications and Limitations

The results of this study provide significant insights into educational practice, starting with the strengthening of autonomy support in family and school education. First, parents should focus on providing emotional support and understanding for their children and fostering their children's intrinsic motivation and self-regulation skills. Parents can help their children reduce their dependence on online games through positive communication, understanding their children's needs and emotions, and building a relationship of trust. Second, teachers should create an atmosphere of independent learning in the classroom and encourage students to explore and learn independently. By designing interesting and challenging learning tasks, they can stimulate students' interest and intrinsic motivation. At the same time, teachers are supposed to pay attention to students' individual differences and provide personalized support and guidance to enhance students' academic perseverance. In addition, psychological counseling and educational programs can help students develop positive learning attitudes and behaviors. Finally, parents and teachers should maintain good communication and cooperation, develop educational strategies together, and pay attention to and respond to students' needs and problems in a timely manner, so as to form a joint effort to reduce students' addiction to online games.

Despite the important findings of this study, there are still some limitations. On the one hand, this study utilized a cross-sectional research design, making it difficult to determine causal relationship between autonomy support environment and online game addiction. In the future, a longitudinal study could be conducted to track students' behavioral changes over time to further explore the long-term effects of parental and teacher autonomy support on online game addiction. On the other hand, this study mainly relied on self-reported data, which may have social expectation bias. Future studies can combine multiple data collection methods, such as interviews, observations to increase the reliability and validity of the data. In addition, this study only explored the mediating roles of academic perseverance and academic motivation, and future studies could explore other potential mediating variables, such as emotional regulation, self-esteem, and social support, to fully understand the mechanisms of parental and teacher autonomy support on online game addiction. Despite these limitations, this study provides important theoretical and practical basis for understanding and intervening in online game addiction among middle school students.

Conclusions

Based on a survey and analysis of 6146 samples, the study identified parental and teacher autonomy support was negatively related to junior high student's online game addiction. Moreover, the study revealed the underlying psychological mechanism, i.e., the autonomy support environment indirectly reduces the occurrence of online

game addiction by enhancing students' academic motivation and academic persistence.

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Availability of Data and Materials: The anonymized data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to containing information that may comprise the participants' privacy.

Ethics Approval: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Suzhou Education Quality Monitoring Center (Ethical review number SZKT2023-LLSC03). All participants signed the informed consent in this study.

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