The Influence of Home Computer and Internet on Junior High School Students' Cognitive Ability: Evidence from China Education Panel Survey

Yue Liu[1], Jiacheng Gao[2]

[1] *Belarusian National Technical University, Minsk, Belarus*
E-mail: 18646335496@163.com
ORCID: https://orcid.org/0000-0001-9330-8861

[2] *Belarusian State University, Minsk, Belarus*
E-mail: 13951841399@163.com
ORCID: https://orcid.org/0000-0003-2087-2212

DOI: 10.26907/esd.20.1.02
EDN: GKZCRV
Submitted: 14 November 2023; Accepted: 26 December 2024

Abstract
Based on the China Education Panel Survey 2017-2018 school year baseline data and 2018-2019 school year follow-up data, this paper forms short panel data, and uses the unconditional fixed effect panel quantile regression method to discuss the impact of home computer and Internet on junior high school students' cognitive ability. The results show that: firstly, home computer and internet have significant improvement effect on junior high school students with moderate cognitive ability. Secondly, Parents' discipline on junior high school students' use of computers and the Internet has an inverted U-shaped on their cognitive development as a whole. Thirdly, for junior high school students with low level of cognitive ability, the quality of the school is more important to their cognitive ability development. Fourthly, "expectation friction" between junior high school students and their parents' educational expectations will limit the development of junior high school students' cognitive ability as a whole. According to this, on the one hand, the government should implement the access and use of junior high school students' home computers and the Internet. On the other hand, parents should play the role of guidance and supervision in the process of junior high school students' using home computers and Internet, communicate in a timely manner, and create a good environment for the students' use of home computers and Internet.
Keywords: home computer and internet, cognitive abilities, junior high school students, panel data, quantile regression method.

Влияние домашнего компьютера и Интернета на когнитивные способности учащихся младших классов средней школы: данные национального опроса «China Education Panel Survey»

Юэ Лю[1], Цзячен Гао[2]

[1] *Белорусский национальный технический университет, Минск, Белоруссия*
E-mail: 18646335496@163.com
ORCID: https://orcid.org/0000-0001-9330-8861

[2] *Белорусский государственный университет, Минск, Белоруссия*
E-mail: 13951841399@163.com
ORCID: https://orcid.org/0000-0003-2087-2212

DOI: 10.26907/esd.20.1.02
EDN: GKZCRV
Дата поступления: 14 ноября 2023; Дата принятия в печать: 26 декабря 2024

Аннотация
Основываясь на сведениях национального опроса «China Education Panel Survey» (2017/18 учебный год) и результатах 2018/19 учебного года, авторы данной статьи представляют полученные короткие панельные данные. Исследование проводилось методом квантильной регрессии с фиксированным эффектом, не ограниченным условиями. Оценивалось влияние домашнего компьютера и интернета на когнитивные способности учащихся младших классов средней школы. Результаты показывают, что: во-первых, домашний компьютер и интернет оказывают значительное положительное воздействие на учащихся младших классов средней школы с умеренными когнитивными способностями. Во-вторых, строгое отношение родителей к использованию компьютеров и интернета учащимися младших классов оказывает обратное влияние на когнитивное развитие последних в целом. В-третьих, для учащихся младших классов средней школы с низким уровнем когнитивных способностей качество обучения в школе более важно для развития вышеуказанных способностей. В-четвертых, неоправданные ожидания учеников младших классов и их родителей в отношении образования ограничивают когнитивное развитие учащихся младших классов в целом. В соответствии с этим, с одной стороны, правительство должно обеспечить учащимся младших классов доступ к использованию домашних компьютеров и интернета. С другой стороны, родители должны играть руководящую и контролирующую роль в использовании домашних компьютеров и интернета учащимися средней школы, постоянно общаться с детьми, чтобы создать благоприятную среду для образовательной деятельности.
Ключевые слова: домашние компьютеры и интернет, когнитивные способности, младшие школьники, панельные данные, метод квантильной регрессии.

Introduction

The current educational goal has changed from the past era of purely pursuing the academic achievements of junior high school students to the era of quality-oriented education of cultivating students' all-round development. In order to better realize all-round development, the cultivation of cognitive ability is crucial. The so-called cognitive ability refers to the human brain's ability to process, store and extract information. It is a person's "inner" ability. This "inner" ability will have a series of significant effects on the future development of junior high school students (Korniotis & Kumar, 2010). Cognitive ability not only has a positive effect on the academic performance of junior high school students, but also affects their future career choices and income. The stronger the cognitive ability, the higher their future wage income will be (Heckman et al., 2006;

Hanushek & Woessmann, 2008; Hora & Blackburn Cohen, 2018; Guo & Adenan, 2025). In addition, although the degree of self-control a person has over his or her behavior depends largely on the level of development of the frontal lobes of the brain, the role of cognitive ability cannot be ignored, and cognitive ability is also closely related to individual behavior results. Junior high school students with higher cognitive ability will adjust their emotions to prevent deviant behavior. Junior high school students with lower cognitive ability are more prone to deviant behavior because they cannot effectively manage their emotions (Dilchert et al., 2007). It is very important to clarify the factors that affect the development of junior high school students' cognitive ability. Schools and families are the main places for junior high school students' growth and development. Academic circles have launched a series of studies on this issue from the above two levels.

However, it should be noted that the current wave of digitalization is sweeping the world. As the underlying equipment and technology of the digital age, home computer and Internet have profoundly changed the way people live and work. So, will home computer and Internet have an impact on the cognitive ability development of junior high school students? If so, will it be a positive impact or a negative impact? Answering this series of questions will have important theoretical value and practical significance for promoting the development of junior high school students' cognitive ability in the background of the digital age. Therefore, based on the data of the China Education Panel Survey (CEPS), this study examines the impact of home computer and Internet on the cognitive ability development of junior high school students on the basis of controlling a series of characteristic variables at the family level and the school level, in order to contribute to the development of junior high school students' cognitive ability in the background of the digital age.

Literature Review

From the family level, Yue et al. (2018) found that the socio-economic status of the family had a positive and significant impact on the cognitive development of junior high school students. The cognitive level of junior high school students from poor families was 2% lower than that of their peers. The reason was that parents with high socio-economic status could purchase higher quality resources to invest in children's education, thus promoting the development of junior high school students' cognitive ability. In addition, parents' educational expectation is also an important path that affects the development of junior high school students' cognitive ability. Yamamoto & Holloway (2010) found that parents' positive educational expectations and career expectations can promote the cognitive ability of junior high school students. It can be explained that when parents have higher development expectations for junior high school students in the future, they will devote more education investment and affect their children's learning time to promote the development of junior high school students' cognitive ability (Figlio et al., 2017). From the school level, as the main place for junior high school students to study and live, schools also play an important role in the development of junior high school students' cognitive ability. Frenzel et al. (2010) pointed out that schools can weaken the influence of family background, such as family economic status and parents' social status, which are relatively difficult to change, on the development of junior high school students' cognitive ability. Xie et al. (2019) believe that the lack of school education is an important reason for the decline of junior high school students' cognitive ability.

In addition to external factors, junior high school students' own efforts will also significantly affect the development of cognitive ability, and there is a complementary relationship with their environment. Chevalier (2018) found that after entering junior high school, junior high school students will significantly improve their cognitive

development through their own efforts. Before that, due to their younger age, cognitive ability was mainly affected by environmental factors.

Through literature review, it can be found that although previous studies have achieved many results, the impact of home computers and Internet on junior high school students' cognitive ability is seldom considered. It should be noted that in the current digital era, home computer and Internet are profoundly changing the life state, thinking mode and development mode of junior high school students. When the home computer is connected to the Internet, the junior high school students will obtain a large amount of information. If the information can be fully utilized, it will greatly promote the development of junior high school students' cognitive ability. However, there is little research on this issue in the current academic circle, which focuses more on the discussion on the relationship between traditional factors such as family and school and junior high school students' cognitive ability (Frenzel et al., 2010; Yamamoto & Holloway, 2010; Tine, 2014; Figlio et al., 2017; Chevalier, 2018; Xie et al., 2019), and the data used are mostly cross-sectional data (Mills, 2016). Therefore, based on the CEPS 2017-2018 school year baseline data and 2018-2019 school year follow-up data, this paper composes short panel data and uses the unconditional fixed effect panel quantile regression method to analyze junior high school students' promotion from grade 7 (2017-2018 school year) to grade 8 (2018-2019 school year). This period is an important stage of cognitive development in life. How will home computer and Internet affect the cognitive ability of junior high school students? The contributions of this paper are reflected in the following three aspects: Firstly, the existing research rarely discusses the impact of home computer and Internet on junior high school students' cognitive ability. Therefore, in order to make up for the deficiencies of the existing research, this paper further enriches and expands the relevant literature and investigates the impact of home computer and Internet on the cognitive ability of junior high school students. Secondly, the existing research mostly uses cross-sectional data, and cannot make causal inference, nor can it investigate the dynamic development of junior high school students' cognitive ability. Therefore, this paper constructs panel data to dynamically analyze the development of junior high school students' cognitive ability. Thirdly, the existing research rarely examines the influence of home computer and Internet on the cognitive ability of junior high school students at different levels, which probably ignores the differences of cognitive ability among junior high school students, resulting in endogeneity. Therefore, on the basis of panel data, this paper introduces non-conditional quantile and controls individual fixed effects to avoid the endogeneity caused by the difference in the distribution of junior high school students' cognitive ability.

Methodology

1.1 Data Source and Processing

The data of this paper comes from the baseline data of 2017-2018 academic year and the follow-up data of 2018-2019 academic year of China Education Tracking Survey (CEPS) published by China Survey and Data Center of Renmin University of China. After eliminating the missing data, 9610 valid samples were obtained, and the short panel data were formed.

1.2 Variable Selection

1.2.1 Explained Variable

The explained variable of this paper is Student's Cognitive Ability (SCA), which was measured by the cognitive ability test result of junior high school students after the standardization of three-parameter IRT model in CEPS.

1.2.2 Core Explanatory Variables

The first core explanatory variable in this paper is Home Computer and Internet (HCI), which was measured by the corresponding question in CEPS: "Do you have a computer and Internet at home?". The question options include "No computer and no Internet", "Have computer but no Internet" and "Have computer and Internet", which were respectively assigned to 0, 1 and 2.

The second core explanatory variable of this paper is Parents' Discipline (PD) on junior high school students' use of home computers and Internet, which was measured by the corresponding question in CEPS: "Are you strict with your children's use of computers and the Internet?" The question options include "No discipline", "Not strict discipline" and "Strict discipline", which were respectively assigned to 1, 2 and 3.

In addition, to investigate whether there was an inverted U-shaped effect of parental discipline on junior high school students' cognitive development, a squared term for parental discipline on junior high school students' use of home computers and Internet was introduced (PD^2).

1.2.3 Control Variables

Referring to the related literatures (Mills, 2016; Moulton et al., 2021), this paper further added a series of control variables, such as Students' Educational Expectation (SEE), Parents' Educational Expectation (PEE), Mother's Educational Level (MEL), Subsistence Allowance (SA), Interest Class Expenses (ICE), Health Status (HS) and School Ranking (SR). Among them, in order to investigate whether there is "expectation friction" between junior high school student's educational expectations and parent's educational expectations, the interaction term (PT) between student's and parent's educational expectations was introduced. The assignment of each of the above variables was presented in Table 1.

Table 1. *Assignment of Variables*

variable	*Meaning and assignment of variables*
SCA	The results of cognitive ability test of junior high school students, the results of cognitive ability test of junior high school students after standardization of three-parameter IRT model in CEPS
HCI	Home Computer and Internet, No computer and no Internet =0; Have computer but no Internet =1; Have computer and Internet =1
PD	Parents' Discipline on Junior High School Students' Use of Home Computer and Internet, No discipline =1; Not strict discipline =2; Strict discipline =3
PD^2	The square item of parents' use of home computer and Internet discipline for junior high school students, No discipline =1; Not strict discipline =4; Strict discipline =9
SEE	Junior high school students' educational expectations, Drop out of school now = 1; Junior high school = 2; Technical secondary school/technical school = 3; Occupation = 4; High school = 5; College = 6; Undergraduate = 7; Master = 8; Doctor =9
PEE	Parents' educational expectations, Don't read it now = 1; Junior high school = 2; Technical secondary school/technical school = 3; Occupation = 4; High school = 5; College = 6; Undergraduate = 7; Master = 8; Doctor =9
PT	Interaction between junior high school students and parents' educational expectations
MEL	Mother's education level, Without any education = 1; Graduation from primary school = 2; Graduation from junior high school = 3; Graduated from technical secondary school/technical school = 4; Vocational high school graduation = 5; Graduation from high school = 6; College graduate = 7; Bachelor degree = 8; Master degree or above =9

variable	*Meaning and assignment of variables*
SA	Whether families receive subsistence allowances, Yes = 1; No =0
ICE	Education expenditure inside and outside the school, The tuition fees of junior high school students in this semester and the total fees of off-campus remedial classes/interest classes.
HS	The physical health status of junior high school students, Very bad = 1; Not so good = 2; General = 3; Good = 4; Very good =5
SR	The local ranking of junior high school students' schools, Worst = 1; Middle and lower = 2; Middle = 3; Upper = 4; Best =5

1.3 Model Setting

In this paper, the benchmark model is set as a linear model, and the linear model is chosen for better marginal analysis of explanatory variables. Build the following model:

$$SCA_{i,t} = \alpha_{i,t} + \beta_{i,t}HCI_{i,t} + \gamma_{i,t}PD_{i,t} + \partial_{i,t}PD^2{}_{i,t} + \sum \delta_{i,t}X_{i,t} + \varepsilon_{i,t}$$

In the above formula, $SCA_{i,t}$, $HCI_{i,t}$, $PD_{i,t}$, $PD^2{}_{i,t}$ and $\sum X_{i,t}$ respectively represent the Cognitive Ability, Home Computer and Internet, Parents′ Discipline, squared term of Parents′ Discipline, and a set of control variables including Students′ Educational Expectation, Parents′ Educational Expectation, Mother′s Educational Level, Subsistence Allowance, Interest Class Expenses, Health Status and School Ranking, for the i–th surveyed student in period t. $\beta_{i,t}$, $\gamma_{i,t}$, $\partial_{i,t}$ and $\sum X_{i,t}$ respectively represent the coefficients to be estimated before each variable. $\alpha_{i,t}$, and $\varepsilon_{i,t}$ respectively represent the constant term and the random perturbation term of the above equation.

1.4 Descriptive Statistic

Descriptive statistics of the above variables are shown in Table 2.

Table 2. *Descriptive Statistics of Variables*

variable	*2017-2018 academic year*	*2018-2019 academic year*
SCA	0.0122	0.3229
HCI	1.3170	1.3883
PD	2.6593	2.5565
PD^2	7.3602	6.8459
SEE	6.9305	6.7707
PEE	7.1581	6.9882
PT	49.3729	43.4969
MEL	3.8727	3.9834
SA	0.1090	0.1089
ICE	1806.0680	1702.2000
HS	4.1829	4.2026
SR	3.9363	3.9621
Sample Numbers	9610	9610

Note: The data in the table are compiled according to the baseline data of CEPS in 2017-2018 and the follow-up data of 2018-2019.

According to the observation table 2, The average value of Students′ Cognitive Ability (SCA) in Grade 8 was 0.303, which has significantly improved compared with Grade 7, indicating that it is an important cognitive ability development stage for junior high school students from Grade 7 to Grade 8. The average value of Home Computer and Internet (HCI) was about 1.3. Overall, the majority of families had home computers, but networking rate was low. The average value of Parents' Discipline (PD) was about 2.6, which meant that the parents imposed strict discipline on the students. In addition, it should be noted that Parents' Educational Expectation (PEE) was higher than Students' Educational Expectation (SEE) by about 0.2, indicating that there was "expectation friction".

Empirical Analysis

2.1 Mean Regression Analysis

In order to control the endogenous influence as much as possible, this paper firstly uses the fixed effect panel model to analyze the influencing factors of junior high school students' cognitive ability by mean regression, and the corresponding regression result is presented in Table 3.

Table 3. *Mean Regression Analysis of Students' Cognitive Ability*

Variable	*Coefficient*	*Std. Error*	*T-value*	*P-value*
HCI	0.1051**	0.0411	2.55	0.011
PD	0.5361**	0.2636	2.03	0.042
PD^2	-0.1355**	0.0568	-2.38	0.017
SEE	0.0867**	0.0406	2.13	0.033
PEE	0.0724**	0.0365	1.98	0.048
PT	-0.0152***	0.0057	-2.65	0.008
MEL	2.19e-06	0.0168	0.00	1.000
SA	-0.0742	0.0685	-1.08	0.279
ICE	3.70e-06	4.07e-06	0.91	0.363
HS	0.0253	0.0240	1.05	0.292
SR	0.0868**	0.0402	2.16	0.031
Constant	-1.1095***	0.4283	-2.59	0.010
F	3.48***			

Note: *** represents p<0.01; ** represents p<0.05; * represents p<0.1.

According to the regression results in Table 3, the coefficient of Home Computer and Internet (HCI) is 0.1051, which is significant at the level of 1%. This indicates that home computer and Internet have a significant positive impact on the development of junior high school students' cognitive ability, and every unit of its numerical value will increase junior high school students' cognitive ability by 0.1051. Under the background of the current digital age, junior high school students can have more information interactions with the Internet with the help of home computers, which will contribute

to the development of their cognitive ability. Parents' Discipline (PD) on junior high school students' use of home computer and Internet has an inverted U-shaped on their cognitive ability development, which indicates that parents should pay attention to the principle of moderation in disciplining junior high school students' use of home computer and Internet, otherwise it will be detrimental to the development of junior high school students' cognitive ability. At the same time, according to the regression analysis of the whole sample, the best point can be calculated as 1.97, which indicates that parents should discipline junior high school students in using home computers and Internet, but it should not be too strict. After all, it is the digital age, and excessively restricting junior high school students' use of home computers and Internet will make them out of the current digital environment.

In terms of control variables, the coefficients of Students' Educational Expectation (SEE) and Parents' Educational Expectation (PEE) are 0.0867 and 0.0724, respectively, both of which are significant at the level of 5%, indicates that both junior high school students' educational expectation and parents' educational expectation have significantly improved junior high school students' cognitive ability. The coefficient of interaction (PT) is -0.0152 and significant at 1% level of significance, it indicates that "expectation friction" between students and parents has a negative effect on junior high school students' cognitive ability. The coefficient of School Ranking (SR) of junior high school students' schools is 0.0868, which is significant at the level of 5%, indicates that as school ranking improves, junior high school students' cognitive ability will also improve further. The coefficients of Mother's Educational Level (MEL), Interest Class Expenses (ICE) and Health Status (HS) are all positive, which indicates that they will contribute to the development of junior high school students' cognitive ability to some extent. Although the coefficient of Subsistence Allowance (SA) is not significant, the sign is negative, which may indicate that the families receiving the minimum living allowance restrict the development of junior high school students' cognitive ability to some extent due to the comprehensive influence of many factors.

2.2 Quantile Regression Analysis

In order to prevent the results from being interfered by extreme values and avoid the endogenous problems caused by the difference of cognitive ability distribution, this paper further adopts the quantile regression model of unconditional fixed effect panel to investigate the influence of Home Computer and Internet (HCI) and Parents' Discipline (PD) on junior high school students' cognitive ability development at different cognitive ability levels, and divides them into 10 percentile, and defines the 10-percentile, 20-percentile and 30-percentile as low cognitive ability levels of junior high school students. The 40-percentile, 50-percentile and 60-percentile are defined as middle cognitive ability levels of junior high school students. The 70-percentile, 80-percentile and 90-percentile are defined as high cognitive ability levels of junior high school students. Actually, the results are presented in Table 4, Table 5 and Table 6.

Table 4. *Regression Analysis of Students' Cognitive Ability in Low Percentile*

Variable	*10-percentile*	*20-percentile*	*30-percentile*
HCI	0.0453 （0.0679）	0.0215 （0.0513）	0.0690 （0.0508）
PD	0.3463 （0.5015）	0.3102 （0.3380）	0.3627 （0.3314）

Variable	*10-percentile*	*20-percentile*	*30-percentile*
PD^2	-0.0750 （0.1057）	-0.0782 （0.0720）	-0.0982 （0.0706）
SEE	-0.1113 （0.1029）	-0.0170 （0.0654）	0.0728 （0.0609）
PEE	-0.0443 （0.0960）	-0.0160 （0.0596）	0.0548 （0.0552）
PT	0.0092 （0.0136）	-0.0006 （0.0087）	-0.0141* （0.0082）
MEL	-0.0107 （0.0284）	0.0037 （0.0185）	0.0004 （0.0196）
SA	-0.0242 （0.1381）	-0.0795 （0.0909）	-0.1496* （0.0903）
ICE	9.05e-07 （5.87e-06）	3.26e-06 （5.31e-06）	4.60e-06 （5.26e-06）
HS	0.0426 （0.0414）	0.0379 （0.0295）	0.0227 （0.0291）
SR	0.1161* （0.0674）	0.1283** （0.0508）	0.1217** （0.0494）
Constant	-1.3697 （0.9411）	-1.2373** （0.6099）	-1.3350** （0.5792）
F	0.72	1.51	2.73***

Note: *** represents p<0.01; ** represents p<0.05; * represents p<0.1. Numbers in parentheses are standard errors.

According to the regression result in Table 4, when junior high school students are in low cognitive ability, that is, at the 40-percentile, 50-percentile and 60-percentile, the coefficients of the influence of Home Computer and Internet (HCI) on Student's Cognitive Ability (SCA) are 0.0453, 0.0215 and 0.0690, respectively, but none of them is significant. From the coefficient point of view, with the improvement of quantile, the coefficient of the influence of Home Computer and Internet (HCI) on junior high school students' cognitive ability decreases slightly in the 20 quantiles, but increases distinctly in the 30 quantiles compared with the 10 quantiles and the 20 quantiles. This may be because junior high school students will devote more time and energy to entertainment preferences when their cognitive ability is low, and they can't absorb the information value brought by home computers and Internet. When junior high school students' cognitive ability is gradually improved, they will put more energy into their learning preferences. For home computers and Internet, they will also be used more fully, so they can solve their doubts for themselves. In contrast, School Ranking (SR) not only has a significant positive impact on junior high school students' cognitive ability, but also its coefficients are 0.1161, 0.1283 and 0.1217, respectively, which are much higher than those of Home Computer and Internet (HCI). This indicates that when junior high school students' cognitive ability is low, the school is very important to promote the development of junior high school students' cognitive ability.

Table 5. *Regression Analysis of Students' Cognitive Ability in Middle Percentile*

Variable	*40-percentile*	*50-percentile*	*60-percentile*
HCI	0.1107** (0.0477)	0.1051** (0.0411)	0.0923** (0.0392)
PD	0.5100* (0.3118)	0.5361** (0.2636)	0.2931 (0.2708)
PD^2	-0.1280** (0.0669)	-0.1355** (0.0568)	-0.0765 (0.0582)
SEE	0.0825 (0.0534)	0.0867** (0.0406)	0.0662* (0.0358)
PEE	0.0579 (0.0477)	0.0724** (0.0365)	0.0542* (0.0323)
PT	-0.0154** (0.0073)	-0.0152*** (0.0057)	-0.0109** (0.0051)
MEL	0.0029 (0.0187)	2.19e-06 (0.0168)	-0.0004 (0.0167)
SA	-0.0795 (0.0801)	-0.0742 (0.0685)	-0.0081 (0.0632)
ICE	3.19e-06 (4.17e-06)	3.70e-06 (4.07e-06)	1.78e-06 (3.54e-06)
HS	0.0367 (0.0277)	0.0253 (0.0240)	0.0256 (0.0229)
SR	0.1214** (0.0477)	0.0868** (0.0402)	0.0433 (0.0396)
Constant	-1.3975*** (0.5256)	-1.1095** (0.4283)	-0.4687 (0.4102)
F	3.34***	3.48***	1.75*

Note: *** represents p<0.01; ** represents p<0.05; * represents p<0.1. Numbers in parentheses are standard errors.

According to the regression result in Table 5, when junior high school students are in middle cognitive ability, that is, at the 40-percentile, 50-percentile and 60-percentile, the coefficients of the influence of Home Computer and Internet (HCI) on Student's Cognitive Ability (SCA)are 0.1107, 0.1051 and 0.0923, respectively, which are not only significant at the 5% level, Moreover, the coefficient values are all higher than 0.0453, 0.0215 and 0.0690 corresponding to the 10-percentile, 20-percentile and 30-percentile, which indicates that Home Computer and Internet (HCI) will have a positive impact on the students with middle cognitive ability, and greatly improve their cognitive ability. In addition, at the 40-percentile and the 50-percentile, there is an inverted U-shaped relationship between Parents' Discipline (PD) and Student's Cognitive Ability (SCA), which indicates that when the cognitive ability of junior high school students develops to a middle level, the influence of parents' discipline on junior high school students' cognitive ability firstly increases and then decreases, and proper discipline can better improve junior high school students' cognitive ability. Through calculation, it can be concluded that the best points at the 40-percentile and the 50-percentile are 1.992 and 1.971, respectively. That is, with the continuous improvement of junior high school students' cognitive ability, parents need to relax the discipline of junior high school students to a certain extent, and if parents blindly carry out strict discipline, it will hinder them.

Table 6. *Regression Analysis of Students' Cognitive Ability in High Percentile*

Variable	*70-percentile*	*80-percentile*	*90-percentile*
HCI	0.0794** (0.0405)	0.0358 (0.0346)	0.0344 (0.0401)
PD	0.4443* (0.2721)	0.3846 (0.2425)	0.1950 (0.2935)
PD^2	-0.1050** (0.0589)	-0.0865 (0.0528)	-0.0407 (0.0644)
SEE	0.0640* (0.0341)	0.0351 (0.0300)	0.0157 (0.0304)
PEE	0.0473 (0.0293)	0.0112 (0.0253)	0.0132 (0.0271)
PT	-0.0109** (0.0049)	-0.0040 (0.0044)	-0.0028 (0.0048)
MEL	0.0021 (0.0177)	-0.0034 (0.0161)	0.0048 (0.0203)
SA	-0.0102 (0.0665)	-0.0499 (0.0520)	-0.0143 (0.0517)
ICE	2.70e-07 (3.41e-06)	2.50e-06 (3.37e-06)	3.06e-06 (4.13e-06)
HS	0.0175 (0.0243)	0.0060 (0.0219)	0.0007 (0.0253)
SR	0.0696* (0.0409)	0.0013 (0.0347)	0.0717* (0.0401)
Constant	-0.3843 (0.3947)	0.3544 (0.3507)	0.5899 (0.4156)
F	1.69*	0.69	0.51

Note: *** represents p<0.01; ** represents p<0.05; * represents p<0.1. Numbers in parentheses are standard errors.

According to the regression results in Table 6, when junior high school students are in high cognitive ability, that is, at the 70-percentile, 80-percentile and 90-percentile, the coefficients of the influence of Home Computer and Internet (HCI) on Student's Cognitive Ability (SCA) are 0.0794, 0.0358 and 0.0344, respectively. However, it was significant only at the 70-percentile, but not at the 80-percentile and the 90-percentile, and the coefficient decreases with the increases of the percentile. Combined with the regression result of Table 4 and Table 5 for junior high school students in low and middle cognitive ability, it can be found that the coefficient of the influence of Home Computer and Internet (HCI) on their cognitive ability is increasing and the significance is constantly increasing in the process of increasing from the 10-percentile to the 50-percentile, while in the process of increasing from the 50-percentile to the 90-percentile, the coefficient of the influence of Home Computer and Internet (HCI) on junior high school students' cognitive ability shows a decreasing trend and its significance keeps decreasing, which indicates that in the process of developing junior high school students' cognitive ability from a low level to a middle level, Home Computer and Internet (HCI) has a significant incremental impact on their cognitive ability, while in the process of developing junior high school students' cognitive ability from a middle level to a high level, it is affected by the law of diminishing marginal utility, although the development of their cognitive ability is still influenced by Home Computer and Internet (HCI). In addition, on the 70-percentile, Parents' Discipline

(PD) still has an inverted U-shaped influence on Student's Cognitive Ability (SCA), and the best point is 2.114, which is higher than that of the 40-percentile and the 50-percentile, while on the 80-percentile, only squared term of parents' discipline (PD^2) is still significant and the coefficient is negative, when reaching 90-percentile, Parents' Discipline (PD) and its squared term (PD^2) are not significant, which may indicate that when the cognitive ability of junior high school students is at a middle level (40-60 percentiles), because their use of home computers and Internet may be in a groping stage, parents need to give them space to explore and conduct appropriate discipline. However, when junior high school students' cognitive ability is in a lower level at a high level (70 percentile), although they are fully skilled in using home computers and Internet, and can interact with Internet more fully, junior high school students have not deeply been involved in the world after all, and probably can't control this amount of information interaction well. In order to prevent junior high school students from going astray, parents need to discipline them more strictly to help them thoroughly form good usage methods and habits. When junior high school students' cognitive ability really reaches a higher level (80 percentile and above), junior high school students already have the cognitive ability to control this amount of information interaction. At this time, if strict discipline is imposed on them, it will hinder the development of their cognitive ability.

Discussion

This study uses the unconditional fixed effect panel quantile regression method to quantitatively examine the impact of home computers and Internet on the cognitive ability of junior high school students at different cognitive levels. This study finds that home computers and Internet can indeed significantly promotes the cognitive ability of junior high school students as a whole, but home computers and Internet do not have a statistically significant promoting effect on the cognitive ability of junior high school students at the high cognitive levels and the low cognitive levels. In fact, home computers and Internet can only significantly promote the cognitive ability of junior high school students at the middle cognitive levels. However, since the cognitive ability of most junior high school students in the sample is at the medium levels, a very confusing overall conclusion is produced. The reason for this result is that the estimation results are affected by the differences in the distribution of cognitive ability among junior high school students, and thus resulting the endogenous effect. Therefore, on the basis of controlling individual fixed effects, the introduction of unconditional quantiles can not only further analyze the heterogeneity of the research conclusions, but also effectively control the endogenous effect of the differences in the cognitive ability distribution of junior high school students on the estimation results.

At the same time, this study also examines the non-linear impact of parents' discipline on the cognitive ability development of junior high school students. It is found that as the cognitive levels of junior high school students improve, parents should appropriately relax the supervision of junior high school students' use of home computers and Internet, giving them more space to use, otherwise it will be counterproductive. In addition, the quality of the school has a significant promoting effect on the cognitive ability development of junior high school students, especially those at the low cognitive levels. This conclusion is consistent with the research conclusions of Frenzel et al. (2010), Chevalier (2018) and Xie et al. (2019). Of course, parents' educational expectations can significantly promote the cognitive ability development of junior high school students, which is consistent with the research conclusions of Brehm & Silova (2014) and Figlio et al. (2017), but different from existing research, this study also finds that if there is "expectation friction" in educational expectations between junior high school students and their parents, the "expectation

friction" can significantly inhibit the cognitive ability development of junior high school students.

In summary, in the context of the current digital era, this study fully reviews the existing literature on the cognitive development of junior high school students and finds that the existing research rarely examines the impact of the Internet, the underlying technology of the digital era, on the cognitive ability development of junior high school students. To this end, this study further examines the impact of home computers and Internet on the cognitive ability development of junior high school students from the perspective of empirical analysis, breaking through the lack of existing research on the impact of home computers and Internet, an emerging factor that contains the background of the digital era, and the research conclusions with policy implications are drawn. However, this study also has certain shortcomings. The CEPS is not a continuous year-by-year follow-up survey in the traditional sense. It is a two-year period, but the interval between each period of CEPS is not a year. This has resulted in its latest public data can only form very short panel data. Although this study has used the unconditional fixed effect panel quantile regression method to control the interference of potential endogenous factors on the estimation results as much as possible, it may not yet absolutely clearly clarify the net impact of home computers and Internet on the cognitive ability of junior high school students. In addition, although the introduction of quantile conditions can examine the differential effects of home computer and Internet on the cognitive ability of junior high school students under different cognitive ability levels, it is impossible to examine the differences in the effects of changes in the accessibility levels of home computer and Internet on the cognitive ability of junior high school students, that is, it is impossible to examine the nonlinear effects of home computer and Internet on the cognitive ability of junior high school students. Therefore, in future research, the panel threshold model should be introduced tentatively to more deeply explore the relationship between home computer and Internet and the cognitive ability of junior high school students.

Conclusions and Recommendations

3.1 Conclusions

Under the background of digital age, this paper uses China Education Panel Survey (CEPS) 2017-2018 school year baseline data and 2018-2019 school year follow-up data to form short panel data, and uses unconditional fixed effect panel quantile regression method to investigate the impact of home computer and Internet and parents' discipline on junior high school students' cognitive ability development from different quantiles. The study finds:

1) Home computers and Internet have a significant effect on improving junior high school students' cognitive ability at middle cognitive levels.

2) Parents' discipline on junior high school students' use of home computer and Internet has an inverted U-shaped effect on the development of students' cognitive ability.

3) For junior high school students with low level of cognitive ability, the quality of the school is more important to their cognitive ability development.

4) The "expectation friction" between junior high school students' educational expectation and parents' educational expectation will limit the development of junior high school students' cognitive ability as a whole.

3.2 Recommendations

The research conclusions of this paper have important policy implications for promoting the development of junior high school students' cognitive ability under the current Internet background, and put forward the following three suggestions:

1) Effectively guarantee the access of junior high school students' home computers to the Internet. According to the statistics of the Ministry of Education, the Internet access rate of schools across the country has reached 100%, and 95.2% of schools have multimedia classrooms, basically eliminating the "physical access" difference between urban and rural schools. However, the learning places of junior high school students are not only limited to the classroom, but also the access of computers and the Internet in the family will have an important effect on them. In particular, junior high school students from poor families can obtain a large amount of learning resources through the correct and effective use of home computer and Internet, make up for the uneven distribution of educational resources, narrow the educational gap and promote the realization of educational equity. However, the cost of computers and broadband network is not cheap. It is necessary for the government to introduce corresponding preferential policies. For example, junior high school students' families can purchase computers at a lower price, and certain subsidies can be given for broadband services to protect junior high school students' families' access to the use of computers and the Internet.

2) In the process of using the Internet, parents should play the role of guidance and supervision. For junior high school students with low cognitive ability, the way to improve cognitive ability is still mainly through school education. As the main place for the growth and development of junior high school students, schools should make more efforts to promote the development of junior high school students' cognitive ability. At the same time, when the junior high school students use the Internet, their parents should supervise them more, control the time of Internet entertainment activities, guide the junior high school students to focus on "serious application preference" instead of "entertainment application preference", cultivate healthy and scientific Internet use behavior, avoid the excessive entertainment application of information technology by the junior high school students, and prevent Internet addiction. However, for junior high school students with strong cognitive ability, parents should give them more free use of space, appropriate supervision and give them more trust.

3) During the growth of junior high school students, parents should communicate with them in time to avoid "expectation friction". Only when parents and junior high school students have the same educational expectation, can junior high school students realize expectation, care from parents' communication and companionship, be inspired, strengthen the motivation to realize expectation, and ultimately have a positive impact on the development of junior high school students' cognitive ability. Otherwise, the parents' high expectations will only bring too much psychological burden to the junior high school students, which is not conducive to the development of the junior high school students' cognitive ability.

Conflicts of Interest

The authors declare no conflict of interest.

References

Brehm, W. C., & Silova, I. (2014). Hidden privatization of public education in Cambodia: Equity implications of private tutoring. *Journal for educational research online*, *6*(1), 94-116. https://doi.org/10.25656/01:8842

Chevalier, N. (2018). Willing to think hard? The subjective value of cognitive effort in children. *Child development*, *89*(4), 1283-1295. https://doi.org/10.1111/cdev.12805

Dilchert, S., Ones, D. S., Davis, R. D., & Rostow, C. D. (2007). Cognitive Ability Predicts Objectively Measured Counterproductive Work Behaviors. *Journal of Applied Psychology*, *92*(3), 616-627. https://doi.org/10.1037/0021-9010.92.3.616

Figlio, D. N., Freese, J., Karbownik, K., & Roth, J. (2017). Socioeconomic status and genetic influences on cognitive development. *Proceedings of the National Academy of Sciences*, *114*(51), 13441-13446. https://doi.org/10.1073/pnas.1708491114

Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. G. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of research on adolescence*, *20*(2), 507-537. https://doi.org/10.1111/j.1532-7795.2010.00645.x

Guo, Y., & Adenan, A. (2025). The Effects of Cognitive and Non-Cognitive Abilities on Labor's Income in China. *ICCCM Journal of Social Sciences and Humanities*, *4*(1), 26-32. https://doi.org/10.53797/icccmjssh.v4i1.5.2025

Hanushek, E. A., & Woessmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, *46*(3), 607-668. https://doi.org/10.1257/jel.46.3.607

Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The Effects of Cognitive and Noncognitive ability on Labor Market Outcomes and Social Behavior. *NBER Working Papers*, *24*(3), 411-482. https://doi.org/10.1086/504455

Hora, M. T., & Blackburn Cohen, C. A. (2018). Cultural capital at work: How cognitive and noncognitive skills are taught, trained, and rewarded in a Chinese technical college. *Community College Review*, *46*(4), 388-416. https://doi.org/10.1177/0091552118784352

Korniotis, G. M., & Kumar, A. (2010). Cognitive abilities and financial decisions. *Behavioral finance: Investors, corporations, and markets*, 559-576. https://doi.org/10.1002/9781118258415.ch30

Mills, K. L. (2016). Possible effects of internet use on cognitive development in adolescence. *Media and Communication*, *4*(3), 4-12. https://doi.org/10.17645/mac.v4i3.516

Moulton, V., Goodman, A., Nasim, B., Ploubidis, G. B., & Gambaro, L. (2021). Parental wealth and children's cognitive ability, mental, and physical health: evidence from the UK Millennium Cohort Study. *Child Development*, *92*(1), 115-123. https://doi.org/10.1111/cdev.13413

Tine, M. (2014). Working memory differences between children living in rural and urban poverty. *Journal of Cognition and Development*, *15*(4), 599-613. https://doi.org/10.1080/15248372.2013.797906

Xie, W., Sandberg, J., Huang, C., & Uretsky, E. (2019). Left-behind villages, left-behind children: Migration and the cognitive achievement of rural children in China. *Population, space and place*, *25*(8), e2243. https://doi.org/10.1002/psp.2243

Yamamoto, Y., & Holloway, S. D. (2010). Parental expectations and children's academic performance in sociocultural context. *Educational Psychology Review*, *22*, 189-214. https://doi.org/10.1007/s10648-010-9121-z

Yue, A., Gao, J., Yang, M., Swinnen, L., Medina, A., & Rozelle, S. (2018). Caregiver depression and early child development: a mixed-methods study from rural China. *Frontiers in Psychology*, *9*, 2500. https://doi.org/10.3389/fpsyg.2018.02500