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The effects of children's Internet use: A Chinese longitudinal study

Los efectos del uso de Internet por niños: Un estudio longitudinal en China

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ABSTRACT

In this study, we investigate the mediating effects of children's Internet use on the relationship between family socioeconomic status and their academic achievement, and whether the mediating effects vary across different academic subjects. We used the data from the China Family Panel Studies on the socioeconomic status of children's families, children's Internet use, and their academic performance. In the 2014 sample, there were 2,686 participants (females=1,272). In 2016, there were 2,330 participants (females=1,069), and in 2018, there were 2,485 participants (females=1,151). The socioeconomic status and the Internet use were measured by a questionnaire. Standardized tests measured the academic performance. Our findings showed that family socioeconomic status was positively related to math performance, but not significantly related to Chinese performance. The results also indicated that Internet use did not significantly mediate the relationship between family socioeconomic status in 2014 and math performance in 2016, while the frequency of Internet use to study in 2016 partly mediated the relationship between family socioeconomic status in 2016 and math performance in 2018. Our findings suggest that Internet use can only mediate the relationship between family socioeconomic status and math performance and the mediating effects become stronger over time.

RESUMEN

En este estudio investigamos los efectos mediadores del uso de Internet por parte de los niños en la relación entre el nivel socioeconómico de la familia y su éxito académico y si los efectos mediadores varían entre diferentes disciplinas académicas. Usamos los datos de Estudios de Paneles de las Familias Chinas sobre el nivel socioeconómico de las familias de los niños, el uso de Internet por parte de los niños y su rendimiento académico. Hubo 2.686 participantes en 2014 (mujeres=1.272), 2.330 participantes (mujeres=1.069) en 2016 y 2.485 participantes (mujeres=1.151) en 2018. El estado socioeconómico y el uso de Internet se midieron mediante un cuestionario. Las pruebas estandarizadas midieron el rendimiento académico. Nuestros hallazgos mostraron que el nivel socioeconómico de la familia se relaciona positivamente con el éxito en matemáticas, pero no significativamente con los puntajes chinos. Los resultados indicaron que el uso de Internet no mediaba en la relación entre el estatus socioeconómico familiar en 2014 y el rendimiento matemático en 2016, mientras que la frecuencia de uso de Internet para estudiar en 2016 mediaba en parte la relación entre el estatus socioeconómico familiar en 2016 y el rendimiento matemático en 2018. Nuestros hallazgos proponen que el uso de Internet sólo puede mediar en la relación entre el nivel socioeconómico de la familia y el éxito en matemáticas, y los efectos mediadores se vuelven más fuertes con el paso del tiempo.

KEYWORDS | PALABRAS CLAVE

Socioeconomic status, Internet, academic achievement, children, math, language.
Nivel socioeconómico, Internet, éxito académico, niños, matemáticas, idiomas.

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1. Introduction

The Internet is an integral part of the daily lives of children and adolescents. It's not surprising to see a 5-year-old child using an iPad, watching videos on Apps or playing games. Children now have greater autonomy in Internet use and are subjected to its influence from an early age (Kirkorian & Anderson, 2008). Over the past ten years, researchers have paid more attention to how the Internet mediates the effects of the real world on children's developmental outcomes rather than to examine its direct effects. They are interested in investigating whether the influence of family, education, culture and society is reconfigured in the technical age or not (Livingstone et al., 2017).

Among the diverse developmental outcomes, there is no doubt that academic achievement is not only an important indicator of children's learning abilities, but also a key outcome to see the influence of family, educators, culture, and society. Recently, a longitudinal study in Switzerland revealed the mediating role the Internet played in the relationship between family socioeconomic status and children' s academic performance (Camerini et al., 2018). They found that children with lower socioeconomic status used the Internet more frequently for entertainment and online communication which reduced their academic performance.

However, until now, few studies have examined whether this phenomenon can be generalized to other cultures. In the present study, we first examine the mediating effects of children's Internet use on the relationship between socioeconomic status and academic performance in a Chinese sample. In previous research, some evidence showed that the strength of the relationship between Internet use and academic performance varied across different academic domains (Habriichuk & Tulchak, 2017; Zhou et al., 2020 Gómez-García et al., 2020). Hence, the second objective of the present study is to investigate whether the mediation is consistent across different academic domains.

1.1. Socioeconomic status and academic performance

Since Brooks-Gunn and Duncan' s work (1997) which revealed a high correlation between children' s academic achievement and their parents" occupation, numerous studies have documented that socioeconomic status (SES) which was usually measured by parents' jobs, parents' education attainment, and family income was associated with children's school achievement and intelligence (Liu & Xie, 2015; Marks & Pokropek, 2019; Baker et al., 2018; Assari et al., 2020). As families can transfer advantages to their children via their greater resources (Duncan et al., 1994), "powerful parents" usually help children get better education resources (Liu & Xie, 2015). By contrast, children who experience greater socioeconomic adversity, in particular during early developmental periods, exhibit lower academic achievement compared to their peers from socio-economically advantaged backgrounds (Bradley & Corwyn, 2002; Farooq et al., 2011; Fergusson et al., 2008).

In empirical research, a number of studies from different countries have found that family's SES is related to children's academic achievement in general (Liu & Xie, 2015; Marks & Pokropek, 2019; Baker et al., 2018; Assari et al., 2020) as well as achievements in math (Anders et al., 2012; DeFlorio & Beliakoff, 2015; Wang et al., 2014; Gómez-García et al., 2020), and reading (Cheng & Wu, 2017; Liu et al., 2016). However, there are also some inconsistent findings regarding this relationship across different academic domains. For example, based on a rural basic education survey of elementary school students (from Gansu province, China), Park and Hannum's study (2001) found that parents' educational level was related to students' math performance but not related to Chinese language performance.

1.2. Socioeconomic status and Internet use

In the past, purchasing media devices and supporting an Internet connection were so expensive that they posed a financial barrier for low socioeconomic status families to access the Internet (Resta, 1992; Sutton, 1991). Hence, there was a digital divide (first-order) which is described as a binary opposition between those who had access to online technologies and those who did not (Mascheroni & Ólafsson, 2015; Norris, 2001). With the development of digital technology, the cheap cost of Internet access and the common use of smart phones are making the first-order digital divide gradually disappear. The digital divide was no longer about owning media devices or not, but about the difference in Internet using skills.

More specifically, the digital divide (second-order) has been defined as a user's competence to transform the information reached on the web into knowledge (Hargittai, 2001; Dijk & Hacker, 2003).

Some previous western studies have confirmed the existence of a second-order digital divide (Park, 2015; Scheerder et al., 2017; Vigdor et al., 2014). Children from families with higher SES possibly use the Internet for informational needs, while those from lower SES families use the Internet more frequently for entertainment. In China, the Internet usage by children and adolescents has changed a lot during the past decade. In 2005, there were only about 16 million Chinese teenagers who could access the Internet (Cao & Su, 2007), but about 175 million teenagers had online access by June 2018 (China Internet Network Information Center, 2018), which indicates that the first-order digital divide is gradually disappearing in China. However, until now, little is known about the phenomenon of digital divide (second-order) in an Eastern context (Camerini et al., 2018).

1.3. Internet use and academic achievement

There is no doubt that the Internet is a powerful learning environment. In terms of the relationship between children's Internet use and academic performance, there have been mixed findings. Fairlie and Robinson (2013) conducted a field experiment which randomly provided free computers for home use to 1,123 grade 6-10 students in California, they found increased computer ownership and use did not influence children's educational outcomes. Hunley et al. (2005) also found that the correlation between computer use and adolescents' grade point was not significant. Meggiolaro's (2018) study revealed that Internet use was not associated with children's mathematical achievement. However, several other empirical studies have documented both positive (Kim et al., 2017; Mitra, 2019) and negative (Stavropoulos et al., 2013; Huang, 2018) effects of Internet use on academic achievement.

Moreover, some evidence has implied that different purposes of using the Internet might deferentially influence children's academic outcomes (Camerini et al., 2018). For example, Kubey et al. (2001) found that recreational Internet use was significantly correlated with poorer academic achievement, Kim et al. (2017) found that using the Internet to study for more than 2 hours per day was positively correlated with Korean adolescents' academic achievement.

Additionally, some studies showed that the strength of the relationship between Internet use and academic performance varied across different academic domains (Habriichuk & Tulchak, 2017; Zhou et al., 2020; Gómez-García et al., 2020; Mitra, 2019). For instance, Internet use could improve children's reading comprehension (Mitra, 2019), while it was not associated with children's mathematical achievement (Meggiolaro, 2018).

1.4. Research hypotheses

In the present study, we investigate the mediating effects of the different purposes for children's Internet use on the relationship between family's SES and their academic achievement, and whether the mediating effects vary across different academic subjects.

Based on the previous findings, we expect that (1) children's Internet use can mediate the relationship between family's SES and their academic achievement; and (2) the academic domain can moderate the mediating effects.

2. Material and methods

2.1. Data source

In this study, we used the data from a national longitudinal survey: the China Family Panel Studies (Xie, 2012). The baseline survey of the CFPS started in 2010. It collected data of 33,600 adults and 8990 children from 14,960 families and 634 communities, which cover 25 provinces, municipalities, and autonomous regions in China. A number of variables in several different areas such as health, education, and sociology were measured. As a longitudinal project, the participants were invited to complete the questionnaire again every 2 years.

In the present study, we used data on the socioeconomic status of children's families (2014 and 2016), Internet use (2014 and 2016), and academic performance (2014, 2016, and 2018). In the 2014

sample, there were 2,686 participants (females=1,272, 47.36%). The mean ages of males and females were 12.42 (SD=1.75) and 12.52 (SD=1.75), respectively. In 2016, there were 2,330 participants (females=1,069, 45.88%), and there were 2,485 participants (females=1,151, 46.32%) in 2018.

2.2. Measures

2.2.1. Families' socioeconomic status

Families' socioeconomic status (SES) was measured by five indicators: (1) a family' s total income in the past 12 months, (2) father's education (one for illiteracy, two for primary school, three for middle school, four for high school, five for junior college, six for bachelor, seven for master, and eight for PhD), (3) mother's education(one for illiteracy, two for primary school, three for middle school, four for high school, five for junior college, six for bachelor, seven for master, and eight for PhD), (4) father's occupation measured by International Socio-Economic Index of occupational status (ISEI), and (5) mother's occupation (ISEI).

2.2.2. Frequency of Internet use

A four-item scale measured the frequency of using the Internet to study, to entertain, to do commercial activities, and to socialize. A seven-point scale ranging from 1= "never" to 7= "almost every day" was used. The internal consistency of this scale was good (α=0.81).

2.2.3. Academic achievement

Standardized tests by interview were conducted to measure children's verbal and mathematical abilities. In 2014, for verbal test, children were asked to read out the words on a card (a total of 34 cards ranging from easy to hard).When the number of 'missed' words equalled three, the test ended (Liu & Xie, 2015). Children's scores were recorded. The mathematical test included the operations of addition, subtraction, multiplication, division, exponential, logarithmic and trigonometric functions, series and permutation, and combination.

The scores were computed according to the highest difficulty a child could reach. In 2016, a word recall and number series test adapted from theHealth and Retirement Study was used to test children's verbal and math performance. For verbal performance, interviewers read out ten words (e.g. mountain, rice, river, etc.) to children and asked them to recall the words immediately and once again after a few minutes (delayed test) after the reading.In this study, we used the score of the delayed test to measure children's verbal performance.

An adaptive test based on modern test theory was used to measure children's math performance. A child was presented with three items and a score ranged from 0 to 3 based on the number of correctly answered items was calculated. Then, the child got a new set of items according to her/his prior score. Those children with better prior performances received more difficult items.

Children's test scores on the two tests were recorded. Then, a new score was computed by the Rasch model (one type of Item Response Theory models) based on their test scores, which represents their math performance. In 2018, the tests were the same as the tests used in 2014. Standardized z-scores of the scores in all the three years were used for our analysis.

3. Results

3.1. Descriptive results

Descriptive data including mean and standard deviation is shown in Table 1. The data indicated that children often used Internet to study, to socialize and for entertainment, but seldom used it to do commercial activities.

Table 1. Descriptive data				
Variable	Mean (round1)	SD (round 1)	Mean (round 2)	SD (round 2)
Family income	4.72	9.34	5.57	4.15
Father's education	2.80	1.18	2.68	1.47
Mother's education	2.78	1.20	2.39	1.91
Father's occupation	3.61	14.56	32.06	11.75
Mother's occupation	29.25	16.34	28.77	11.60
Frequency of using Internet to study	4.19	1.92	4.37	1.88
Frequency of using Internet to socialize	4.77	2.17	4.90	2.08
Frequency of using Internet to entertain	4.85	1.80	5.26	1.88
Frequency of using Internet to do commercial activities	1.26	.96	1.34	.82
Math performance	528.46	4.56	13.71	28.61
Word performance	5.47	1.30	22.53	2.10
Prior math performance	10.47	4.50	524.15	30.18
Prior word performance	21.37	7.39	5.43	2.02
Age	12.47	1.68	12.41	1.75
Gender	.53	.50	.54	.50

3.2. The relationship between family SES and children's academic achievement

In the present study, we examined the relationship between family socioeconomic status and children's Chinese achievement and math achievement respectively in a two-rounds design (round 1: 2014 SES on 2016 academic performance and round 2: 2016 SES on 2018 academic performance) by structural equation model. The analysis was conducted in MPLUS 8.0 (Muthén & Muthén, 2016).

Regarding the fit index, the general cut-offs for accepting a model are equal to, or greater than, 0.90 for CFI, and equal to, or less than, 0.08 for RMSEA and SRMR (Hu & Bentler, 1999), In Table 2, our results indicated that the fitting of our models were good.

The results of the two rounds both showed that family SES was positively related to math performance (for the round 1 β=.24, p<.01; for the round 2, β=.35, p<.01), but not significantly related to Chinese scores (for the round 1 β=.07, p>.05; for the round 2, β=.22, p>.05).

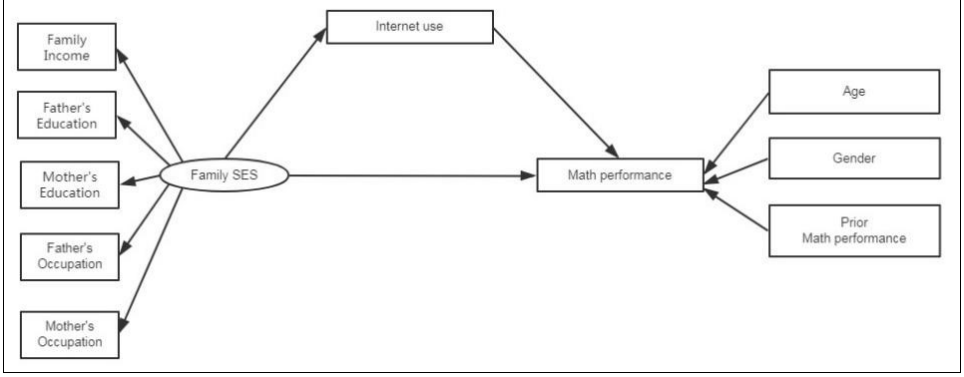
Table 2. Fit index of the mediation models					
	χ2(df)	p	RMSEA	CFI	SRMR
Round 1 (2014-2016)					
SES——Math	41.25(8)	.00	.04	.98	.04
SES——UITS——Math	92.30(30)	.00	.03	.97	.04
SES——UITSO——Math	192.95(30)	.00	.05	.91	.06
SES——UITE——Math	80.38(30)	.00	.03	.97	.04
SES——UITC——Math	105.09(30)	.00	.03	.96	.04
SES——Word	4.84(8)	.00	.04	.98	.04
Round 2 (2016—2018)					
SES——Math	79.68(9)	.00	.06	.97	.02
SES——UITS——Math	243.46(32)	.00	.05	.93	.04
SES——UITSO——Math	156.38(30)	.00	.04	.96	.03
SES——UITE——Math	263.46(32)	.00	.06	.93	.05
SES——UITC——Math	285.82(32)	.00	.06	.92	.05
SES——Word	89.60(9)	.00	.06	.96	.03

Note. SES, Socioeconomic status; UITS, Using Internet to study; UITSO, Using Internet to socialize;UITE, Using Internet to entertain; UITC, Using Internet to do commercial activities; Math, Math performance; Word, Word performance.

3.3. The mediating effects of Internet use on the relationship between family SES and children's math achievement

We then tested the mediating effects of the different purposes for using the Internet on the relationship between family SES and children's math performance. The conceptual model used for the analysis is illustrated in Figure 1.

Figure 1. Mediation model for current study



The results indicated that the fit index of the mediation models were good as well (see Table 2). As shown in Table 3, the results indicated that the four purposes for using the Internet did not significantly mediate the relationship between family SES in 2014 and math performance in 2016. However, the results indicated that the frequency of using the Internet to study in 2016 partly mediated the relationship between family SES in 2016 and math performance in 2018.

Table 3.The Mediating effects of the Internet use on the relationship between family socioeconomic status and math performance

	To study	To socialize	For entertainment	To do commercial activities
Round 1 (2014-2016)				
SES—Internet use	.14**	-.07	.12**	.12**
Internet use — Math	-.05	-.05	.08.	-.04
SES—Math	.15**	.14**	.15**	.15**
Indirect effects	-.01	.00	-.01	-.01
Round 2 (2016- 2018)				
SES—Internet use	.20**	.01	.01	.09*
Internet use — Math	.13**	.02	-.01	-.06*
SES—Math	.26**	.28**	.28**	.29**
Indirect effects	.03**	.00	.00	-.01

Note. *p<.05 ,**p < .01 (two tailed).

4. Discussion and conclusion

Our study contributes to the existing literature in several important ways. First, the previous research mostly relied on a cross-sectional design (Cheng & Wu, 2017; Kim et al., 2017; Assari et al., 2020), in this study, we used a longitudinal design, which can explore the changes of the mediating effects of Internet use on the relationship between family socioeconomic status and academic performance with the development of the Internet. Second, we used a Chinese youth sample to test the generalization of prior western findings. Third, this study investigated the mediating effects of the different purposes for Internet use, so that the mediating effects of Internet use could be analyzed in more detail. Fourth, we examined the mediating effects of Internet use on the relationship between SES and academic performance across two academic areas, which enabled the comparison of the strength of these mediating effects across different academic domains.

In the present study, we hypothesized that (1) Internet use can mediate the relationship between family socioeconomic status and academic performance and (2) the academic domain can moderate this mediation. Our findings partly support the two hypotheses. We found that only the frequency of using the Internet to study can mediate the relationship between SES and math performance. That is, children with higher socioeconomic status used the Internet more frequently for study which increased their math performance.

In previous research, a number of studies have linked family SES to students' math achievement (Anders et al., 2012; DeFlorio & Beliakoff, 2015; Wang et al., 2014; Gómez-García et al.,2020). In the longitudinal Chinese sample, our results from the two rounds showed that family SES was significantly related to

mathematical scores. This finding is in line with the prior empirical findings from various cultures (Wang et al., 2014; Kim et al., 2017; Gómez-García et al., 2020) and it supports the view of Ferraro et al. (2016) that low family economic status has a cumulative disadvantage for the development of children's mathematical abilities. With regard to the relationship between family SES and verbal achievement, the previous empirical findings showed mixed results. Our results provide supportive evidence to studies which reveal a non-significant link between family SES and verbal achievement (Park & Hannum, 2001). Taken together, our findings indicated that family SES was more likely to be related to Chinese students' math achievement than verbal achievement. In previous research, some researchers proposed that compared to the learning of Chinese, Chinese parents are more likely to buy learning materials, hire private tutors, and support outside school learning to help children learn math (Wang et al., 2014). Hence, the relationship between family SES and math achievement may be stronger than the relationship between family SES and verbal achievement.

We then examined whether children's Internet use can help explain the mechanism of the relationship between family SES and math achievement. We used four models to test the mediating effects of four reasons for using the Internet (to study, for entertainment, to do commercial activities, and to socialize) on the relationship between family SES and math achievement. Our data showed that only using the Internet to study can mediate the relationship between family SES and math performance, while the other purposes cannot. The findings are in line with the assumption of the second-order digital divide that individuals with a higher educational level and more financial resources are more likely to use the Internet for informational needs which directly benefits academic development (Bonfadelli & Heinz, 2002). Our findings also imply that the purposes for using the Internet can moderate the mediating effects. In previous research, the evidence from Switzerland revealed that children with lower socioeconomic status used the Internet more frequently for entertainment and online communication, which reduced their academic performance (Camerini et al., 2018). Our findings suggest that this cannot be generalized to Chinese children and that there are cultural differences in the mediating effects of the different purposes for using the Internet. Moreover, our results indicated that the frequency of using the Internet to study in 2016 mediated the relationship between family SES in 2016 and math performance in 2018, while it did not significantly mediate the relationship between family SES in 2014 and math performance in 2016. These findings suggest that with the development of the Internet, the role of Internet use in the relationship between family SES and academic performance becomes more significant over time.

This study has some limitations that could be improved in further research. First, the data on the Internet use relied on participants' self-reporting, which may be influenced by some bias caused by personal perceptions. Further research may measure the frequency of the Internet use by using some objective measures to record the frequency of children' s Internet use. Second, this study only focused on two major subjects (mathematics and Chinese), future research could continue to examine the consistency of the mediating role of Internet use between family socioeconomic status and other disciplines. Third, our study only used data from four years, in further research, data from more points in time may be helpful to investigate the dynamic relationship between family' s SES, Internet use, and academic performance.

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