Digital Inequality: Internet Access and Children's Cognitive Performance in China

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Abstract

This study examines the effects of having Internet access at home on children's cognitive performance by employing a nationally representative survey in China. After balancing factors that influence both having Internet access and cognitive skills through propensity score matching, preliminary results show that children who have Internet access at home score 0.17 standard deviation higher in cognitive test than those without access to Internet. The analysis reveals that inequality in children's cognitive development has been complicated by Internet access in the digital age.

Extended abstract

By the end of 2017, there were about 772 million Internet users in China, of which 25 percent are students (CNNIC 2018). Growing up with information and communication technology integrated into their everyday lives, the current generations of young children are indeed 'digital natives' (Bennett, Maton, and Kervin 2008). Meanwhile, scholars have paid attention to the so-called digital inequality, or digital divide in Internet access, in which children from lower SES families are less likely to have access to the Internet at home (Attewell 2001; Guillén and Suárez 2005; Hargittai and Hinnant 2008).

The digital divide in Internet access has implications for children's unequal cognitive development. Research has found that Internet access is associated with children's positive cognitive development in terms of visual intelligence and language skills (Bittman et al. 2011; Subrahmanyam et al. 2001), yet without effective parental supervision, the relationship can be negative (Vigdor, Ladd, and Martinez 2014). Moreover, as a digital dimension of social inequality, unequal access to home Internet may further contribute to inequality in children's cognitive skills, net of other forms of social inequality. Research has shown that children from higher SES families are not only more likely to have Internet access at home, but they also tend to use the Internet more often for informational purposes rather than for communication and computer games, compared to children from low-status families (Notten et al. 2009). Yet, more causal evidence is needed to evaluate the impact of Internet access on children's cognitive performance, adjusting for the effects of factors that influence both Internet access and cognitive skills.

Furthermore, in the Chinese context, to the best of my knowledge, there has been no empirical study on the effects of Internet access at home on children's cognitive skills. Nevertheless, existing literature on child wellbeing in China can help identify confounders that affect children's cognitive skills and may simultaneously influence children's Internet access at home. Specifically, previous literature on child well-being in China has examined the effects of *hukou* (household registration system) and rural-to-urban migration on children's well-being (Hao and Yu 2017; Huang, Xie, and Xu 2015; Xu and Xie 2015; Zhou, Murphy, and Tao 2014). Another line of research focuses on differences in cognitive skills for only children and children with siblings (Falbo and Poston 1993; Jiao, Ji, and Jing 1996; Li, Zhang, and Zhu 2008).

This paper seeks to fill the empirical gap by examining the impact of Internet access on children's cognitive performance in China. Furthermore, this paper will also explore heterogeneous effects of Internet access on different groups of children, categorized by rural left-behind, rural local, rural-to-urban migrants, and urban migrants. To address the concern of self selection into the treatment (i.e., having Internet access at home), I use propensity score matching to balance covariates between children in the treatment and in the control.

Data and methods

This paper uses data from the China Education Panel Survey (CEPS), which is a nationally representative longitudinal survey of junior high school students in China. Multistage probability proportional to size sampling (PPS) was used, with sampling unit from administrative districts/counties, schools, to classrooms in three stages. The baseline survey of 19487 7th and 9th graders was conducted during the 2013-2014 academic year in 112 schools of 28 counties. The CEPS administered different questionnaires to students, parents, teachers, and principals.

The outcome variable in this paper is cognitive skill test score. The cognitive test score comes from a 15-minute in-class standardized test, which evaluates students' reasoning abilities in verbal, numerical, and graphical forms. The scores are IRT scaled. I standardized the cognitive scores to make them comparable across schools and regions.

The key explanatory variable of interest is Internet access at home. The construction of the causal variable is based on the question asking students whether they have computer and Internet access at home. Students having both computer and Internet at home are coded as 1, while those who have neither computer or Internet and only have computer but not Internet are coded as 0. Therefore, the two causal states defined here are having Internet access at home and no home Internet access.

I measure family socioeconomic status by parental education (father's and mother's year of education) and highest parental occupation. Based on the work by Wu and Treiman (2007), I categorize occupation into five groups: unemployed, peasant, unskilled and semi-skilled worker, skilled worker and small business owner, and professionals (the reference category). Additionally, I include a dummy variable indicating whether both parents were at home.

To examine the role of *hukou* and rural-to-urban migration that may affect both home Internet access and children's cognitive development, I divide students into four categories based on their *hukou* and migrant status: rural local, rural migrants, urban migrants, urban local (the reference category). In addition, a predictor of children's residence location is included, which is categorized as rural areas, town, city's peripheral areas, and downtown (the reference category).

To measure relevant school facilities that are related to both children's access to Internet at home and their cognitive ability, I created an indicator of whether schools have computer lab. Based on answers by school principals, the predictor is categorized as no computer lab in school, having computer lab without good equipment, and having computer lab with good equipment (the reference category).

Other explanatory variables include students' individual characteristics such as age, gender, grade, ethnicity minority status, only child, and self consciousness.

These explanatory variables described above can affect both children's access to Internet at home and their cognitive skills. For instance, children from higher SES families are more likely to have computer and Internet provided by their parents at home, and they are also more likely to score higher in cognitive tests. Therefore, it is important to remove the self-selection bias to estimate the causal effect of Internet access on child cognitive performance. In this paper, I use propensity score matching to balance distributions of covariates between the treatment group and the control group and reduce the self-selection into the treatment.

Preliminary results

The descriptive patterns in Table 1 and Table 2 show that about 60 percent of the students have Internet access at home. Children from higher SES families have advantages in getting access to Internet at home. Their parents tend to have more education and higher occupation status. They are also more likely to have both parents at home. Moreover, children who have home Internet are also more likely to have computer lab with good equipment in school. As expected, *hukou*-based inequality also applies to Internet access. Residence location matters, suggesting that living in cities rather than villages is associated with greater advantage in web access. Also note that only child is more than twice as likely as those with siblings to have home Internet access in China.

Table 2 shows that notable balance is achieved after propensity score matching.

In Table 3, I report the average treatment effects (ATE) for having Internet access at home on children's cognitive performance using nearest-neighbor matching. On average, children with Internet access score 0.17 standard deviation higher than their counterparts who do not have Internet at home. Additional matching algorithms will be used to compare ATE from the nearest-neighbor match in the final analysis. I will further extend the analysis by exploring whether the impact of Internet access varies across different child groups (i.e., rural left-behind, rural local, rural-to-urban migrant, and urban migrant).

Table 1. Summary statistics

	Mean	SD	Min	Max
Cognitive performance	-0.000	1.000	-2.351	3.140
Internet access at home	0.604	0.489	0	1
Individual Characteristics				
Age	13.904	1.333	11	18
9th grade	0.473	0.499	0	1
Male	0.514	0.500	0	1
Ethnic minority	0.090	0.286	0	1
Only child	0.434	0.496	0	1
Conscientiousness	-0.005	1.001	-4.147	1.468
Child Group (urban local is the reference categroy)				
rural left-behind	0.128	0.334	0	1
rural local	0.306	0.461	0	1
rural migrant	0.114	0.318	0	1
urban migrant	0.065	0.247	0	1
Parental Education				
Father's year of education	10.297	3.107	0	18
Mother's year of education	9.533	3.531	0	18
Highest Parental Occupation (professional is the reference categroy)				
unemployed	0.013	0.113	0	1
peasant	0.229	0.420	0	1
unskilled and semi-skilled worker	0.157	0.364	0	1
skilled worker and small business owner	0.364	0.481	0	1
Both parents at home	0.767	0.423	0	1
School Facility (computer lab with good equipment is the reference categroy)				
No computer lab	0.036	0.186	0	1
Computer lab without good equipment	0.379	0.485	0	1
Residence Location (downtown is the reference categroy)				
rural areas	0.413	0.492	0	1
town	0.067	0.250	0	1
city's peripheral areas	0.200	0.400	0	1
Observations	19487			

Table 2. Imbalance checking of covariates before and after matching

	Before matching			After matching		
	Treatment	Control	Standardized diff.	Treatment	Control	Standardized diff.
Individual Characteristics						
Age	13.800	14.063	-0.196	13.910	13.900	0.004
9th grade	0.466	0.483	-0.034	0.470	0.480	-0.005
Male	0.511	0.519	-0.015	0.530	0.540	-0.014
Ethnic minority	0.053	0.146	-0.316	0.080	0.070	0.028
Only child	0.550	0.257	0.628	0.360	0.370	-0.016
Conscientiousness	0.035	-0.066	0.102	-0.030	-0.020	-0.004
Child Group						
rural left-behind	0.061	0.230	-0.493	0.130	0.130	0.013
rural local	0.247	0.396	-0.322	0.360	0.360	-0.010
rural migrant	0.121	0.105	0.050	0.140	0.140	0.009
urban migrant	0.083	0.038	0.188	0.060	0.060	-0.002
Parental Education						
Father's year of education	11.200	8.917	0.804	9.710	9.720	-0.005
Mother's year of education	10.631	7.856	0.854	8.990	9.020	-0.013
Highest Parental Occupation						
unemployed	0.011	0.015	-0.036	0.020	0.020	0.012
peasant	0.094	0.436	-0.840	0.240	0.230	0.029
unskilled and semi-skilled worker	0.151	0.165	-0.037	0.170	0.180	-0.021
skilled worker and small business owner	0.411	0.293	0.248	0.410	0.430	-0.045
Both parents at home	0.837	0.660	0.417	0.750	0.750	-0.012
School Facility						
No computer lab	0.008	0.078	-0.351	0.020	0.020	0.016
Computer lab without good equipment	0.345	0.431	-0.177	0.400	0.400	0.003
Residence Location						
rural areas	0.242	0.674	-0.962	0.490	0.470	0.026
town	0.074	0.057	0.069	0.080	0.080	-0.012
city's peripheral areas	0.240	0.139	0.260	0.200	0.210	-0.013

Table 3. Average treatment effects from nearest-neighbor match

	ATE
Nearest-neighbor match (1)	0.179***
	(0.023)
Nearest-neighbor match (1) with caliper(.05 SD)	0.179***
	(0.023)
Nearest-neighbor match (5)	0.166***
	(0.020)
Nearest-neighbor match (5) with caliper(.05 SD)	0.166***
	(0.020)
Observations	19487

Note: *** $p < 0.001$. Robust standard errors in parentheses.

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