Change in Computer Access and the Academic Achievement of Immigrant Children

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Background/Context: *Increased interest in the correlates of media devices available to children has led to research indicating that access to and use of technology are positively associated with children's academic achievement. However, the digital divide remains; not all children have access to digital technologies, and not all children can acquire technological literacy. Specifically, immigrant families are known to be slow to adopt new technologies in the increasingly digital society of the United States.*

Purpose/Objective: *This study examined whether the benefits of computer access observed in the general U.S. population were also applicable to children from immigrant families in the early 2000s.*

Research Design: *Using data on 2,139 children in immigrant families from the Early Childhood Longitudinal Study-Kindergarten cohort, this study examined the association between children's gaining access to a computer at home and their reading and mathematics test scores between the late 1990s and the early 2000s.*

Findings/Results: *We found that if children had access to a computer during the early elementary school years, they demonstrated increased mathematics test scores later on.*

Conclusions/Recommendations: *Three characteristics of computer access are discussed in terms of implications for media popular today, including type of media (old vs. new), featured functions of technology, and timing of availability to children. In particular, the computer's spatial and virtual functions may be likely to translate into improved mathematics skills, especially when access occurs early in kindergarten and first grade. Extra effort is needed to inform immigrant and minority parents about the benefits of new technologies so that their children can access them at home as much as children from nonimmigrant and nonminority families. To lessen the digital divide in children's education, timely financial support and educational information should be provided to parents to encourage early adoption of new media technologies, thus ensuring that immigrant and minority children are not left behind in the digital age.*

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The U.S. Department of Education has long recognized the potential of technology use for education (U.S. Department of Education, 2010); in December 2015, Congress released the new National Educational Technology Plan to close the achievement gap and increase college completion rates through the effective use of technology in learning environments (U.S. Department of Education, 2016). Many learning sectors promote technology use to accelerate and amplify learning, teaching, and assessment. However, the digital divide has remained a significant barrier because access to digital technologies at home and acquisition of digital literacies depend heavily on family household incomes and race/ethnicity (Yelland & Neal, 2013).

To gain a better understanding of the needs of disadvantaged children in the digital era, this study focused on children from immigrant families, a population whose technology use has not been well investigated. To track down when/where the digital divide may begin (Gore, 1998), this study examines children's computer access at home between the late 1990s and the early 2000s, when a computer was considered a new media technology device. Characteristics of immigrant families that might have interfered with having a computer available to children at home were reviewed. Based on the findings from a longitudinal study examining the benefits of computer access during the elementary school years for children's academic performance among immigrant families, we discuss the evidence that growth in school performance may have been lower relative to their peers when immigrant families were slow to adopt new technology in the digital age.

TRENDS IN CHILDREN'S COMPUTER USE AND DISPARITIES IN ACCESS

A series of longitudinal studies on children's media use (Hofferth, 2010a; Hofferth & Moon, 2012b) showed that both the proportion of children using a computer and the amount of time they spent using a computer at home have been increasing; the rate of growth is also becoming steeper. In 1997, 23% of children used a computer at home, for an average of less than an hour per week; by 2008, these numbers had increased dramatically, with 55% of children using a computer for an average of 3 hours a week (Hofferth, 2010b). But at the same time, there were disparities in children's access to computers at home depending on child characteristics and family background, particularly family income and parental educational level (Fairlie, London, Rosner, & Pastor, 2006). A computer is one of the most expensive pieces of household equipment, ranging from several hundred to even several thousand dollars, and owning one also

requires additional purchases, such as a mouse, speakers, a monitor, a printer, and software designated for specific purposes or users. Ninety-six percent of children whose families had a yearly household income of over $75,000 had access to a computer at home in 2003, compared with only 43% of those whose families made less than $15,000 (Rideout, Foehr, & Roberts, 2010). Immigrants' lower family incomes may contribute to lower rates of computer ownership.

Financial capability alone cannot fully explain the disparities in access, however. Immigrant families are less likely to have a computer than nonimmigrant families within the same income group, although the pattern of computer ownership rising with family income holds for both immigrants and nonimmigrants (Fairlie et al., 2006). Research indicates that parents' educational level also accounts for a substantial amount of the variation in computer ownership (Fairlie et al., 2006; Rideout et al., 2010). Even though the price of a computer has dropped drastically over the years, with a 20% decrease every year since 1999, there are still households that do not have a computer (U.S. Department of Labor: Bureau of Labor Statistics, 2011), and this appears to be tied to parental education. Immigrants tend to have lower levels of education than do nonimmigrants; this fact accounted for 29.7% of the difference between immigrant and nonimmigrant home computer ownership rates (Fairlie et al., 2006). The association between parents' educational attainment and computer ownership may be explained by parents' occupational types. Many people with a high school education or less hold relatively low-skilled jobs that do not require extensive computer use, and they cannot or do not bring work home (Carnevale, Smith, & Strohl, 2010). Immigrants are more likely to be employed in services, production, farming, construction, and transportation, which are job sectors less likely to require home computer use (Bureau of Labor Statistics, 2016).

HAVE IMMIGRANT CHILDREN BENEFITED FROM THE COMPUTER REVOLUTION IN TERMS OF ACCESS?

Immigrant children might not have benefitted as much as nonimmigrant children from the computer revolution. Some reports (Fairlie et al., 2006; Rideout et al., 2010) indicate that children in immigrant families run a greater risk of being left behind in the digital culture because of lower rates of computer ownership. Family socioeconomic status (SES) and parental characteristics that may interact with the immigrant context could have uniquely contributed to children's limited access to a computer. Immigrants have, on average, lower family incomes than do nonimmigrants, and this affects their financial ability to purchase a computer (Fairlie et al., 2006).

Immigrant parents also report less desire to have a computer at home, which might be due to uncertainty about how to facilitate English-based computer use for their children, and this also contributes to lower computer ownership among immigrant families (Fairlie et al., 2006; Rideout et al., 2010). The rate of computer ownership in Spanish-speaking households is 16 percentage points lower than in non-Spanish-speaking Latino households, even after controlling for child's characteristics, parent's education, and family income (Fairlie et al., 2006).

In addition to low SES and parents' English language limitations, cultural values and beliefs that immigrant families hold may influence children's access to a computer. Thus, children whose families do not have computer access may have parents with less focus on educational achievement, resulting in less support in general for early language and mathematical achievement. According to the ecological perspective (Bronfenbrenner, 1979), children's daily environment and learning opportunities are determined by their parents and family conditions. Specifically, Bourdieu's (1984) sociocultural theoretical framework emphasizes the critical role of parents and families in helping their children to acquire knowledge and skills that are valued and required by society.

Consistent with this expectation, the research shows that just having access to a computer has been found to be positively associated with children's academic performance (Attewell, Suazo-Garcia, & Battle, 2003; Schmitt & Wadsworth, 2006; Wartella & Jennings, 2000). Third graders who had a computer at home showed significantly higher test scores on mathematics, reading, and language arts compared with those who reported no home computer (Borzekowski & Robinson, 2005; Judge, Puckett, & Bell, 2006). Children with access to a computer at home were 6 to 8 percentage points more likely to graduate from high school than those without a home computer (Beltran, Das, & Fairlie, 2008).

COMPUTER USE AND CHILD DEVELOPMENT

Having a computer available to children, of course, increases the likelihood that they will use it. We therefore also reviewed what benefits may arise from children's computer use. Computers have been recognized as an educational resource, and research demonstrates that using a computer is a strong predictor of academic achievement (Smerdon et al., 2000; Spiezia, 2011). Computer uses that involve deciphering written language on a screen, along with those that require spatial, iconic, and attentional skills, appear to be positively linked to children's language, reading, and problem-solving skills (Fiorini, 2010; Hofferth, 2010a; Subrahmanyam, Kraut, Greenfield, & Gross, 2000). Text-based computer activities may

explain why more computer use appears to be positively linked to children's letter-word recognition and reading comprehension skills (Fiorini, 2010; Hofferth, 2010a; Hofferth & Moon, 2012b). In an experimental study of the provision of home computer/Internet access to low-income families, children who spent more time online had higher scores on a reading test than did children who spent less time online (Jackson et al., 2006). Computer use also requires fine motor skills of pointing and clicking for using a mouse, and spatial, iconic, and attentional skills for searching and gaming (Subrahmanyam et al., 2000). These characteristics have been found to benefit children's matrix reasoning and problem-solving abilities (Fiorini, 2010; Hofferth, 2010a). Young children who could control a computer mouse well showed better executive functioning skill to shift attention, inhibit responses, and use working memory (Lauricella, Barr, & Calvert, 2009), all of which are expected to improve later academic performance. These benefits of computer use are critical because children's cognitive and noncognitive development are important predictors of school adjustment and future social and economic success in the United States (Heckman, Stixrud, & Urzua, 2006). Contrary to concerns about children's computer use resulting in increased isolation from peers, emailing and visiting social network sites have functioned to deepen and extend children's relationships with peers (Lenhart & Madden, 2007; Tripp, 2011). Furthermore, as information technology skills are increasingly becoming the norm and, therefore, expected in the labor market (Carnevale et al., 2010; Freeman, 2002), the long-term benefits of children's computer use have become exceedingly clear.

Although we assume that access implies use, such that almost 95% of children with access to a home computer have been shown to use that computer (Beltran et al., 2008), immigrant children whose parents have a computer at home may use it less than nonimmigrant children. Although U.S. immigrant parents have higher educational aspirations for their children (Hofferth & Moon, 2016), Latino parents were reported to be less likely to believe that their child could learn from computer use compared with White and African American parents (Rideout, 2014). Immigrant parents' high educational expectations for their children may mean that when a computer is available, these parents limit its use to those with a clear educational purpose and discourage using it for socializing and entertainment (Tripp, 2011). This may result in dismissing the notion that their child could learn from noneducational (recreational) activities using a computer. The net result is that children in immigrant families have had less access to, and use of, a computer at home and, compared with nonimmigrant children, may not have derived the same benefits from computer access.

PURPOSE OF THE STUDY

The social and intellectual benefits of computer access have been confirmed for the general population of American children since the mid-1990s. However, there have as yet been few attempts to examine whether children in immigrant families also experience the same benefits, even though some research suggested that the positive influence of computer access and use would be greater for minority children (Hofferth, 2010a; Judge et al., 2006). To fill the gaps in research on the digital divide and its effects on children from underserved populations, our study examines the influences on immigrant children of having access to a computer in the late 1990s and early 2000s and discusses implications to help researchers, educators, and policy makers better understand the possible influences on immigrant families of media now popular among children.

Our research questions are as follows:

1. Was there an association between computer access at home and increased reading and mathematics test scores during subsequent years?
    a. Was computer access *at kindergarten* associated with changes in reading and mathematics test scores *between kindergarten and first grade*?
    b. Was the gaining of computer access *between kindergarten and first grade* associated with changes in reading and mathematics test scores *between first grade and third grade*?
    c. Was the gaining of computer access *between first grade and third grade* associated with changes in reading and mathematics test scores *between third grade and fifth grade*?
2. During which grades was access to a home computer associated with the largest increases in reading and mathematics test scores?

As with many of their activities, children's computer use is sex-typed: gaming for boys and communicating for girls (Hofferth, 2010a; Louie, 2003). Children choose different activities, and parents also encourage or allow different activities based on their child's gender (McHale, Crouter, & Whiteman, 2003). Even though current study data are not available for specific computer activities, presumably these gender differences may hold for immigrants too. Therefore, we tested all study models listed above by gender to determine whether there are different effects of computer access for boys and girls.

METHODS

DATA AND SAMPLE

This study uses data from the Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ECLS-K), sponsored by the National Center for Educational Statistics, U.S. Department of Education. The ECLS-K sampled 21,260 kindergarten children from over 1,000 schools and had tracked the early school experiences of these children through eighth grade by 2007. The survey contains extensive information on children's family background, teacher and school characteristics, and test scores. Data collection for the ECLS-K was conducted in the fall and spring of kindergarten, spring of first grade, spring of third grade, spring of fifth grade, and spring of eighth grade.

Of the six data waves available, this study uses four data waves for child outcomes: fall kindergarten, spring first grade, spring third grade, and spring fifth grade. Because of the larger influence of peers and differing school contexts beyond elementary school, eighth graders were not included. The current sample is limited to families in which at least one of the parents was born somewhere other than the United States or a U.S. territory. Of the 16,649 families in which both parents' countries of origin were identifiable (from the initial sample of 21,260 children), the sample size for analysis is 2,139. The divergence in academic performance observed during the early elementary school period in immigrant families was better explained by maternal origin than by children's immigrant generational status (Glick & Hohmann-Marriott, 2007). Therefore, children were grouped according to the mother's country of origin: Latin-origin families, Asian-origin families, others, and foreign-born father families. Also, because all children in this study began school in the United States, and previous research (Kao & Tienda, 1995; Rumbaut, 2005) did not find any difference in academic performance between first- and second-generation children, children's immigrant generation status was not included in the analyses. To take into account the complex stratified cluster sampling design of the ECLS-K data, the appropriate stratification and cluster identification variables and child-level weight variables were used (Tourangeau, Nord, Le, Pollack, & Atkins-Burnett, 2006).

MEASURES

Reading and Mathematics Test Scores

To ensure accurate measurement of ability over time and to reduce floor and ceiling effects, the ECLS-K used item response theory (IRT) to create a common scale of ability estimates across rounds (Tourangeau et al., 2006). The assessment employed a two-stage design; at the first stage, all children received a set of assessment items, and then, depending on their performance, they were given a second-stage set of items. By using the overall pattern of right and wrong responses and the characteristics of each item to estimate ability, IRT compensates for the possibility of a low-ability student guessing several hard items correctly. Omitted items are also less likely to cause distortion of scores as long as enough items have been answered right and/or wrong to establish a consistent pattern. The IRT scale score had high internal item-consistency reliability, .92–.96 at each round.

The reading assessment measures the child's ability to identify upper- and lowercase letters by name, associate letters with sounds at the beginning of words and at the end of words, recognize common words by sight, read words in context, make inferences using cues that are directly stated with key words in the text, demonstrate understanding of the author's craft, and critically evaluate texts. The mathematics assessment measures the child's ability to recognize/perform number and shape, relative size, ordinality and sequence, addition/subtraction, multiplication/division, place value, rate and measurement, fractions, and area and volume.

Access to a Computer at Home

Computer access was measured by parents' response to the item, "Do you have a home computer your child uses?" The responses for computer access were coded 0 for no and 1 for yes. Using parents' answers available at kindergarten, first grade, and third grade, four groups of children were categorized: those who had not had a computer at home since kindergarten, those who gained access to a computer at kindergarten, those who gained access at first grade, and those who gained access at third grade.

Control Variables

Factors of children's immediate environment (Bronfenbrenner, 1979) within the immigrant family context that may have influenced children's computer use and outcome variables were included in the analysis. A parent English proficiency scale was created using the sum of each parent's

speaking, reading, and writing skills. Parents rated these skills on a scale ranging from 1 (*very well*) to 4 (*not well at all*). After reverse coding, a higher value means better English proficiency. Parents' length of stay in the United States was calculated using information on age at immigration and age at which they were interviewed. The mother's length of stay in the United States was used in data analyses except in the case of single-father families or families with a U.S.-born mother and a foreign-born father, in which case the father's length of stay was substituted. A standardized composite measure of family SES provided by the ECLS-K, created from the father's and mother's education, occupation, and household income, was included as a control.

Variables that may influence children's academic performance were also included. The activities of reading for pleasure and watching television, which are among the most influential factors predicting children's academic performance (Cunningham, 2005; Hofferth, 2010a; Krashen, 1995; Pfost, Dorfler, & Artelt, 2013), were controlled in the analyses to ensure that the results measured a genuine effect of having access to a home computer. Children's reading activity at home ranged from 1 (*never*) to 4 (*every day*). Parents were also asked how many hours of television their child watched at home, separately for a weekday and a weekend day. To calculate the total time spent watching television per week, the total weekday time was multiplied by 5, the total weekend time was multiplied by 2, and then these numbers were added together. Number of siblings, ranging from 0 to 11, and whether both parents were living together were also included. Dummy variables for the location of the family residence, categorized into three groups—large or mid-size city, suburb or large town, and small town or rural—were included.

ANALYSIS

We regressed changes in reading and mathematics test scores between waves from kindergarten through fifth grade on having access to a computer at home at kindergarten, having access to a computer at first grade but not kindergarten, and having access at third grade but not until after first grade, controlling for parent and family backgrounds (see Figure 1) and assuming that gaining access to a computer was not reversible. The rationale for linking changes in test scores between waves occurring in subsequent years to the change in computer access is to examine whether computer access at one time period was associated with *increasing or decreasing* children's academic performance in the next time period. Otherwise, the concurrent associations—e.g., between computer access in kindergarten and test scores in kindergarten—would dominate, which would not

allow us to determine whether gaining computer access would be associated with increased academic performance. In addition, using longitudinal data allowed us to examine the *long-term association* between having had access since kindergarten versus not having access since kindergarten, along with the effects of gaining access to a computer at different times after kindergarten and later performance.

Specifically, children's computer access in kindergarten was included with changes in test scores between kindergarten and first grade (Model 1 in Figure 1). Children with access to a computer in kindergarten (dummy group 1), those without access in kindergarten who gained access to a computer at first grade (dummy group 2), and those who still did not have access to a computer until after first grade (reference group) were included for the analysis of changes in test scores between first and third grade (Model 2 in Figure 1). Children with access in kindergarten (dummy group 1), those without access in kindergarten who gained access at first grade (dummy group 2), those without access until after first grade who had gained access by third grade (dummy group 3), and the remaining children who did not have a computer until after third grade (reference group) were included in the examination of changes in test scores between third and fifth grade (Model 3 in Figure 1).

RESULTS

CHANGES IN ACADEMIC PERFORMANCE AND COMPUTER ACCESS

Table 1 shows that girls tended to have higher reading test scores than boys from the beginning of first grade up to fifth grade, whereas boys excelled more in mathematics than girls from first grade on. Before first grade, about 45% of children's families had a computer at home at least from kindergarten on, 16% procured a computer between kindergarten and first grade, and 38.7% did not have a computer at either time point. Almost 16% procured a computer between first and third grade. By third grade, only 23.1% still did not have a computer. Computer ownership (in other words, having a computer accessible to children at home) during kindergarten and up to third grade did not differ by gender, with one exception: A larger fraction of boys than girls had no access to a computer during the entire period from kindergarten through third grade.

Figure 1. Analytical model for computer access at home from kindergarten to fifth grade

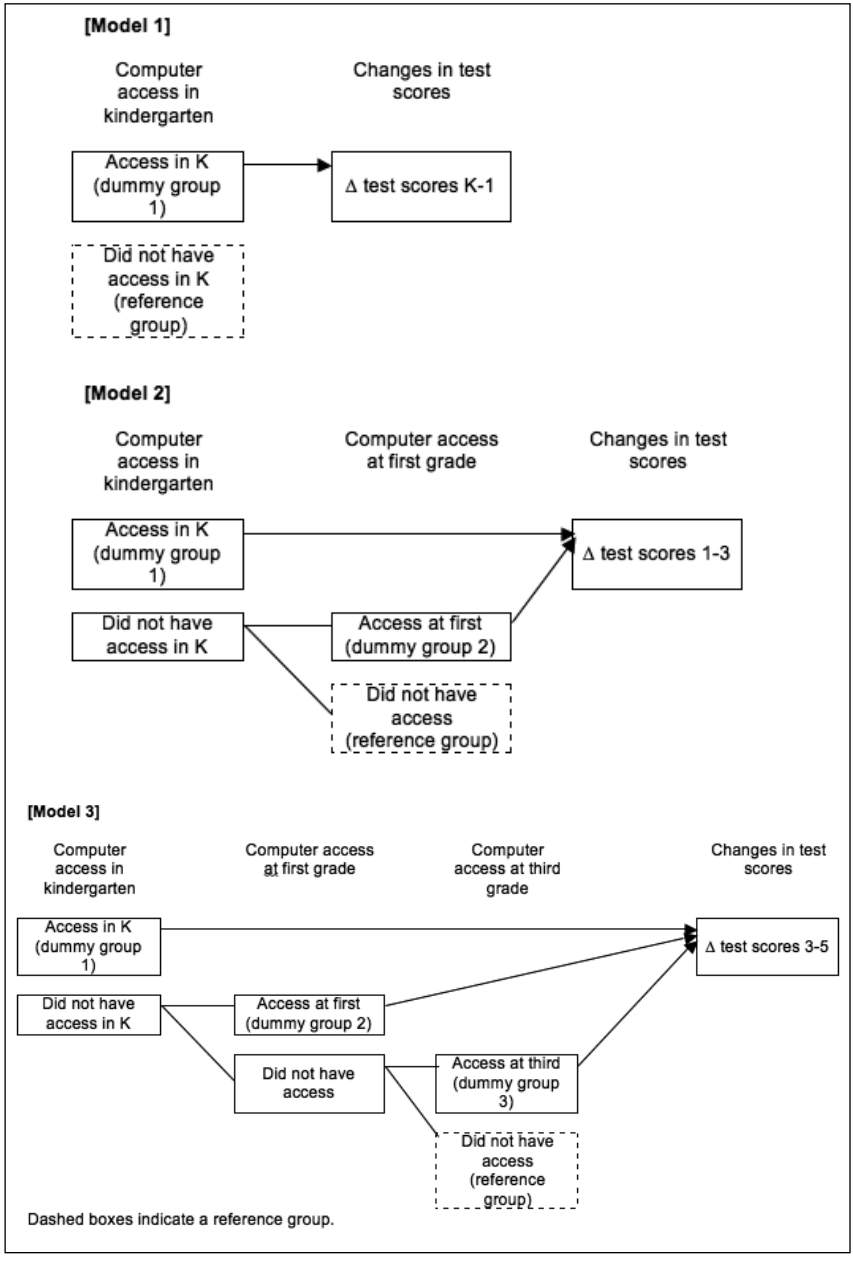

Table 1. Means and Standard Deviations of Test Scores and Percentage With Computer Access, for All Children and by Gender

	All Children		Boys		Girls		Boy vs. Girl
	Mean/%	SD	Mean/%	SD	Mean/%	SD	
Test Scores							
Reading scores (K)	46.90	16.42	46.42	15.86	47.39	16.92	
Reading scores (1)	76.45	24.83	74.60	24.66	78.39	24.84	***
Reading scores (3)	122.17	28.35	119.60	27.76	124.81	28.67	***
Reading scores (5)	145.67	26.41	143.23	27.20	148.13	25.42	***
Math scores (K)	34.23	12.69	34.74	13.20	33.69	12.16	
Math scores (1)	58.84	17.75	59.78	18.80	57.85	16.59	*
Math scores (3)	97.11	25.05	99.20	26.16	94.95	23.79	***
Math scores (5)	122.91	24.71	125.31	24.76	120.50	24.48	***
Computer access							
Had at kindergarten	45.3%		44.9%		45.8%		
Changes between K and 1st grade							
Never had	38.7%		39.5%		37.8%		
Access at 1st grade	16.0%		15.6%		16.4%		
Access in kindergarten	45.3%		44.9%		45.8%		
Changes between 1st and 3rd grade							
Never had	23.1%		25.0%		21.2%		*
Access at 3rd grade	15.5%		14.6%		16.5%		
Access at 1st grade	16.0%		15.6%		16.4%		
Access in kindergarten	45.3%		44.9%		45.8%		
N	2139		1068		1071		

* < .05. ** < .01. *** < .001.
Data are weighted.

CHANGES IN DEMOGRAPHICS THROUGH FIFTH GRADE

The majority of immigrant families (54.1%) were Latino, 13.3% were from Asian families, and 15.2% were from other backgrounds (Table 2). About 17% of children had a U.S.-born mother and a foreign-born father. The average length of stay in the United States was 16.4 years. Parents' English proficiency score averaged 8.76, with a range from 3 to 12. Immigrant families' SES was lower than the average for U.S. families throughout all elementary school years. The average number of siblings in the household ranged from 1.6 to 1.8. The majority of children lived with two parents. More than half of the children lived in a large city, followed by those living in the suburbs, and less than 10% lived in a small town or rural area. Family backgrounds did not change much over time from kindergarten through fifth grade and did not differ significantly by gender. Additionally, girls read books more than boys at all grades during elementary school years, and boys watched TV more than girls at kindergarten and first grade.

TIME PERIOD DURING WHICH A COMPUTER WAS AVAILABLE TO CHILDREN AT HOME AND CHILDREN'S ACADEMIC PERFORMANCE

The first panel of Table 3 shows the association of having access to a computer during kindergarten with changes in reading and mathematics test scores between kindergarten and first grade. There was a significant positive association between access to a computer at home in kindergarten and increased mathematics scores for boys but not for girls.

The second panel shows that neither having a home computer at kindergarten nor gaining access at first grade was associated with increased reading test scores for either boys or girls between first and third grade. However, for boys, gaining access at first grade was significantly associated with increased mathematics test scores between first and third grade.

The third panel shows that gaining access to a computer in a previous time period did not matter to boys' reading or mathematics test scores between third and fifth grade. In contrast, gaining access at first grade was significantly associated with increased mathematics test scores between third and fifth grade for girls. Neither computer access from kindergarten on nor gaining access at third grade was associated with increased mathematics test scores for girls between third and fifth grades.

The results suggest that access to a computer is associated with increased mathematics scores for boys and girls but not with increased reading scores. There is variability between boys and girls in test score changes depending on the timing of when they first gained computer access. Early access appears to matter more for boys' early mathematics scores than for girls'.

Table 2. Means, Standard Deviations, and Percentages of Control Variables, for All Children and by Gender

	All Children		Boys		Girls		Boy vs. Girl
	Mean/ %	SD	Mean/ %	SD	Mean/ %	SD	
Girl	48.9%						
Mother's race/ethnicity							
U.S.-born	17.4%		17.1%		17.7%		
Latino	54.1%		55.0%		53.2%		
Asian	13.3%		13.6%		12.9%		
Other	15.2%		14.3%		16.2%		
Parents' length of stay in the U.S.	16.36	139.74	16.21	141.68	16.52	137.80	
Parents' English proficiency	8.76	47.06	8.67	48.25	8.87	45.83	
At kindergarten							
SES	-0.15	12.17	-0.16	12.64	-0.15	11.68	
Number of siblings	1.61	17.12	1.58	17.17	1.64	17.06	
Two parents	87.5%		87.1%		87.9%		
Residence-Rural	7.3%		6.9%		7.6%		
Suburb	41.1%		43.4%		38.8%		*
Large city	51.6%		49.7%		53.6%		
At 1st grade							
SES	-0.21	12.25	-0.20	12.83	-0.22	11.63	
Number of siblings	1.66	16.80	1.64	16.99	1.68	16.60	
Two parents	87.8%		87.5%		88.1%		
Residence-Rural	7.1%		6.7%		7.5%		
Suburb	41.9%		43.6%		40.1%		
Large city	51.0%		49.7%		52.4%		
At 3rd grade							
SES	-0.21	12.14	-0.20	12.66	-0.23	11.59	
Number of siblings	1.75	16.89	1.72	17.11	1.77	16.67	
Two parents	88.5%		88.4%		88.7%		
Residence-Rural	7.2%		6.7%		7.8%		
Suburb	42.7%		44.3%		41.0%		
Large city	50.1%		49.0%		51.2%		
At 5th grade							
SES	-0.22	12.09	-0.21	12.59	-0.23	11.59	
Number of siblings	1.77	16.77	1.73	16.95	1.80	16.59	
Two parents	85.2%		83.9%		86.6%		
Residence-Rural	7.5%		7.0%		7.9%		
Suburb	43.3%		44.8%		41.9%		
Large city	49.2%		48.2%		50.2%		
Other activities							
Reading for pleasure (K)	3.00	14.40	2.83	14.95	3.17	13.42	***
Reading for pleasure (1)	3.11	12.97	2.96	13.74	3.27	11.77	***
Reading for pleasure (3)	3.29	11.69	3.18	12.49	3.41	10.58	***
Reading for pleasure (5)	3.36	11.49	3.23	12.41	3.49	10.21	***
Watching TV-weekly hr (K)	14.10	125.40	15.10	132.27	13.04	116.40	***
Watching TV-weekly hr (1)	14.76	116.46	15.29	120.40	14.20	111.90	**
Watching TV-weekly hr (3)	14.43	111.29	14.74	109.60	14.11	112.83	
Watching TV-weekly hr (5)	14.88	117.93	15.26	125.58	14.50	109.79	
N	2139		1068		1071		

* < .05. ** < .01. *** < .001. Data are weighted.

Table 3. Coefficients of Changes in Test Scores Between Grades Regressed on Gaining Access to a Home Computer by Gender

	Reading Scores				Mathematics Scores			
[Model 1]	**Boys**		**Girls**		**Boys**		**Girls**	
Δ Scores between K and 1st	**b**	**SE**	**b**	**SE**	**b**	**SE**	**b**	**SE**
Intercept	29.74***	4.07	28.13***	4.57	24.17***	2.97	23.40***	2.67
Computer access (ref. Did not have in K)								
Access in K	1.15	1.48	2.62	1.34	2.01*	.97	.75	.84
N	829		836		984		988	
R^2	.10		.10		.04		.03	
[Model 2]	**Boys**		**Girls**		**Boys**		**Girls**	
Δ Scores between 1st and 3rd	**b**	**SE**	**b**	**SE**	**b**	**SE**	**b**	**SE**
Intercept	57.07***	5.24	51.11***	4.94	46.36***	4.50	40.44***	4.00
Computer access (ref. Did not have since K)								
Access at 1st grade	2.89	2.25	-.43	1.81	3.53*	1.71	.11	1.50
Access in kindergarten	2.03	2.01	.12	1.68	0.69	1.60	.63	1.42
N	887		903		958		965	
R^2	.06		.05		.11		.07	

Table 3. Coefficients of Changes in Test Scores Between Grades Regressed on Gaining Access to a Home Computer by Gender (continued)

[Model 3]	Boys		Girls		Boys		Girls	
Δ Score between 3rd and 5th	b	SE	b	SE	b	SE	b	SE
Intercept	27.50***	4.73	24.75***	4.92	26.50***	3.64	28.46***	3.86
Computer access (ref. Did not have since K)								
Access at 3rd grade	2.84	2.04	1.72	1.90	-.04	1.52	2.82	1.82
Access at 1st grade	-.94	2.07	2.06	1.83	1.15	1.60	3.97*	1.67
Access in kindergarten	.88	1.88	.76	1.64	1.82	1.49	2.15	1.65
N	793		837		798		838	
R^2	.03		.02				.03	

* < .05, ** < .01, *** < .001.

Data are weighted. Controlled for changes in activities of reading for pleasure and watching TV, and other background factors.

DISCUSSION

Given previous research findings of a positive association between computer access and children's academic performance, we examined whether the benefits observed in the general U.S. population were also applicable to children from immigrant families in the early 2000s. Our study found that access to a computer during kindergarten was linked to boys' increased mathematics test scores between kindergarten and first grade. Gaining computer access at first grade was linked to boys' increased mathematics scores between first and third grade and to girls' increased mathematics scores between third and fifth grade. However, we could not find any significant association between gaining computer access and increased reading test scores for either boys or girls at any time point.

IMMIGRANT FAMILIES

The average SES of immigrant families was below the average for all American families. Their lower SES contributed to children's lower reading and mathematics test scores throughout all elementary school years (not shown in the table). Immigrant children's families also reported lower access to a computer at home than did those of nonimmigrant children. One reason may have been lower financial capability and/or educational level that limited parents' ability to purchase a computer for home use. In addition to financial capability, low SES could also be related to parents' desire to have a computer at home. Immigrant parents tend to have higher educational aspirations for their children (Hofferth & Moon, 2016; Louie, 2003). If they recognized the educational value of children's computer use, immigrant parents may have been willing to own a computer. But according to research on racial/ethnic minority parents, they were likely to doubt the usefulness of a computer and less likely to utilize a computer at home for their children with educational purposes in mind (Rideout, 2014). Perceptions about the possible negative impacts of media may have influenced these parents to limit their children's access to new media.

Immigrant parents may need not only financial support but also information about how new electronic media may benefit their children's academic performance. Media devices available to children are part of the home learning environment given that they are used for reading, searching, gaming, and communicating, activities that replace traditional activities of reading books/being read to, playing with puzzles, building with blocks, and discussions with parents at home (Moon & Hofferth, 2016). Immigrant and minority parents' worries about their children's computer

use may be due to lack of knowledge. If they are unfamiliar with computers, they may fear that they are not competent to guide or control their child's computer experience (Rideout, 2014). Immigrant parents need to be informed about the media devices/apps that their children and other children use. For example, schools could keep parents informed not only about the context of the curriculum but also about tools/devices and software used outside the home. Communities may help immigrant families obtain information on media by providing space or instruction so that parents can experience new devices/apps/software officially used at school or that are now popular among children. Guidelines and instructions for parental monitoring and engagement are needed when new media are introduced. Strategies that involve parents, particularly those that help immigrant and minority parents keep pace with new media technologies, will enhance the benefits of media use for their children.

TIMING

Having a computer available at home during the *early* elementary school years was more advantageous to children's mathematics skills development than gaining access later on. This finding means that the benefits of home computer access found among children in the general population were also applicable to those from immigrant families. Additionally, most of the positive influences of media use among immigrants, such as acculturation and English proficiency (Elias, 2013), extend to young immigrant children's academic performance as well. U.S. immigrant children are likely to enter school less prepared compared with children from nonimmigrant families (Crosnoe, 2007). The large increase in mathematics skills during the early elementary school years associated with home computer access may be because these immigrant children entered school with lower scores, and access to a home computer boosted their performance. This suggests that a home computer could play an important role for young immigrant children in preparing them for school. Considering that early intervention has greater effects than later intervention, especially for children from socially and economically disadvantaged families (Burger, 2010), identifying and recognizing possible subsidiary/auxiliary programs or support is important for immigrant families who have added disadvantages, such as low English proficiency and lack of familiarity with the U.S. school system. New media devices such as tablets, smartphones, and e-readers may fulfill many of the same educational functions as traditional literacy activities, and they do so in ways that are more attractive and stimulating to children. Early access to media for immigrant children can be regarded as early intervention/support.

For boys, the strong association between acquiring a computer early and early mathematics scores may reflect the greater effectiveness of three-dimensional, compared with two-dimensional, materials for developing analytical thinking and spatial conceptualization. Repeated exposure to three-dimensional images (Subrahmanyam & Greenfield, 2008) stimulates younger boys' interest and provides motivation (McKenney & Voogt, 2010). Although there was an association for girls, there was a longer latency period; access to a computer at first grade was associated with increased girls' mathematics scores between third and fifth grade. Previous research findings of a significant positive association of girls' spatial skills at first grade on mathematics performance at fifth grade (Casey et al., 2015) corroborate our findings. Computer access at first grade may help children develop skills necessary to interpret spatial abstractions, especially for girls, who struggle more than boys (Uttal et al., 2013). And the rate of development of girls' computer skills was higher than that of boys between kindergarten and third grade (Sackes, Trundle, & Bell, 2011). In other words, there appears to be a longer latency period before gaining computer access is manifested in improved mathematical scores for girls. Also, girls' attitudes toward computer use for gaming (describing it as challenging and intellectually stimulating) may have a positive influence on academic performance, whereas boys' attitudes toward gaming (perceiving it as exciting and expressing appreciation for good visual graphics) may make the academically positive effect disappear by fifth grade (Yelland & Lloyd, 2001).

The fact that there was little influence of computer access on increases in *reading* scores up through fifth grade could be due to the fact that reading skills are more rudimentary in the early grades, and there are fewer applications available to promote reading skills of young children; in fact, the positive effects of computer use on reading skills have been observed primarily among older children, who are presumably more likely than younger children to use a computer for literacy-related activities such as writing emails and searching the web (Hofferth & Moon, 2012b). This finding from data on children's computer use in the late 1990s also suggests that research on children's media use needs to investigate the differences between newer and more traditional functions of media that children use. For example, the traditional function of a cell phone (i.e., talking) was not associated with children's cognitive development test scores, whereas texting, which is relatively newer and has options children may find more entertaining and educational (such as automatic fills), was associated with children's better passage comprehension skills (Hofferth & Moon, 2012a).

LIMITATIONS AND STRENGTHS OF THE STUDY

The major limitation of this study is that we do not know whether and how the computer was used by the children surveyed. To measure computer access, many researchers have used home computer ownership (Attewell et al., 2003; Borzekowski & Robinson, 2005; Schmitt & Wadsworth, 2006) because it is likely that children in these families also have more access to, and make greater use of, a computer at home. In addition, computer access is selective; families who have a computer may be oriented to use it to facilitate children's learning. Others have used frequency of children's computer use at home regardless of the types/purposes of children's computer use (Fiorini, 2010; Judge et al., 2006). The most extensive method of measuring children's computer use was to categorize time spent depending on the purpose of use—for example, for email, studying, game playing, or surfing websites (Hofferth, 2010a; Hofferth & Moon, 2012b).

Internet connectivity was not included in this study even though children's computer use would be qualitatively different if the Internet was connected. First, there is a technical problem in our longitudinal study; ECLS-K data do not include consistent items about Internet connectivity in the household and whether the computer the child used was connected to the Internet across waves. There was no item asking about Internet use in the data for first graders. There was one item asking parents whether the child used a computer to get on the Internet, which is available in kindergarten and third grade, but this did not provide information about differences between children's access to a computer with/without Internet connectivity. Also, considering that only 19% of U.S. children used the Internet in 1998 (Newburger, 2001) and that there were too few reports of a child using a computer to get on the Internet in the ECLS-K, adding the measure of Internet connectivity would not change our results, which were derived from data on children's computer access between 1998/1999 and 2001/2002 and its association with their achievement.

The major strength of this study is that it extends extant research on children's media use by leveraging data on children's access to a computer within the immigrant family context between the late 1990s and early 2000s in order to understand children's access to new media and its effects among immigrant families. Although this study did not intend to compare the benefits of computer access to the children of immigrants versus nonimmigrants, findings from this study confirmed that early access to a computer was beneficial to children from immigrant families. The benefits of access to a computer were demonstrated in children's mathematics skills, given that the spatial and virtual functions of computers were prominently featured in the early years. In addition, we attempted to

understand factors affecting immigrant children's computer access almost two decades ago beyond just whether computers were affordable for this population. In other words, we tried to understand children's computer access within the home environment, which their parents and family provided, agreed on, and valued. For media to be available to children, an agreement or atmosphere in which parents allow or encourage their child to use new media is needed. This can be challenging when parents doubt the usefulness of new media. Late exposure to, and slow adoption of, new media at home can limit children in their school performance and thus in the future labor force (Yelland & Neal, 2013). In the same way that children must take the time and expend the effort to operate a computer (e.g., turning on a computer, connecting with accessories, and downloading/installing/upgrading programs), all of which go beyond the initial purpose of using it, what we found by examining children's computer access in this study can be extended to understand children's acquisition of technological literacy.

The main methodological strength of this study is that we focused on the influence of gaining access to a computer and changes in reading and mathematics scores between grades. Results showed associations between specific time points of gaining access and increased test scores between grades. We did not describe the many significant cross-sectional associations between children's computer access and reading and mathematics test scores at each grade because they do not tell us about the influence of gaining access to a computer.

CONCLUSION AND IMPLICATIONS

Our findings suggest that the influence of computer access in the late 1990s/early 2000s may help researchers understand the possible influences of media that are popular now. Previous research has noted that newer media would have a stronger positive influence on minority children, who have traditionally been under-users of media (Hofferth & Moon, 2012b). Recent research on children's media use confirmed the benefits of children's computer use only in regions where a computer is a relatively new media technology (Malhi, Bharti, & Sidhu, 2016); otherwise, no further benefits were found in the United States where computers are now considered old media amid an influx of varied and innovative technologies (Fairlie & Robinson, 2013). As a new medium in the 1990s, computers were more of a challenge for immigrant parents to adopt and utilize at home for their children's education because of the high costs of equipment and being less informed about the benefits of new media. Socioeconomically disadvantaged families, including those in the immigrant population, may

still have same challenges when it comes to using new technology for their children's education. New media devices are always relatively expensive, and low-SES parents are less likely to be introduced to and use new technologies, given their job characteristics. Even though they have a chance to use new media, those from lower SES families tend to use these new technologies to accomplish very basic operations and for leisure/entertainment, whereas those from high-SES families use them to participate in social networking and civic engagement (Helsper, 2008). The latter may acknowledge the necessity and effectiveness of new technology use and be able to help their children navigate how to use the technology for learning. Extra effort is needed to inform immigrant and minority parents about the benefits of new technologies so that their children can access them at home as much as children from affluent families do. To lessen the digital divide in children's education, timely financial support and educational information should be provided to parents to encourage early adoption of new media technologies, thus ensuring that immigrant and minority children are not left behind in the digital age.

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