Long-Term Effects of Preprimary Education on Cognitive Development :
Evidence from PISA-D Participating Countries

Kyoko Taniguchi
(Received. October 5, 2020)

Abstract: The impact of attending preprimary school on primary education has received considerable attention in the literature. There is persuasive evidence for the hypothesis that preprimary education experience supports children's development of cognitive skills later on in school. However, in the case of middle- and low-income countries, evidence of a long-term effect of preprimary education on cognitive development is not as abundant. This study investigates the relationship between preprimary education and reading achievement at age 15 in seven countries participating in the PISA for Development project—Cambodia, Ecuador, Guatemala, Honduras, Paraguay, Senegal, and Zambia. The sample sizes amounted to more than 4,000 children in each country. The present analysis uses a t-test and multiple liner regression. The findings show that in all analyzed countries the reading achievement of children who attended preprimary education was higher than of those who did not. When taking into account student, family, and school factors, preprimary education had positive effects in Honduras, Senegal, and Zambia but negligible effects in Cambodia, Ecuador, Guatemala, and Paraguay. The results bolster the case for expanding quality preprimary education in both middle- and low-income countries. The findings can contribute to the discussion on early childhood care and education.

Key words: preprimary education, later achievement, long-term effect, PISA for development, low-income countries

1. Introduction

The impact of attending preprimary school on primary education has received considerable attention in the literature. It has been suggested that early educational intervention may compensate for the effects of poverty and insufficient learning environments on children's development and success in school (Barnett, 2011). One of the targets of the United Nations' Sustainable Development Goal 4 (SDG 4) is to ensure early childhood care and education. However, in middle- and low-income countries, access to preprimary education can be a challenge. According to UNESCO (2020), in 2018 preprimary gross enrollment ratios in lower-middle-income and low-income economies were 37 percent and 24 percent, respectively. To achieve the SDG 4 target, access to preprimary education needs to be improved.

What benefits do children receive from preprimary education? Reynolds et al. (1996) found that the development of cognitive and noncognitive skills during preprimary education has a significant effect in later life. Other studies have found that preprimary school experience may support development of children's cognitive skills during primary schooling and later on (Barnett and Lamy

2006; Grantham-McGregor et al. 2007). Several studies set in high-income countries have discussed the short- and long-term effects of preprimary education on achievement (e.g. Larsen and Robinson, 1989; Sylva, 1994; Daniels, 1995). They concluded that attending preprimary education does have a positive effect on later achievement. On the other hand, in the case of middle- and low-income countries, there is evidence of short-term positive effects of preprimary education on achievement. In contrast, evidence of a long-term effect of preprimary education on achievement is less abundant.

This study's objective is to analyze the relationship between receiving preprimary education and student reading achievement at age 15 in seven countries participating in the Organisation for Economic Co-operation and Development's (OECD's) PISA for Development (PISA-D) initiative1. To pursue that aim, the study addresses three research questions: (1) Do differences exist in student achievement (specifically, reading proficiency) between children who did attend and those who did not attend preprimary school? (2) Does preprimary education have any effect on later achievement? and (3) Can any effects of preprimary education be discerned on later achievement after individual, family, and school factors are taken into account?

2. Effects of Preprimary Education on Primary and Later Achievement

Substantial empirical evidence exists of the short- and long-term effects of preprimary education on children's achievement in high-income countries. In the United States, Larsen and Robinson (1989) found a significant positive effect of preprimary education on the language and language-related components, such as spelling and reading vocabulary, of second- and third-grade boys' achievement scores. Caughy, DiPietro, and Strobino (1994) found that reading recognition performance was affected by several interacting factors, such as duration of day care, timing of initiation of day care, pattern of day care, and family income. Campbell and Ramey (1994) found that the effects of preschool treatment on intellectual development and academic achievement were maintained through age 12. Analyzing the effects of the Head Start project, Sylva (1994) concluded that it had immediate, positive effects on children's cognitive ability but that cognitive gains were no longer apparent after the end of the second year at school. Reviewing 36 studies, Barnett (1995) summarized that early childhood programs can produce large short-term benefits on children's intelligence quotient (IQ) and sizable long-term positive effects on school achievement, grade retention, placement in special education, and social adjustment.

In the United Kingdom, a few studies have found that preprimary education does have an effect on primary school student achievement. Daniels (1995) examined the effect of such education on students' reading, writing, numeracy, and science achievement and reported that preschool attendance has a significantly positive effect on those outcomes when compared to nonattendance. In a study assessing the benefits of preprimary education for student mathematical attainment at age 10, Melhuish et al. (2008) found that high-quality preprimary education especially showed significant effects. Apps, Mendolia, and Walker (2012) found that preprimary education largely improves results in cognitive tests at ages 11, 14, and 16 and has a positive effect on students' intent to pursue further education at age 19 to 20.

In the Programme for International Student Assessment (PISA) 2009, 15-year-old students who had attended preprimary education performed better on reading tests than those who did not, even after accounting for their socioeconomic backgrounds (OECD, 2012). In their analysis of the Trends in International Mathematics and Science Study (TIMSS) 2009, Sandoval-Hernandez, Taniguchi, and Aghakasiri (2013) found that preprimary education had a positive effect on fourth-grade student mathematics achievement in most analyzed countries.

In middle- and low-income countries, some empirical evidence exists of the short- and long-term effects of preprimary education on children's achievement. From their study of Thailand, Raudenbush,

Kidchanapanish, and Kang (1991) reported that third graders attending preprimary education achieved significantly more in mathematics and Thai language than did children of similar social background, sex, and age with no preprimary education experience. Berlinski, Galiani, and Gertler (2009) in an investigation of an expansion of preprimary education in Argentina found that preprimary school attendance had a positive causal effect on subsequent third-grade standardized Spanish and mathematics test scores. They found that a year of preprimary school increased average third-grade test scores by 8 percent and a quarter of a standard deviation. Aguilar and Tansini (2010) report that in Uruguay preschool experience positively affected children's academic results in the first year at school. The effect was somewhat weaker but still positive after six years. Similarly, Aboud and Hossain (2011) found that first graders in Bangladesh who had attended preprimary education performed significantly better in five competencies (speaking, writing, reading, oral mathematics, and written mathematics) than those who had not. Bibi and Ali (2012) reported that preprimary education equipped Pakistani children with the prerequisite academic skills for primary school. Taiwo and Tyolo (2002) found in their study of Botswana grade-one students that those with preprimary experience significantly outperformed their counterparts without such experience in English language, mathematics, and science. Similarly, in a study of primary school pupils in Nigeria, Osakwe (2009) found a significant difference in cognitive ability between students who had preprimary education and those who had none.

Although the exact measurements of student achievement differ among the aforementioned studies, a significant positive impact of preprimary education on primary student achievement is seen across the countries. However, there is less evidence of long-term effects of preprimary education on achievement, such as secondary student achievement, in middle- and low-income countries. Therefore, this study proposes to examine whether preprimary experience has any effect on student achievement at age 15 in the participating PISA-D countries.

3. Methodology

3.1 Data and Variables

The data used in this study were collected as part of the OECD's PISA-D pilot project between 2014 and 2016. We look at data from seven participating low- or middle-income countries: Cambodia, Ecuador, Guatemala, Honduras, Paraguay, Senegal, and Zambia. PISA-D represents the first large-scale cross-national educational research undertaken in middle- and low-income countries assessing reading, mathematics, and science proficiency at age 15. In addition to collecting student achievement data, the project collected information from children by way of background questionnaires. Although the PISA-D project collected data from children both in school and out of school, this study makes use only of data for children in school2. The sample sizes are as follows: 5,162 children in Cambodia, 5,664 children in Ecuador, 5,100 children in Guatemala, 4,773 children in Honduras, 4,510 children in Paraguay, 5,182 children in Senegal, and 4,213 children in Zambia.

Table 1 shows the variables used in this study. PISA-D examined three different cognitive domains: reading, mathematics, and science. However, because of limited space, the results of the reading scores were selected to present in this paper. Reading scores were created by computing the average of 10 plausible values in reading. Having preprimary experience is represented by a dummy variable: children who attended preprimary education were coded as "1" and those who did not attend were coded as "0." Based on the available data, the following variables were created: grade, gender, home language, satisfaction of life, health condition, starting time of learning, language in which the child first learned to read, grade repetition, missed school, and distance to school. The school attendance variable was created using factor analysis of the three questions listed in Table 1. The

PISA-D project originally created the variables of attitude toward school, sense of belonging to school, supportive student–teacher relationships, teacher expectations of success, disciplinary climate, teachers' attitude toward work, and an index of economic, social, and cultural status (ESCS). Table 2 shows descriptive statistics for each country.

Table 1 Variables used in the paper

Variable	Scale
Reading score	The average of plausible value in reading
Preprimary experience	0 = No; 1 = Yes
Grade	Grade
Gender	0 = Male; 1 = Female
Home language	0 = Other language; 1 = Language of test
Satisfaction of life	0 to 10 (0 = Not at all satisfied; 10 = Completely satisfied)
Health condition	0 to 10 (0 = Poor; 10 = Excellent)
Starting time of learning	1 = ISCED 2; 2 = ISCED; 3 = ISCED 1; 4 = At home before starting school
Language in which child first learned to read	0 = Other language; 1 = Language of test
Grade repetition	0 = No; 1 = Once; 2 = Twice or more
Missed school	0 = No; 1 = Once; 2 = Twice or more
Attitude toward school	Item response theory (IRT) score of six question items: school has helped give me confidence to make decisions; school has taught me things which could be useful in a job; trying hard at school will help me get a good job; trying hard at school will help me get into a good college; I enjoy receiving good grades; trying hard at school is important. 1 = Strongly agree; 2 = Agree; 3 = Disagree; 4 = Strongly disagree
Sense of belonging to school	IRT score of six question items: I feel like an outsider at school; I make friends easily at school; I feel like I belong at school; I feel awkward and out of place in my school; other students seem to like me; I feel lonely at school. 1 = Strongly disagree; 2 = Disagree; 3 = Agree; 4 = Strongly agree
Supportive student–teacher relationships	IRT score of seven question items: I get along well with most of my teachers; most of my teachers are interested in my well-being; most of my teachers listen to what I have to say; if I need extra help, I will receive it from my teachers; most of my teachers treat me fairly; the teachers show an interest in every student's learning; the teachers give students an opportunity to express opinions: 1 = Strongly agree; 2 = Agree; 3 = Disagree; 4 = Strongly disagree
Teacher expectations of success	IRT score of four question items: our teachers expect us to work hard; our teachers encourage students to do their best work; our teachers expect us to do our homework on time; students understand what is expected of them for their courses: 1 = Strongly agree; 2 = Agree; 3 = Disagree; 4 = Strongly disagree
Disciplinary climate	IRT score of five question items: students don't listen to what the teacher says; there is noise and disorder; the teacher has to wait a long time for students to quiet down; students cannot work well; students don't start working for a long time after the lesson begins. 1 = Every lesson; 2 = Most lessons; 3 = Some lessons; 4 = Never or hardly ever
School attendance	Factor score of three question items: I skipped a whole school day; I skipped some classes; I arrived late for school. 1 = Never; 2 = One or two times; 3 = Three or four times; 4 = Five or more times
Distance to school	1 = 15 minutes or less; 2 = More than 15 minutes but less than 30 minutes; 3 = Between 30 minutes and 60 minutes; 4 = Between 60 minutes and 90 minutes; 5 = More than 90 minutes
Teachers' attitude to work	Factor score of seven question items: one or more classes were cancelled; school was cancelled; one of my teachers did not come for class; there was a teacher strike; my teacher worked at the computer during class time; my teacher answered personal calls during class time; my teacher attended a meeting during class time. 0 = No; 1 = Yes
ESCS	Index of economic, social, and cultural status. The score is derived by principal component analysis of parental education, highest parental occupation, and home possessions.
School	School dummy

Table 2 Descriptive statistics

Variable	Cambodia		Ecuador		Guatemala		Honduras		Paraguay		Senegal		Zambia	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Reading score	316.50	58.86	408.35	74.51	371.61	69.59	373.31	70.90	376.05	76.14	306.56	63.16	294.24	70.20
Preprimary experience	0.69	0.75	1.27	0.70	1.37	0.72	1.24	0.77	1.26	0.67	0.91	0.88	1.03	0.85
Grade	9.44	1.18	10.12	0.81	8.66	0.91	9.14	0.95	9.61	0.78	9.20	0.98	8.64	1.20
Gender	0.53	0.50	0.49	0.50	0.48	0.50	0.54	0.50	0.51	0.50	0.54	0.50	0.52	0.50
Home language	0.97	0.17	0.99	0.11	0.91	0.28	0.98	0.15	0.62	0.49	0.06	0.24	0.19	0.40
Satisfaction of life	8.37	2.15	8.47	1.86	8.35	2.14	8.61	2.03	8.23	2.30	7.31	3.06	6.27	3.23
Health condition	5.25	2.27	7.12	2.24	7.21	2.41	7.76	2.31	7.25	2.48	7.02	2.72	6.88	2.80
Starting time of learning	3.13	0.89	3.88	0.45	3.82	0.57	3.78	0.57	3.54	0.82	2.61	0.87	2.92	0.94
Language in which child first learned to read	0.96	0.18	0.98	0.15	0.97	0.17	0.97	0.18	0.93	0.25	0.85	0.36	0.46	0.50
Grade repetition	0.38	0.60	0.20	0.46	0.42	0.61	0.26	0.51	0.24	0.52	0.56	0.66	0.44	0.64
Missed school	0.10	0.37	0.15	0.46	0.23	0.53	0.17	0.48	0.23	0.57	0.15	0.43	0.29	0.59
Attitude toward school	7.30	2.04	7.68	1.84	7.81	1.91	7.80	2.03	7.35	1.93	7.47	2.16	7.26	2.54
Sense of belonging to school	-0.14	0.82	0.47	1.27	0.13	1.17	0.39	1.35	0.16	1.15	0.01	1.11	-0.17	1.03
Supportive student–teacher relationships	6.06	1.62	6.68	1.95	6.83	2.07	7.01	2.19	6.71	2.00	6.44	1.97	5.99	2.00
Teacher expectations of success	6.30	2.11	7.48	2.23	7.40	2.34	7.73	2.40	7.18	2.32	7.08	2.41	6.69	2.62
Disciplinary climate	0.63	1.17	0.04	0.84	0.17	0.97	0.25	1.07	-0.21	0.98	0.08	1.03	0.13	1.07
School attendance	-0.43	0.66	-0.02	0.92	-0.05	0.89	0.10	1.01	0.64	1.21	-0.23	0.80	0.11	1.18
Distance to school	1.55	0.79	2.02	1.10	1.93	1.08	1.89	1.10	1.68	0.99	1.98	1.14	2.47	1.38
Teachers' attitude to work	0.28	0.15	0.31	0.15	0.30	0.15	0.30	0.15	0.33	0.16	0.41	0.16	0.37	0.15
ESCS	-1.90	1.10	-0.93	1.14	-1.30	1.20	-1.25	1.29	-1.17	1.11	-1.73	1.35	-1.27	1.34

Note: ESCS = index of economic, social, and cultural status.

3.2 Analysis

First, the study compared the reading scores of students who had attended preprimary education and those who had not attended using a t-test. Then, multiple linear regression analysis was used to determine the effect of preprimary experience on reading achievement. The dependent variable was student reading score. The independent variables were preprimary experience and individual, family, and school factors listed in Table 1. In the analysis, the weight (W_FSTUWT) was used. Three models were created: model 1 for preprimary experience alone; model 2 for preprimary experience and individual and family factors; and model 3 for preprimary experience and individual, family, and school factors.

4. Findings

Table 3 shows the percentage by country of children who had preprimary education. It varied from 51.4 percent in Cambodia to 87.0 percent in Paraguay. In Cambodia, Senegal, and Zambia, the rates of preprimary experience were significantly lower. On the other hand, the Latin American countries—Ecuador, Guatemala, Honduras, and Paraguay—showed a more moderate rate.

Table 3 Rate of preprimary experience

	Preprimary experience
Cambodia	0.514
Ecuador	0.856
Guatemala	0.859
Honduras	0.791
Paraguay	0.870
Senegal	0.571
Zambia	0.654

4.1 Difference in Reading Scores between Children with Preprimary Education and Those Without

Table 4 shows the differences in reading achievement between children who attended and those who did not attend preprimary education. Reading proficiency was clearly different between students who attended and those that did not attend preprimary education in all analyzed countries. The difference between the two groups was statistically significant in all countries. However, the difference was variable across countries. For example, in Paraguay and Honduras, students with preprimary education experience achieved scores 43.17 and 37.90 points, respectively, higher than those who did not attend. On the other hand, the difference was smaller in Cambodia and Senegal: 12.41 and 17.07 score points, respectively. From these results, it could be concluded that students' reading achievement was improved when they attended preprimary education in all analyzed countries.

Table 4 Difference in reading scores

Country	Attended	Not attended	Difference
Cambodia	323.68	311.27	12.41
Ecuador	414.15	382.66	31.50
Guatemala	376.58	353.61	22.97
Honduras	382.94	345.04	37.90
Paraguay	383.74	340.57	43.17
Senegal	315.74	298.67	17.07
Zambia	309.51	276.99	32.52

4.2. The Effects of Preprimary Education on Reading Achievement

The study's main objective is to determine the effects of preprimary education on reading achievement. Table 5 shows the coefficients of models 1, 2, and 3. Table 6 shows the results of model 3 (final model). Focusing on model 1 in Table 5, in all countries, preprimary experience positively affected reading achievement at age 15. In model 2, which controls for individual and family factors, the effect of preprimary experience on reading achievement was significant in four countries—namely, Guatemala, Honduras, Senegal, and Zambia—but was not significant in three countries—Cambodia, Ecuador, and Paraguay. In model 3, which controls for individual, family, and school factors, the effect on reading achievement was still significant in three countries—Honduras, Senegal, and Zambia—but was not significant in four countries—Cambodia, Ecuador, Guatemala, and Paraguay.

These results suggest that preprimary experience positively affected reading achievement, but that its effect varied depending on the country. In Honduras and Zambia, preprimary experience had a strong effect on reading achievement at age 15, whereas in Senegal, the effect was moderate. In Honduras and Zambia, the scores of students who had attended preprimary education were 5.31 and 4.11 points higher, respectively, than students who had no preprimary experience. In Senegal, pupils with preprimary experience scored 2.70 points higher. On the other hand, in Cambodia, Ecuador, and Paraguay, the effect was negligible after controlling for family and school factors, and in Guatemala, the effect can be ignored after controlling for individual, family, and school factors. As Table 6 shows, in those countries, other factors strongly affected reading achievement.

Table 5 Coefficient of preschool experience in Models 1, 2 and 3

Model	Variable	Cambodia			Ecuador			Guatemala			Honduras			Paraguay			Senegal			Zambia		
		B	SE	p	B	SE	p	B	SE	p	B	SE	p	B	SE	p	B	SE	p	B	SE	p
Model 1	Preprimary experience	3.643	1.245	**	6.665	1.620	***	12.241	1.595	***	19.755	1.438	***	13.599	2.125	***	14.540	1.190	***	19.960	1.549	***
Model 2	Preprimary experience	0.365	1.062		1.435	1.298		2.708	1.299	*	8.780	1.330	***	1.275	2.046		7.473	1.322	***	6.372	1.304	***
Model 3	Preprimary experience	-0.274	1.078		-0.263	1.187		-0.289	1.120		5.311	1.187	***	-0.465	1.764		2.699	1.265	*	4.113	1.128	***

Note: p*** < 0.01, p** < 0.01, p* < 0.05.

Table 6 Results of Model 3 (Final model)

Variable	Cambodia			Ecuador			Guatemala			Honduras			Paraguay			Senegal			Zambia		
	B	SE	p	B	SE	p	B	SE	p	B	SE	p	B	SE	p	B	SE	p	B	SE	p
Preprimary experience	-0.274	1.078		-0.263	1.187		-0.289	1.120		5.311	1.187	***	-0.465	1.764		2.699	1.265	*	4.113	1.128	***
Grade	18.236	0.901	***	18.762	1.324	***	18.215	1.632	***	16.440	1.308	***	15.283	2.079	***	15.437	1.290	***	18.665	1.193	***
Gender	9.060	1.488	***	4.153	1.746	*	-5.743	1.633	***	2.505	1.839		1.987	2.553		-5.332	2.081	**	-3.224	1.743	
Home language	12.755	4.997	*	7.252	9.242		11.297	4.225		14.576	7.945		6.624	3.274	*	1.002	4.225		-0.810	2.427	
Satisfaction of life	-0.571	0.364		-1.986	0.546	***	-0.040	0.484		-2.011	0.566	***	-0.162	0.606		-0.087	0.354		-0.181	0.326	
Health condition	-0.696	0.362		0.134	0.414		-1.823	0.398	***	-1.244	0.432	**	-0.365	0.529		-0.898	0.376	*	0.460	0.320	
Starting time of learning	-1.222	0.901		9.719	2.001	***	12.509	1.904	***	9.407	1.508	***	7.851	1.642	***	3.065	1.287	*	1.307	1.074	
Language in which child first learned to read	-20.624	5.450	***	9.747	5.949		20.941	4.784	***	0.170	5.277		10.861	5.459	*	8.181	2.988	**	9.591	1.993	***
Grade repetition	-7.711	1.441	***	-14.810	2.239	***	-1.170	2.111		-10.802	2.083	***	-13.537	3.052	***	-5.934	1.639	***	-3.684	1.509	*
Missed school	-12.189	2.207	***	-12.440	1.845	***	-13.589	1.507	***	-7.322	1.794	***	-10.898	2.053	***	1.020	3.290		-10.025	1.947	***
Attitude toward school	-0.212	0.441		-2.561	0.556	***	-0.026	0.525		-0.186	0.533		-0.235	0.745		1.395	0.586	*	1.593	0.485	***
Sense of belonging to school	8.930	1.076	***	2.592	0.704	***	6.364	0.697	***	4.365	0.699	***	4.733	1.036	***	4.801	1.025	***	4.689	0.900	***
Supportive student–teacher relationships	-2.941	0.786	***	-2.236	0.646	***	-3.254	0.594	***	-2.798	0.632	***	-6.134	0.937	***	0.779	0.673		-1.322	0.644	*
Teacher expectations of success	1.345	0.579	*	0.676	0.516		0.790	0.506		1.117	0.533	*	1.127	0.745		0.990	0.572		1.944	0.549	***
Disciplinary climate	3.458	0.751	***	2.917	1.092	**	0.430	1.037		3.052	1.002	**	1.355	1.417		1.099	1.117		3.383	0.942	***
School attendance	-3.781	1.783	*	-2.057	0.931	*	2.494	1.027	*	-0.422	1.016		-0.844	0.989		2.818	1.505		-3.626	0.920	***
Distance to school	-1.078	1.039		-1.541	0.785	*	-1.528	0.836		-0.493	0.876		0.006	1.271		-1.306	0.856		-1.309	0.659	*
Teachers' attitude to work	21.911	6.120	***	21.747	6.157	***	7.235	6.425		-1.935	7.569		-13.199	8.087		-0.876	6.918		3.791	6.553	
ESCS	1.693	0.849	*	7.602	0.942	***	5.149	0.886	***	2.363	0.936	*	8.870	1.253	***	0.824	0.921		2.485	0.880	**
School	Controlled			Controlled			Controlled			Controlled			Controlled			Controlled			Controlled		
Constant	184.521	15.980	***	219.892	24.796	***	267.872	20.947	***	223.079	20.923	***	252.784	28.098	***	166.874	20.303	***	88.494	15.118	***
R^2	0.478			0.513			0.617			0.563			0.500			0.483			0.799		
N	4280			4896			4238			3710			3086			3171			2386		

Note: ESCS = index of economic, social, and cultural status. p *** < 0.01, p ** < 0.01, p * < 0.05.

5. Discussion

This study analyzes the impact of preprimary education on student achievement in seven participating PISA-D countries. Results show variable effects depending on the country. Let is consider the potential reasons. First, the quality of preprimary education might vary from country to country. The curriculum and policies differ by country. For example, in some countries, cognitive development is emphasized, but in others, the focus is on day care. An effective preschool curriculum (Sylva, 1994) and standard preschool programs (Berlinski, Galiani, and Gertler, 2009) are vital to maintain the quality of preprimary education. Moreover, Campbell and Ramey (1994) in their study of follow-up data of an early childhood education intervention found that preprimary education was more influential on primary student cognitive and academic achievement as the duration of the treatment increased. One of the limitations of the present study is that it did not analyze the quality of preprimary education because the PISA-D project did not collect such information. In future studies, one needs to consider how to analyze such factors.

A second reason for the variable findings is that there is less clear evidence in general regarding a long-term effect of preprimary education on achievement, such as secondary school achievement. Many studies have established a short-term effect on cognitive development, such as primary school achievement. This is a challenging issue in this study.

Finally, although the PISA-D project tested for lower levels of proficiency compared with PISA, the cognitive skills measured in the PISA-D initiative might still be at a higher level (i.e., more advanced) than the levels at which the children in the participating PISA-D countries are reading. The OECD (2018) reported that only about 23 percent of students achieved the minimum level of

proficiency in reading, meaning that its assessment might be failing to measure the reading level of the low-achieving children.

6. Conclusion

The study looks at the relationship between preprimary education and primary student reading achievement in seven PISA-D participating countries. The evidence is clear as follows. First, in all of the countries analyzed, children who had attended preprimary education read at a higher level than children with no preprimary education. Second, we can say that the preprimary experience itself had a positive effect on reading achievement in all countries. Finally, even taking into account student, family, and school factors, preschool's effect was positive in Honduras, Senegal, and Zambia; the effect was negligible in Cambodia, Ecuador, Guatemala, and Paraguay.

The effects of preprimary experience varied between countries; however, it positively affected reading achievement at age 15. Therefore, expanding quality preschool in both middle- and low-income countries would bring a significant benefit. In the PISA-D countries, the preschool attendance rate was low, especially in Cambodia, Senegal, and Zambia (see Table 3). It is hoped that the study's findings will contribute to further discussion on early childhood care and education.

Note

1. PISA for Development (PISA-D) is developed for middle- and low- income countries. The difference with PISA is to include the lower levels of the PISA proficiency scales, to reflect on the context of children in middle- and low- income countries, and to assess out of school children at age 14-16. As of September 18, 2020, nine countries participated in PISA-D: Bhutan, Cambodia, Ecuador, Guatemala, Honduras, Panama, Paraguay, Senegal, and Zambia. However, data for the school-based implementation in seven countries were available. Therefore, this study analyzed data in seven countries: Cambodia, Ecuador, Guatemala, Honduras, Paraguay, Senegal, and Zambia.
2. As of September 18, 2020, data for out-of-school children were not available.
3. This paper uses reading scores for the analysis. However, strong relationships exist between reading scores and mathematics scores ($r = 0.861$, p[***] < 0.001) and between reading scores and science scores ($r = 0.914$, p[***] < 0.001). These results predict that the effects of preprimary education on reading achievement would be similar to its effects on mathematics and science achievement.

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