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Foundational mathematics and reading skills of Filipino students over a generation

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ADBI Working Paper Series

**FOUNDATIONAL MATHEMATICS
AND READING SKILLS OF FILIPINO
STUDENTS OVER A GENERATION**

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Abstract

Children around the world largely rely on the formal educational system to teach them foundational mathematics and reading skills. The inability of an educational system to do so may indicate it has structural constraints. In this paper, we take advantage of three rounds of a nationally representative household survey on education and functional literacy implemented by the Philippine Statistics Authority to examine mastery of foundational mathematics and reading skills among students in grades 4–10 students. The three rounds enable us to examine trends in these skills from the turn of the millennium to 2019. We find that one in every 10 tenth-grade students were still unable to solve simple multiplication and division questions, and two could not correctly answer a simple reading comprehension question. We also find that the difference in foundational mathematics and reading skills between grade 10 and grade 4 students is small. Based on a comparison between cohorts, we find that foundational mathematics skills continued to decline between the 2003 and 2019 cohorts. Foundational reading skills, however, trended up between 2013 and 2019 after stagnating between 2003 and 2013. The latter is suggestive evidence that major educational reforms implemented by the Philippine government since 2012 may have successfully improved reading skills but not mathematics skills. Overall, the Philippine basic education system, building on its success in ensuring virtually all children attend elementary schools, still has ample room to ensure all students master foundational mathematics and reading skills.

Keywords: foundational skills, learning outcomes, education quality, Philippines

JEL Classification: I21, O15, O53

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1. INTRODUCTION

Educational systems undergo a two-step process to produce highly skilled individuals. First, a child is enrolled in school. Second, the school must ensure that the child learns. Over the past two decades, many low and lower-middle income countries have been very successful in the former. Data from the World Development Indicators show that in low-income countries, the share of primary school-aged children who were not in school went from 45% at the turn of the millennium to 19% in 2019. In lower-middle income countries, the share was halved to 10% over the same time period.¹

Success in the second step is much harder to realize. There is now consensus that the amount of learning that students gain as they progress through school is generally small (World Bank 2018a). In Indonesia, for example, Beatty et al. (forthcoming) showed that the difference in the proportion of grade 4 students and grade 12 students with basic mathematics skills was only 10 percentage points (42% vs 32%). In the Indian state of Andra Pradesh, only 5% of fifth grade students could do basic arithmetic (Pritchett 2013). Across 50 developing countries, an increase in all women's education to six years would still leave 40% of those women illiterate (Pritchett and Sandefur 2017). The quality of education in low-income countries is so low that even the most elite schools in which the most socioeconomically advantaged students enroll would not be able to produce enough learning to meet the minimum standards set in the Sustainable Development Goals (Pritchett and Viarengo 2021).

However, the between-country variation in learning production per year of schooling is also high. Singh (2020) found that an additional year of schooling in Viet Nam provided students with test scores that were 0.2–0.4 standard deviations higher than test scores in Peru, Ethiopia, or India. Therefore, while on average the production of learning in low and lower-middle income countries' educational systems is low, a small number of countries achieve relatively high production levels.

In this paper, we investigated the mastery of foundational mathematics and reading skills among Filipino students in grades 4–10 using three waves of a nationally representative household survey spanning 2003 to 2019. The ability to compare cohorts over an extended time period with data collected using virtually identical survey instruments is rare in the group of low and lower-middle income countries. These countries also rarely participate in international assessments.²

Specifically, for mathematics, we examined the share of students in each grade who could complete two-digit by one-digit multiplication and division problems. For reading, we calculated the share of students in each grade who could retrieve explicit information from a three-sentence paragraph. Based on the national K–12 basic education curriculum, these skills are taught in grade 3. Our expectations, therefore, were that virtually all grade 4–10 students should be equipped with these skills. In addition to examining the overall sample, we investigated mastery of the skills by subgroups: boys vs girls and wealth quartiles.

¹ Source: children out of school (% of primary school age) for low and lower-middle income countries, from World Development Indicators (<https://databank.worldbank.org/source/world-development-indicators>).

² Out of 29 low-income countries, only 4 have participated at least once in the Programme for International Student Assessment (PISA) and 1 has participated in the Trends in Mathematics and Science Study (TIMSS). Out of 50 lower-middle-income countries, only 13 have participated in PISA and nine have participated in TIMSS. Source for countries by income status: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519>. List of countries participating in PISA: <https://www.oecd.org/pisa/aboutpisa/pisa-participants.htm>. List of countries participating in TIMSS: <https://nces.ed.gov/timss/participation.asp>.

We focused on foundational skills because they are a proxy for the bare minimum functioning of an educational system. Foundational skills are usually taught through procedural, largely scripted methods that require little custom-made teaching props or material. The teaching methods are well established and almost uniformly practiced worldwide. Many tips as well as guidance for teaching or learning these skills are freely available on the internet. If an educational system is unable to ensure that all their students master these foundational skills, then there are likely to be structural issues in the educational system. It would be unlikely that such an educational system would be able to equip their students with higher order skills.

The summary of our findings is as follows. First, students in higher grades have higher skills. This means schooling provides learning benefits. Among grade 10 students in 2019, almost 90% correctly answered the mathematics questions. But only slightly more than 70% answered the reading question correctly. Second, even for these foundational skills, one in ten grade 10 students, equivalent to roughly 150,000 students in 2019, did not have foundational mathematics skills. The number of students without foundational reading skills is even higher at 30%, equivalent to 450,000 students. Therefore, similar to many countries, the Philippine educational system appears to be unable to provide all students with foundational skills.

Third, the foundational mathematics skills of Filipino students consistently regressed between 2003 and 2019. We found that the decline between 2013 and 2019 was four times as severe as the decline between 2003 and 2013. We see a contrasting trend with reading, however. Overall, foundational reading skills improved by 2.4 percentage points between 2013 and 2019. Examining the grade-by-grade pattern, significant improvements took place in grades 4 to 6. In higher grades, the proportion of students with foundational reading skills in the three years was effectively identical. These facts serve as suggestive evidence that the reforms that began in 2013 may have some successes.

The rest of the paper is organized as follows. The next section presents the context of education in the Philippines, including major reforms undertaken over the past decade. The third section describes the data we used. The fourth section contains the main findings. The last section presents conclusions.

2. EDUCATION IN THE PHILIPPINES

Education in the Philippines has evolved over several decades. As stipulated in the 1987 Constitutional Law, the state has guaranteed free universal education at primary and secondary levels.³ At present, the country's educational system is managed by three government agencies and is also referred to as a tri-focalized educational system. The Department of Education (DepEd) manages the K–12 basic educational program, a 13-year compulsory education program. The other two agencies, the Commission for Higher Education (CHED) and the Technical Education and Skills Development Authority (TESDA), which were established in 1994 by separation from DepEd, manage post-basic and tertiary programs, such as colleges and short-term vocational and entrepreneurship training programs.

The education sector maintains a centralized structure in a context in which many other public services, such as health, welfare, childcare, jobs, agriculture, and infrastructure,

³ The 1987 Constitution of The Republic of The Philippines – Article XIV Education, Science and Technology, Arts, Culture and Sports.

have been decentralized and directly administered by local government units (LGUs).⁴ DepEd has the largest bureaucratic organization in the country, consisting of the central office in Metro Manila and field offices in 17 regions, over 200 school divisions, and school districts which together involve over 960,000 employees⁵. DepEd directly manages the national basic education system's core components, including the national K–12 curriculum, school facilities, classroom furniture, learning resources (mainly textbooks), teacher deployment and development, standardized assessments, and other various programs (such as school food programs). Construction of new public school buildings is implemented by the Department of Public Works in close coordination with DepEd, which holds its budget.

At the subnational level, LGUs form respective local education boards in each region, province, city, and municipality which are parallel to the DepEd governance structure, but their main role is generally limited to discussing “supplemental budgetary needs for the operation and maintenance of public schools.”⁶ The vast majority of public education expenditures are centrally managed by DepEd, while LGUs hold their own education budget, mainly sourced from the Special Education Fund (SEF), which LGUs collect by charging an additional one-percent tax on land or other real estate property.⁷ Thus, highly urbanized cities have accumulated large SEFs, enabling them to supplement locally-hired teachers and provide additional materials to schools in their localities, which leaves greater disparities between urban and rural areas (Manasan, Celestino, and Cuenca 2011).

The Philippine government implemented a series of reforms to overhaul the basic education system, which were initiated during the Aquino administration (June 2010–May 2016) and continued by the Duterte administration (from June 2016 to present). The landmark reform was the passage of the 2013 Enhanced Basic Education Act. It transformed a 10-year schooling system, which consisted of a 6-year elementary school and 4-year junior high school (JHS) education, into a 13-year scheme by instituting mandatory 1-year kindergarten and new 2-year senior high school (SHS) education. On the ground, the implementation of the K-12 program with the new national curriculum started with the universal kindergarten program by targeting a cohort of children aged 5 in 2011. Implementation followed the cohort when they entered elementary school and also targeted a new cohort of grade 7 students in 2012.⁸ The SHS level operation began in 2016.

Another major aim of the 2013 Enhanced Basic Education Act is to improve the mastery of the foundational abilities, especially reading skills, while children are in the early grades. The Mother Tongue Based Multi-Linguistic Education (MTB-MLE) program was introduced in K–3 education in 2012, shifting from sole use of Filipino (Tagalog) and English as the medium of instruction to the adoption of 12 mother tongues (or native languages including Tagalog). These mother tongues have also become an additional reading subject for kindergarten and grades 1–3 students. Around this time, DepEd also implemented the Early Literacy, Language, Numeracy program, which aims to train K–3 teachers on teaching early reading and math skills and which has provided textbooks in

⁴ Republic Act No. 7160 An Act Providing for A Local Government Code of 1991.

⁵ Source: Total number of regular employees of DepEd, as of April 2020, from the DepEd Enhanced Basic Education Information System, retrieved from <https://www.teacherph.com/deped-basic-education-statistics-school-year-2019-2020/>.

⁶ Section 99 of the Local Government Code of the Philippines.

⁷ Republic Act No. 5447.

⁸ DepEd Order No. 37, s. 2011.

respective mother tongues. The MTB-MLE program has since expanded to cover 19 native languages.

National education spending in the recent decade has also dramatically increased, supporting the implementation of these ambitious reforms. Recovering from the lower spending levels in the early 2000s, public basic educational spending, which comprises at least 85% of total government spending on education, has more than doubled in real terms from the late 2000s to 2020. The spending as a share of GDP reached 3.8% in 2017, which is comparable to the average level spent by upper-middle-income countries (World Bank 2020).

Even more, the availability of financial resources that schools can autonomously use to purchase supplemental learning materials and to support activities, referred to as the maintenance, operating, and other materials (MOOE) fund, also expanded during the same time period. The per-pupil MOOE amount increased to approximately PHP 2,280 (approximately USD 45) in 2017, a jump from PHP 670 (approximately USD 13) in 2012 in 2000 prices (World Bank 2020).

In addition to increases in the amount of national education spending, the utilization rate also shows an increase since 2016. The bulk of the public basic education budget has been spent on salaries of teaching and non-teaching staff and additional school buildings and classrooms, which were left as backlogs from the past, as well as newly introduced senior high schools. Over time, the overall student–teacher ratios have significantly improved to 30:1 for the elementary level and 25:1 for the secondary level as of 2017, with a significant narrowing of persistent disparities in the teacher ratio throughout the country.

The government has also allocated significant subsidies for private secondary education to keep up with the growing school-age population. In addition to the education service contracting (ESC) program for private junior high schools, the senior high school voucher program (or SHSVP) was introduced in 2016 with the opening of SHS. The voucher provides access to private high schools for students graduating from public schools. Private high schools, which are certified based on criteria set up by the government, receive government assistance for slots that are in excess of the existing capacities for students who “otherwise would have gone to public schools.”⁹ These schemes have resulted in significant cost-savings to the government (World Bank 2011) and have contributed to decongestion of overcrowded public high schools in highly urbanized areas. In 2019, about 20% of JHS students and 40% of SHS students attended private schools, of which 1.1 million JHS and 1.2 million SHS students received these financial supports (Philippine Department of Education 2020).

The basic education sector has shown positive trends over the last few decades, especially with respect to all children attending elementary schools. Kindergarten participation of children at age 5 surpassed 80% in 2017. Junior high school (JHS) participation rates, which were stagnant below 70% in the past decade, increased close to 80%, with 85% completing the level (World Bank 2020). There was a progression of over 90% from JHS to SHS in 2017, two years after the latter's establishment. These gains are significant, particularly with respect to children from poor households, because the national conditional cash transfer (CCT) program targeting the poorest families with children of elementary school-age was rolled out in 2007 and expanded to cover high school age children in 2015 (Acosta, Avalos, and Zapanta 2019).

However, recent evidence reveals that these gains were not realized with regard to learning outcomes. The Philippines was at the bottom in the 2018 Programme for

⁹ <https://peac.org.ph/senior-high-school-voucher-program/>.

International Student Assessment (PISA) and in the 2019 Trends in International Mathematics and Science Study (TIMSS). The TIMSS results for the Philippines sharply dropped from the 2003 TIMSS. In 2019, over 81% of grade 4 students did not reach the lowest category of its international benchmark (Mullis et al. 2020) compared with 59% in 2003 (Mullis, Martin, and Foy 2005). Furthermore, a Southeast Asian student assessment also showed that the majority of Filipino grade 5 students were falling behind their regional peers (UNICEF 2020). The national achievement test results showed little to no improvement between 2008–2016 across all subjects (World Bank 2020). Unfortunately, the national assessments, administered by DepEd at grades 3, 6, and 10, have undergone many revisions since 2012 due to the national curriculum reform. These changes mean that the national assessments cannot be used to monitor trends in student learning outcomes.

Furthermore, despite the overall positive progress, disparities in learning outcomes persist. Gaps within and between regions, as well as between socioeconomic classes, remain a significant challenge (World Bank 2018b). For the poor, CCT has made education more accessible than before, but participation, dropout, and student achievement remain strongly linked to parental wealth levels (World Bank, 2018b). The lagging status of boys in school has improved at the elementary level, but it remains largely significant at the secondary level. For instance, in 2016, 80% of young female adults (between 20–24 years old) had attained secondary education while only 64% of young male adults had done so (World Bank 2020; Paqueo and Orbeta 2019).

Finally, the general quality of teaching remains a concern. The World Bank (2016) has reported that teachers lack sufficient subject-specific knowledge to teach what is prescribed in the national curriculum. Also, skilled teachers are concentrated in urban centers while many of the new hires are deployed to remote schools without sufficient support for professional development (World Bank 2020).¹⁰

3. DATA

This study used the microdata of the Functional Literacy¹¹, Education, Mass Media Survey (FLEMMS), a national household survey that has been conducted in all regions by the Philippines Statistics Authority (PSA) every five years since 1998.¹² The aim of the FLEMMS is to provide quantitative data on the Philippine population's literacy and educational status which can be utilized for evaluating and formulating government policies and programs. The FLEMMS sample is randomly drawn from the master sample constructed based on the Population Census which is representative at the regional level and with respect to sex and age.

¹⁰ Master Teachers and Teacher III are considered to be teachers who are more skilled (or more experienced in the field).

¹¹ Functional literacy means having the ability to read, write, compute, and understand, enabling "individuals to participate fully and efficiently in activities commonly occurring in his life situation that requires a reasonable capability of communicating by written language." (Philippine Statistical Authority 2015).

¹² The 2013 FLEMMS was not conducted in Region 8 due to the calamity of Typhoon Yolanda.

A FLEMMS survey consists of two modules. The first module, administered with the heads of household (HH) or their spouses, asks about all household members' basic demographic information. For HH members aged 5 and above, the survey asks about their highest educational levels and basic literacy (e.g., can a person read and write). HH members aged 3–24 are also asked for their schooling status, including reasons for not attending school. The module includes further questions on the employment status of HH members above the age of 5.

In the second module of FLEMMS, respondents are filtered by age. Only those who are ten years old or older are eligible for this module. Unless respondents lack basic literacy skills, it is a self-administered questionnaire made up of several questions which directly assess literacy levels and record schooling history and the extent to which the sample uses mass media. Furthermore, respondents choose from survey questionnaires prepared in Tagalog, English, Ilocano, Bicolano, Waray, Cebuano, and Hiligaynon languages.

While many question items in the questionnaire vary between survey rounds, three questions—two simple calculation questions and one reading comprehension question—have remained consistent throughout. The two calculation questions are: (a) a two-digit number by one-digit number multiplication and (b) a two-digit number by one-digit number division. The mathematical concepts related to these questions are supposed to be taught by grade 3 in the K–12 curriculum on mathematics.¹³ In addition, the reading comprehension question requires respondents to read a passage consisting of two simple sentences and extract an explicit answer from the passage. The intended grade level for this reading comprehension question is at least grade 2, according to the K–12 curriculum on Mother Tongue.¹⁴ These common questions allow us to examine the trend of foundational reading and math skills which should be acquired by at least Grade 3. The Annex Figures 1 and 2 present these questions.

We use the FLEMMS microdata collected in 2003, 2013, and 2019. Of all the respondents surveyed, we delineated those between 10 and 18 years old, the formal ages for grades 4–10 enrollment, as our sample to analyze the mastery of foundational mathematics and reading skills. Table 1 shows the summary statistics. Overall, about 83% and 63% of our sample correctly answered the mathematics and reading questions, respectively, across these survey rounds. About 90% of the sample are currently attending school. Among those attending school, 75% are in the correct grade for their age. The average age of our sample is 13.9 years and 51% are male.

Table 1 shows some interesting trends over time. First, the share of enrolled students who are in the correct grade for their age increased from 68% in 2003 to 81% in 2019. Second, school participation rates in the sample increased from 83% in 2003 to 94% in 2019, again showing the government's consistency in ensuring Filipino children's access to schooling.

¹³ https://www.deped.gov.ph/wp-content/uploads/2019/01/Math-CG_with-tagged-math-equipment.pdf. Look for the curriculum codes: M3NS-IIb40.5/ M3NS-IIc43.1 (for a 2-digit by 1-digit number multiplication – Grade 3) and M2NS-IIIb51.1/ M2NS-IIc56.1 (for a 2-digit by 1-digit number division – Grade 2).

¹⁴ <https://www.deped.gov.ph/wp-content/uploads/2019/01/Mother-Tongue-CG.pdf>. Look for the curriculum codes under Reading Comprehension, such as MT1RCIVg-h-4.2 (Understand cause and effect from text).

Table 1: Summary Statistics

	Mean	Standard Deviation
All Sample (N = 61,408)		
Have foundational mathematics skills (Yes = 1)	0.83	0.38
Have foundational reading skills (Yes = 1)	0.63	0.48
Currently in school (Yes = 1)	0.89	0.32
Currently in the correct grade (conditional on being in school) (Yes = 1)	0.75	0.43
Age (years)	13.87	2.52
Male (Yes = 1)	0.51	0.50
2003 (N = 19,160)		
Have foundational mathematics skills (Yes = 1)	0.83	0.38
Have foundational reading skills (Yes = 1)	0.59	0.49
Currently in school (Yes = 1)	0.83	0.37
Currently in the correct grade (conditional on being in school) (Yes = 1)	0.68	0.47
Age (years)	13.73	2.49
Male (Yes = 1)	0.50	0.50
2013 (N = 15,872)		
Have foundational mathematics skills (Yes = 1)	0.84	0.37
Have foundational reading skills (Yes = 1)	0.62	0.49
Currently in school (Yes = 1)	0.86	0.34
Currently in the correct grade (conditional on being in school) (Yes = 1)	0.73	0.44
Age (years)	13.90	2.51
Male (Yes = 1)	0.51	0.50
2019 (N = 26,376)		
Have foundational mathematics skills (Yes = 1)	0.81	0.39
Have foundational reading skills (Yes = 1)	0.65	0.48
Currently in school (Yes = 1)	0.94	0.24
Currently in the correct grade (conditional on being in school) (Yes = 1)	0.81	0.40
Age (years)	13.95	2.53
Male (Yes = 1)	0.51	0.50

4. LEARNING PROFILES

We start with presenting the situation of foundational mathematics and reading skills among students in 2019. After that, we present the trend from 2003 to 2019.

4.1 Foundational Mathematics and Reading Skills in 2019

Figure 1 shows the proportion of students in each grade who correctly answered the mathematics or the reading questions. Since the youngest respondents for these questions were 10 years old, we set grade 4 as the lowest grade because 10-year-olds are normally enrolled in that grade.¹⁵ We set grade 10 as the highest grade to enable a consistent comparison throughout the period.

¹⁵ In the sample, the proportion of students 10+ years-old who were enrolled in grades 1, 2, or 3 is 6.8% in 2003 and 1.3% in 2019. Including this sample and extending our analysis to grade 2 does not change our findings.

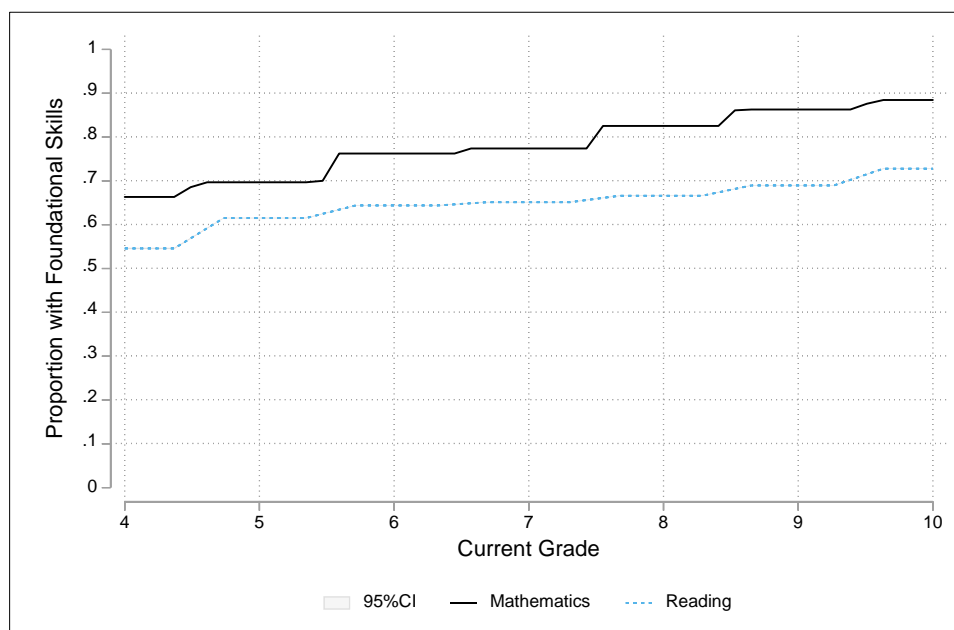
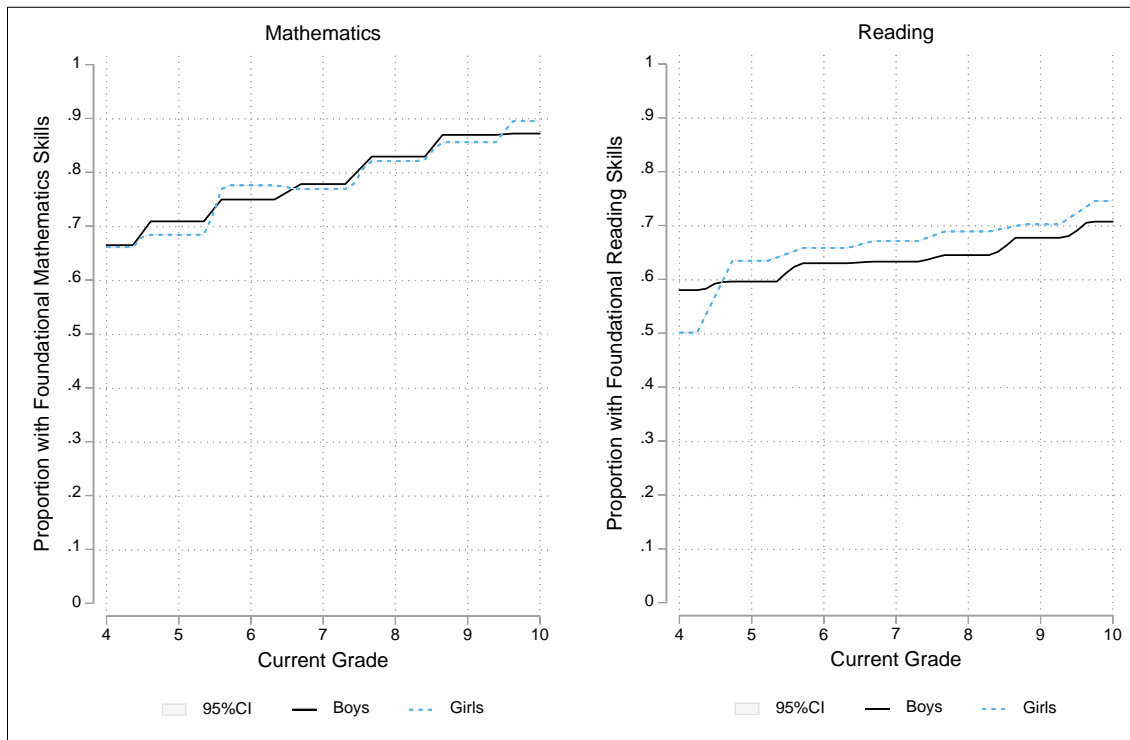
Figure 1: Proportion of Students with Foundational Skills

Figure 1 shows that 68% of students in grade 4 correctly answered the mathematics questions. Slightly more than half of the students in that grade answered the reading question correctly. Therefore, while these skills were supposed to be taught in grade 3, we observe that a substantial proportion of grade 4 students have not yet mastered them.

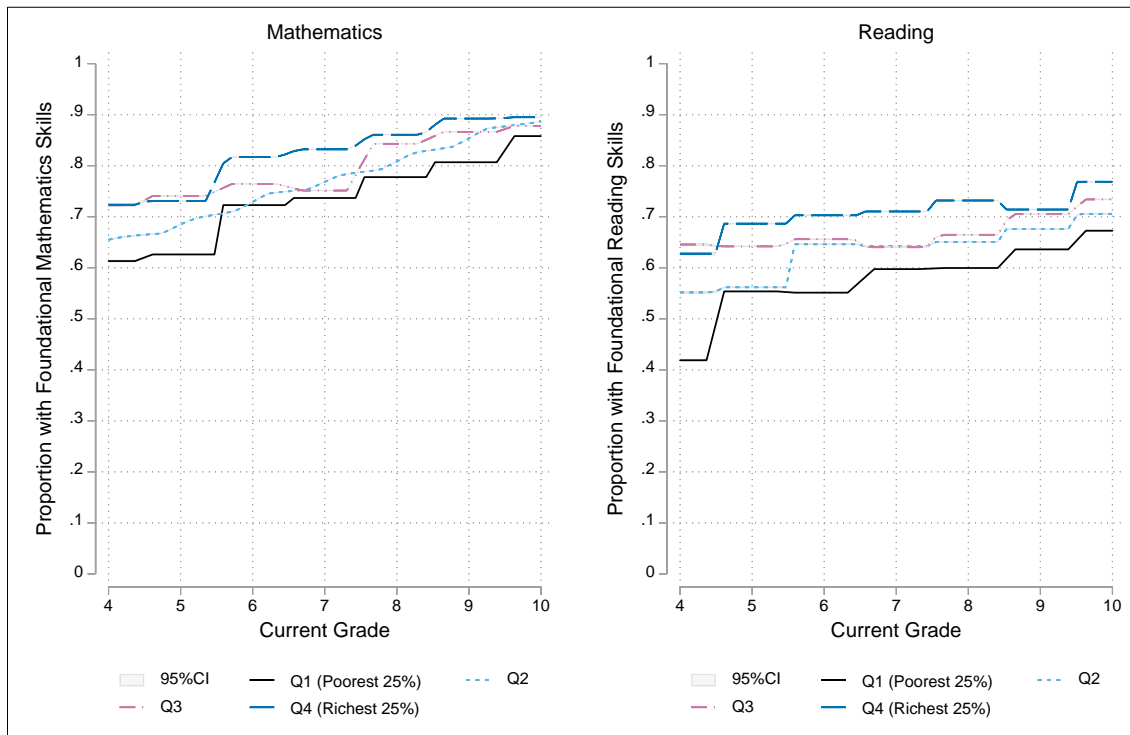
Both lines slope upwards, showing that a higher share of students have mathematics and reading skills in higher grades. Both slopes, however, flatten with grade levels. This suggests that marginal gains should be distinguished between grades, especially for foundational reading skills. Among grade 10 students, almost 90% correctly answered the mathematics questions; but only slightly more than 70% correctly answered the reading question. The figure shows, therefore, that even after 10 years of schooling, 10% of students were still unable to correctly answer simple multiplication and division questions that were taught in grade 3. In addition, almost 30% of students could not retrieve explicit information from a short paragraph.

We next disaggregated the sample into boys and girls. Figure 2 separately shows the results for mathematics and reading. Overall, both boys and girls have similar mathematics skills by grade. For reading, however, we find that in grade 4, the share of boys with foundational reading skills is higher than girls by about eight percentage points. This is a large gap, since only 50% of female students in grade 4 could answer the reading question correctly. In higher grades, however, we found that a slightly higher percentage of girls could answer the reading question correctly as the girls' learning profile overtakes the boys' in grade 5.

Figure 2: Proportion by Sex of Students with Foundational Skills

The third aspect that we looked at is a comparison of foundational mathematics and reading by wealth quartiles. We constructed a wealth index through a principal components analysis of family asset ownership, a method proposed by Filmer and Pritchett (2001). The following facts should be noted when we consider the results. First, school participation has a wealth gradient that becomes more apparent as children grow older. Our data show that the gap in school participation between children in the richest 25% of families and children in the poorest 25% of families is about four percentage points (99% vs 95%) at the age of 12. By the age of 14, the gap reaches 10 percentage points (99% vs 89%). By the age of 16, the gap stands at 17 percentage points (95% vs 78%). Second, studies from other developing countries have found that school participation is a function of mathematics or reading skills (for example, Hanushek and Lavy 2018). While our exercise is purely descriptive, it is worth noting that the selection means that observed differences in reading and mathematics skills between wealth quartiles in the higher grades are likely to be an underestimation. Therefore, selection is a small issue when we compare skills between children from different wealth levels in sixth grade, a somewhat larger issue in eighth grade, and a very large issue in 10th grade.

Figure 3 shows the wealth gradient for foundational skills. For students in grade 4, 70% of students from the two richest quartiles answered the mathematics questions correctly. For reading, around 65% of students answered the questions correctly. In contrast, only slightly more than 60% of grade 4 students who were from the bottom wealth quartile answered the mathematics questions correctly. The share is even lower, at around 40%, for reading.

Figure 3: Proportion of Students with Foundational Skills by Wealth Quartiles

It is encouraging, however, that the gap narrowed in higher grades due to a steeper learning profile of the two bottom quartiles. In grade 7, students from the second wealth quartile have caught up with students in the third quartile in terms of mathematics. Students from the poorest quartile were only slightly behind. This happened because the learning profile for students in the second quartile was flat from grades 4 to 7. In addition, the gap between the top and the bottom quartiles narrowed to about 10 percentage points in grade 8. The story is similar for reading. At grade 8, a very similar proportion of students from the second and third quartiles answered the questions correctly. The gap between the top and the bottom quartile also narrowed from 20 percentage points in grade 4 to 12 percentage points in grade 8.

Our final point from an examination of Figure 3 is not as positive. We observe that even for students from the richest 25% of the population, foundational mathematics and reading skills are far from universal. About 10% of these students, even when they are sitting in grade 10, answered the mathematics questions incorrectly. The condition is more serious in reading, where the learning profile of students in the top wealth quartile appears to have relatively flattened since grade 5. Among those enrolled in grade 10, around a quarter of students from the top wealth quartile did not have foundational reading skills. These findings are similar to those found by Pritchett and Viarengo (2021), who analyzed countries much poorer than the Philippines.

The figures so far show that foundational mathematics and reading skills are correlated with schooling and wealth. However, foundational mathematics skills are not correlated with sex. A higher proportion of girls have foundational reading skills. Table 2 shows the results of a regression on the correlation between current grade in school and foundational mathematics and reading skills, controlling for the other factors. The first two columns show the estimates for foundational mathematics skills without control (Column 1) and with controls (Column 2). Overall, the estimates between the two columns are very similar and not statistically different. Column 2 shows that being in

Grade 10 is correlated with a 24.2 percentage-point higher probability to have foundational mathematics skills. However, the added benefit of being in higher grades declines very rapidly. Between grade 9 and grade 10, for example, the probability to have foundational mathematics skills only increased by around 3 percentage points. We found a similar pattern with regards to foundational reading skills. Each higher grade is associated with a higher probability of having foundational reading skills by about 2 to 5 percentage points. Therefore, our finding holds that the learning profiles in the Philippines with regards to foundational skills are positive but relatively flat.

Table 2: Current Grade and Foundational Skills in Mathematics and Reading

	Mathematics		Reading	
	(1)	(2)	(3)	(4)
Current Grade (reference grade is grade 4)				
Grade 5	0.034*** (0.018)	0.031*** (0.018)	0.075*** (0.019)	0.061*** (0.019)
Grade 6	0.080*** (0.018)	0.090*** (0.020)	0.099*** (0.019)	0.089*** (0.022)
Grade 7	0.097*** (0.018)	0.117*** (0.022)	0.106*** (0.019)	0.118*** (0.024)
Grade 8	0.148*** (0.017)	0.174*** (0.023)	0.129*** (0.019)	0.165*** (0.025)
Grade 9	0.186*** (0.017)	0.217*** (0.023)	0.148*** (0.019)	0.196*** (0.027)
Grade 10	0.201*** (0.017)	0.242*** (0.024)	0.189*** (0.019)	0.251*** (0.028)
Constant	0.683*** (0.016)	0.673*** (0.022)	0.527*** (0.017)	0.537*** (0.026)
Control variables	No	Yes	No	Yes
Observations	19,843	19,843	19,843	19,843
R-squared	0.024	0.048	0.008	0.024

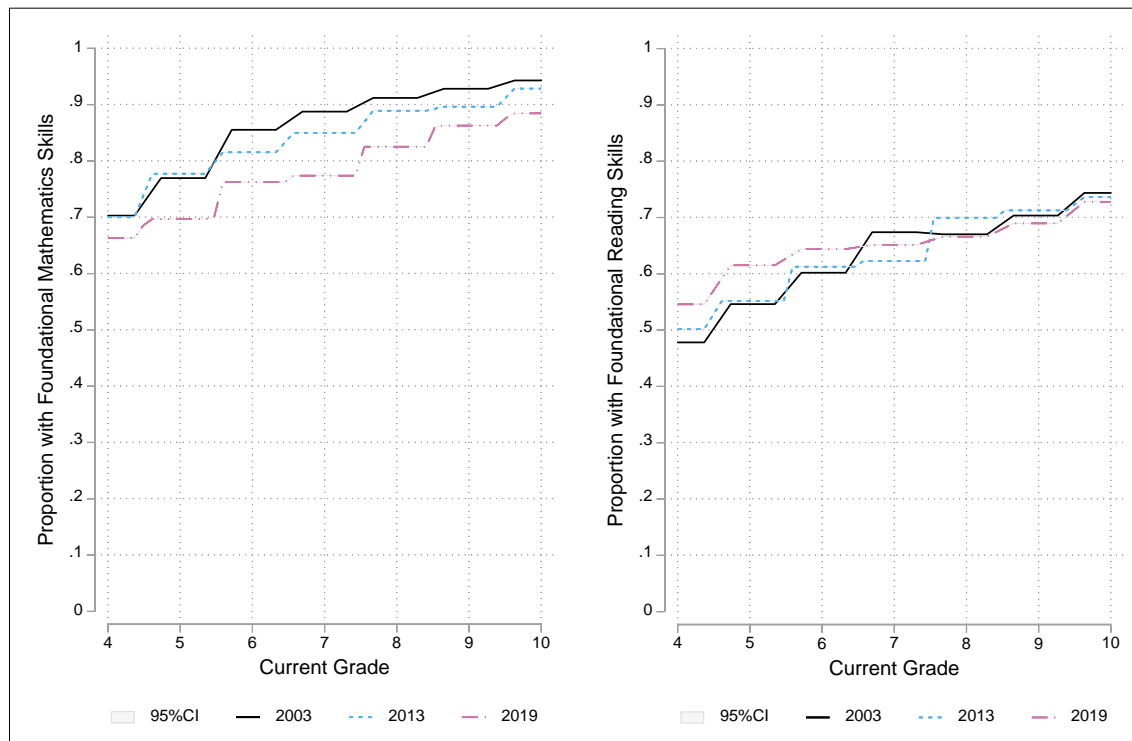
Notes: *** 1% significance, ** 5% significance, * 10% significance; the dependent variable is a binary variable with the value of 1 if the individual answered the mathematics or reading questions correctly; the model is estimated with OLS; robust standard errors in parentheses; control variables are: age dummy variables; an indicator variable for female; wealth quartile dummy variables; and region dummy variables.

4.2 Foundational Mathematics and Reading Skills in 2003, 2013, and 2019

We now turn to the long-term trend in foundational mathematics and reading skills among students in the Philippines. As we mentioned in Section 2, the TIMSS show that learning levels in the country have declined between the 2003 cohort and the 2019 cohort. We used FLEMMS to delve deeper. First, we focused on foundational mathematics and reading skills. Second, we focused on students by enrolled grade, from grades 4 to 10. Third, we have the 2013 cohort as a “midpoint.” Since the year approximately coincides with the start of major educational reforms in the country, it may provide an indication of whether the 2003–2013 trend is different from the 2013–2019 trend. Note, however, that these trends do not measure the impact of the educational reforms. Such impact evaluations require more thorough analyses and construction of counterfactuals.

Figure 4 shows the learning profiles for foundational mathematics and reading skills, respectively, between the 2003, 2013, and 2019 cohorts. First, we observe that the profiles for both skills are similar for the 2003 and 2013 cohorts. However, we see a slight decline in the proportion of students in grades 6–9 with foundational mathematics skills. Overall, the decline was statistically significant at 1.2 percentage points. In reading, the learning profile from grades 4 to 10 is not statistically different between the 2003 and 2013 cohorts.

Figure 4: Proportion of Students with Foundational Skills, 2003, 2013, and 2019 Student Cohorts



Second, we observed an improvement in foundational reading. Overall, foundational reading skills improved by 2.4 percentage points between the 2013 and 2019 cohorts. Examining the grade-by-grade pattern, significant improvements took place in grades 4 to 6. In the higher grades, the proportion of students with foundational reading skills during these three years is very similar. Contextually, note that the MTB-MLE and the universal kindergarten policies began in 2012. In 2019, the first group of students who benefitted from the programs were in grade 6. As a first cut, Figure 4 shows suggestive evidence that the policies may have a positive effect on foundational reading skills. However, a careful evaluation of the programs' impacts is needed before the claim could be made that the changes we observed in the 2019 cohort were due to these programs.

Third, the mathematics learning profile shifted further downwards in 2019. The overall decline was 5 percentage points. It was steeper in grades 6 and 7. Among grade 10 students, 93% of students in the 2013 cohort answered the mathematics questions correctly. In 2019, the share was 88%. The decline shown by FLEMMS corroborated the TIMSS results. Different from TIMSS, however, we determined that the decline between 2013 and 2019 was four times as severe compared to the decline between 2003 and 2013. A report on the implementation of MTB-MLE (Monje et al. 2019) states that teachers found mother tongues too cumbersome for teaching mathematics and science

classes. Often teaching materials for these subjects are available only in English, and some key terms and concepts are often missing in mother tongues. This issue could be made more challenging when students are required to learn these subjects in English at Grade 4. This anecdotal evidence could point to an explanation for the significant decline in foundational mathematics skills.

Next, we examine the evolution of differences in foundational skills between male and female students. We discuss two points: changes in the learning profiles for boys and girls separately over the different cohorts; and changes between cohorts in the gap in foundational learning between boys and girls.

Figure 5 shows the learning profiles for boys and girls in foundational mathematics in 2003, 2013, and 2019, respectively. We find that for both sexes, the 2019 cohort's learning profiles are significantly lower than the 2013 cohort's, starting from grade 4. The overall decline was 3.8 percentage points for boys, and 3.7 percentage points for girls. For some grades, the decline was almost 10 percentage points.

The overall sex gap in foundational mathematics was statistically significant at 2 percentage points in 2003. The gap has since declined to 0.7 percentage points. As mentioned above, the gap in the most recent cohort is not statistically significant.

Figure 5: Proportion of Students by Sex with Foundational Mathematics Skills, 2003, 2013, and 2019 Student Cohorts

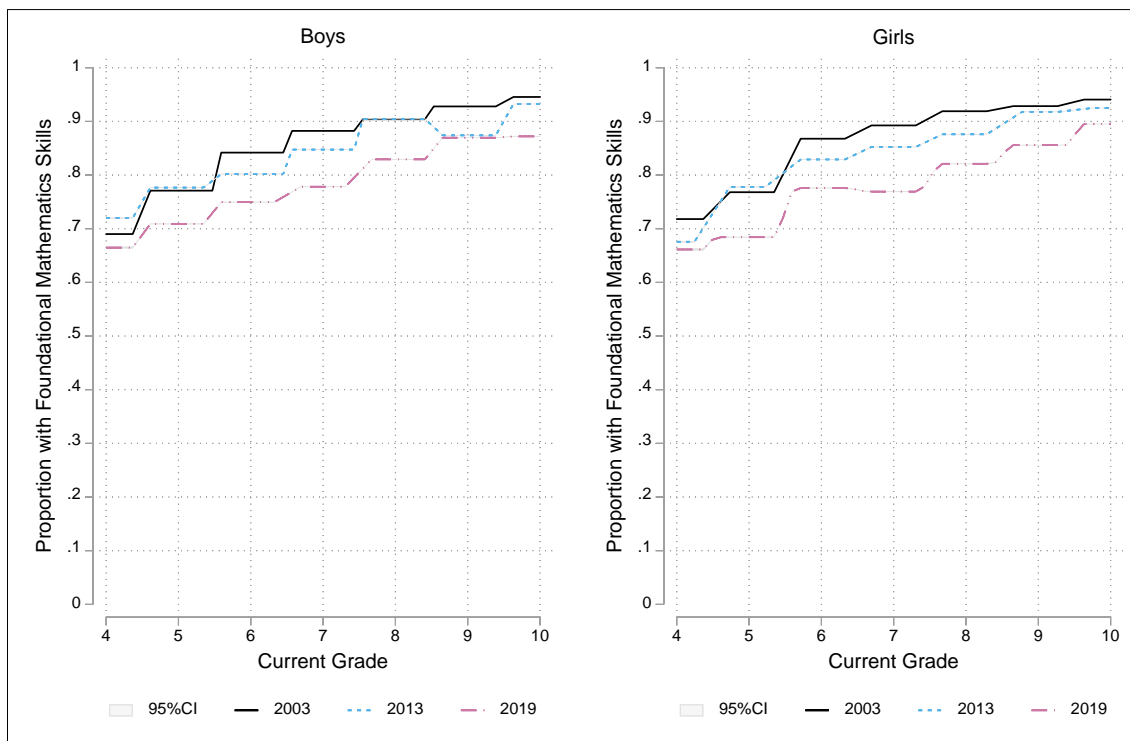
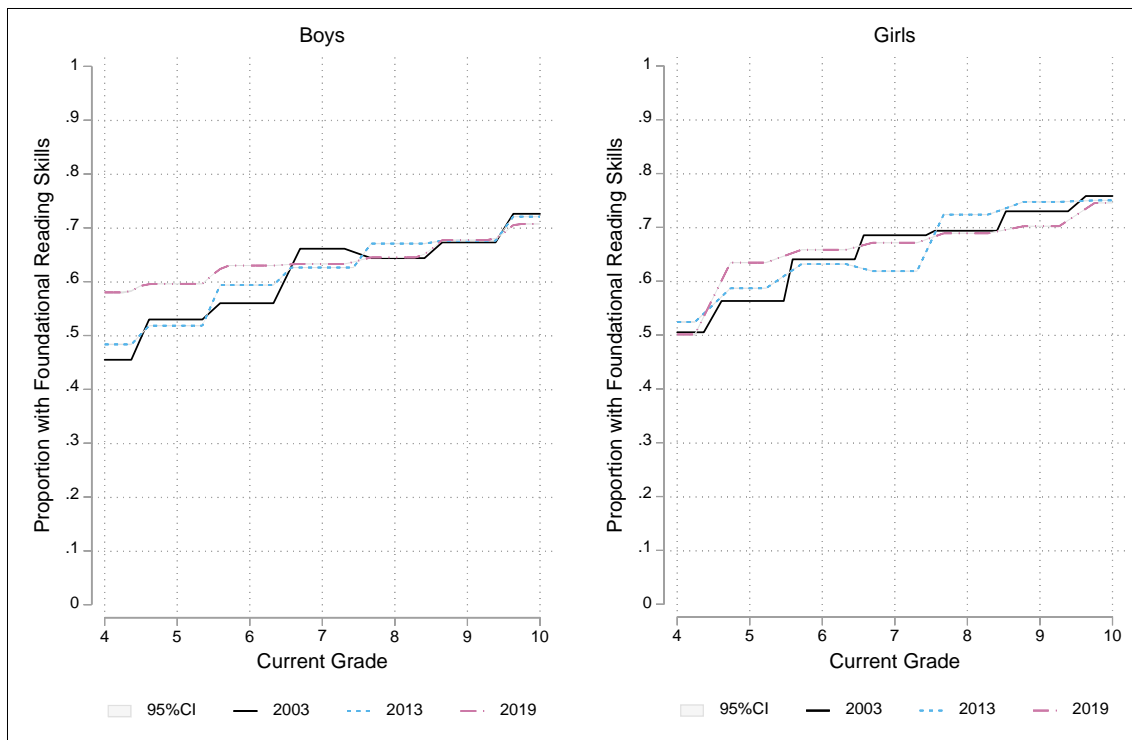


Figure 6 shows foundational reading skills by grade for boys and girls. We find that the 2019 cohort of grade 4–6 students had better foundational reading skills than the 2003 and 2013 cohorts. The increase is much larger for boys, at 2.7 percentage points, than for girls. The share of students with foundational reading skills in the latter group increased by 2.1 percentage points. The larger improvement for boys reduces the sex gap in foundational reading skills by 2.3 percentage points. As such, the gap in

foundational reading skills between male and female students in the 2019 cohort was the narrowest.

Figure 6: Proportion of Students by Sex with Foundational Reading Skills, 2003, 2013, and 2019 Student Cohorts

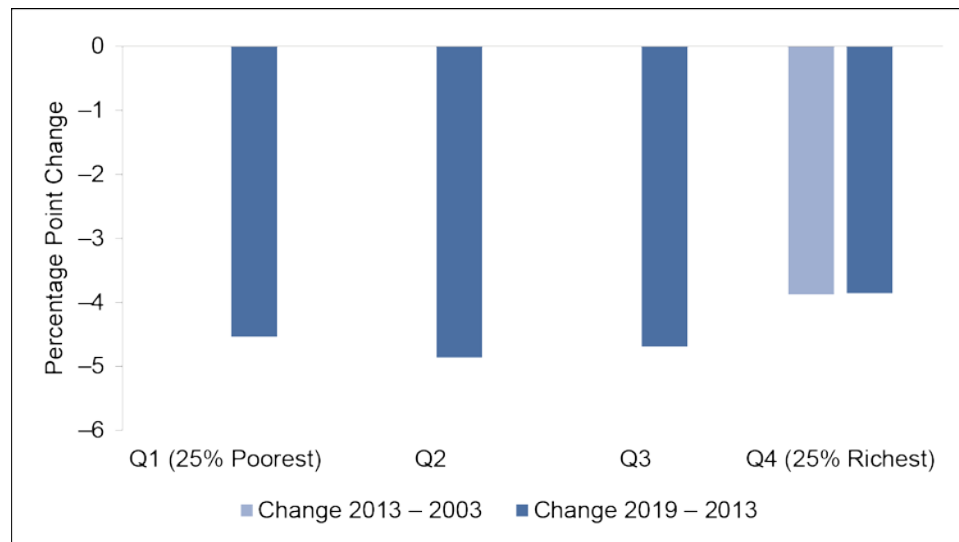


The final aspect that we examined was the changes by wealth quartiles. Figure 7 presents the changes in the overall share of students in each wealth quartile between the 2003 and 2013 cohorts as well as the 2013 and 2019 cohorts who answered the mathematics questions correctly.

Examining the changes between the 2003 and 2013 cohorts, we find that only students from the richest 25% group suffered a statistically significant decline in foundational mathematics skills. The decline of 3.9 percentage points is relatively small since 92% of students in this group had foundational mathematics skills. Because of this trend, however, the gap in foundational mathematics skills between the students in the bottom 25% and top 25% declined from 13.0 percentage points in the 2003 cohort to 9.1 percentage points in the 2013 cohort.

Students from all wealth groups in the 2019 cohort had significantly lower foundational mathematics skills compared to the 2013 cohort. The decline of between 3.9 to 4.9 percentage points is not statistically different among all four groups. Overall, therefore, the gap between students in the top and bottom quartiles in the 2019 cohort remained the same as in 2013.

Figure 7: Changes in the Proportion of Students with Foundational Mathematics Skills over Time by Wealth Quartiles, 2003, 2013, and 2019 Student Cohorts

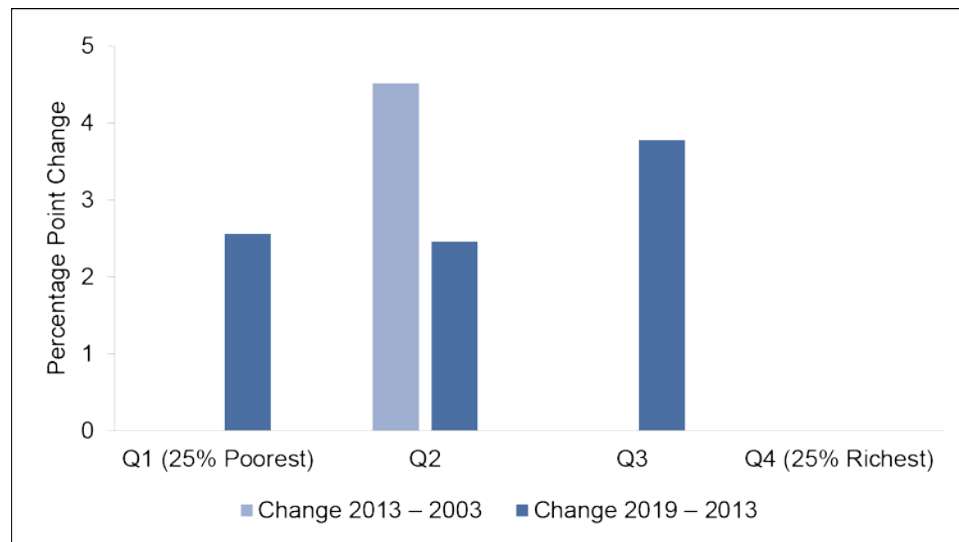


Note: only statistically different changes are shown. Note that the bars show changes between cohorts of grades 4–10 students in different years.

We see a stark difference in the pattern for reading skills, as shown in Figure 8. Between the 2003 and 2013 cohorts, the only statistically significant positive change was for students in the second quartile, by about 4.5 percentage points. Between the 2013 and 2019 cohorts, foundational reading skills in the first and second quartile significantly improved by 2.6 and 2.5 percentage points, respectively. In the third quartile, the improvement was as high as 3.8 percentage points. These improvements are not statistically different. In contrast, there was no significant change in the top quartile. This is not due to all students in the top quartile mastering foundational reading skills. Between the 2003 and 2019 cohorts, foundational reading skills in the top quartile remained stagnant at about 70%. As a result, the gap in foundational reading skills between the top and the bottom quartiles (shown in Figure 3) was the narrowest in the 2019 cohort.

We checked for any evidence to support a conjecture that the MTB-MLE or universal kindergarten policies benefit students in the lower quartiles differently than students in the top quartile. When we look at changes over time by grade, Annex Figure 3 shows that the increase in the bottom quartile between 2013 and 2019 was driven almost exclusively by improvements in grade 5. There was a decrease in foundational reading skills in grade 8–10. In the top quartile, Annex Figure 4 shows no difference in all the grades between the 2013 and 2019 cohorts, except an improvement in grade 5 and a decrease in grade 9. Therefore, in both quartiles, we see an improvement in the students that were exposed to the MTB-MLE and universal kindergarten act and stagnant conditions among higher grade students. Overall, it does not appear that these policies have any differential effect on students between quartiles.

Figure 8: Changes in the Proportion of Students with Foundational Reading Skills over Time, by Wealth Quartiles



Note: only statistically different changes are shown. Note that the bars show changes between cohorts of grades 4–10 students in different years.

In summary, the gap in both foundational skills between the top and bottom quartiles narrowed over the three cohorts of students that we examined. Foundational mathematics skills in the top quartile continuously declined for the three cohorts, from 92% in the 2003 cohort to 84% in the 2013 cohort. For the bottom quartile, foundational mathematics skills also declined over the period, with all of it taking place between the 2013 and 2019 cohorts. Since the decline in the bottom quartile is smaller, the overall gap in foundational mathematics skills between the two quartiles narrowed. For reading, the pattern is somewhat different. The top quartile did not experience any changes over the 16-year period, while the bottom quartile saw a small increase between the 2013 and 2019 cohorts. Therefore, the narrowing of the gap in foundational reading skills is a more positive outcome than the one in mathematics.

5. CONCLUSION

We examined the trends in foundational mathematics and reading skills for three student cohorts, separated over a 16-year period. We focused on foundational skills as they proxy for the capability of an education system to deliver basic quality services. Among low and lower-middle income countries, the Philippines have an unusually consistent and nationally representative functional literacy survey. To our knowledge, a similar dataset is rarely available in low or lower-middle income countries.

We found that the share of students with foundational skills increases between grades, indicating that schooling improves learning. However, we found that a substantial share of grade 10 students still do not have foundational mathematics or reading skills. This shows that like in many countries, the amount of learning produced for each year of schooling in the Philippines was lower than expected.

When we compared the share of students with foundational skills between cohorts, we found that the 2019 cohort's mathematics skills are the lowest. However, we also found a significant improvement in foundational reading skills among students exposed to the

recent education reforms that began in 2012. These improvements helped reduce the gap in reading skills between students from the bottom wealth quartile and those at the top of the wealth quartile.

Our findings indicate several conditions with regard to the Philippines education system. First, the education system is not yet able to ensure that all students master foundational skills, even for students who have been in school for a decade. Second, the continued losses in foundational mathematics skills between cohorts, despite significant investments and education reforms, may indicate that the reforms have yet to address a fundamental constraint in the system that pertains specifically to mathematics education. The decline in mathematics skills could also be an unintended consequence of the recent reforms. As an example, Metila et al. (2016) surveyed teachers in the Philippines and found that overall, the mother tongues introduced in the MTB-MLE policy were limited in mathematics lexicon. Third, since foundational reading skills appear to be higher after these reforms, our findings provide hope that the Filipino educational system could continue to be reformed such that it can ensure all children master foundational mathematics and reading skills. However, more rigorous evaluations on the impact of the educational reforms should be done to confirm this suggestive evidence.

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ANNEX

Annex Figure 1: Foundational Mathematics Questions in FLEMMS

<p>Q7. If a kilo of rice costs ₱55.00, how much will two kilos cost? Write your answer on the space provided.</p> <p><i>(Kung ang halaga ng isang kilong bigas ay ₱55.00, magkano ang halaga ng dalawang kilo?) (Isulat ang sagot sa patlang.)</i></p> <p style="text-align: right;">₱ _____</p>	<input type="text"/>
<p>Q8. How much will half a kilo of sugar cost, if one kilo costs ₱72.00?</p> <p><i>(Magkano ang halaga ng kalahating kilong asukal kung ang isang kilo nito ay ₱72.00?) (Isulat ang sagot sa patlang.)</i></p> <p style="text-align: right;">₱ _____</p>	<input type="text"/>

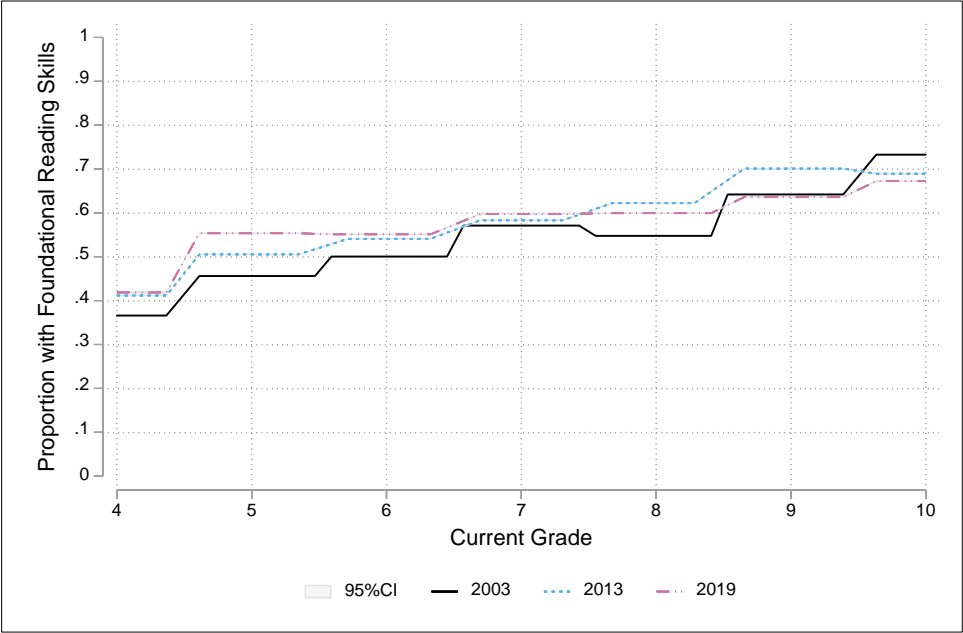
Note: we show the 2019 questions. The questions from 2003 and 2013 are different in terms of the numbers, but the 2x1 digit operation is the same.

Annex Figure 2. Foundational Reading Question

<p>Q9. Read the following paragraph and write your answer on the space provided.</p> <p>The depletion of our forests is one of the most serious environmental problems of the Philippines. It causes frequent floods and loss of fertile soil. Crops and property are destroyed and many lives are lost because of frequent floods.</p> <p>Based on the paragraph you read, what are the effects of forest depletion?</p> <p><i>(Basahin ang sumusunod na talata at sagutin ang tanong.)</i></p> <p><i>Ang pagkaubos ng punongkahoy sa gubat ay isa sa pinakamabigat na suliraning pangkapa-ligiran ng Pilipinas. Dulot nito ang malimit na pagbaha at pagkaanod ng matabang lupa. Dahil naman sa malimit na pagbaha, ang mga pananim at ari-arian ay nawawasak at buhay ang nasasawi.</i></p> <p><i>Ayon sa binasa mong talata, ano ang resulta ng pagkaubos ng punongkahoy sa gubat?)</i></p> <p>_____</p> <p>_____</p> <p>_____</p>	<input type="text"/>
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Note: this question is identical in FLEMMS 2003, 2013, and 2019.

Annex Figure 3: Proportion of Students in the 25% Poorest Wealth Quartile with Foundational Reading Skills, 2003–2019



Annex Figure 4: Proportion of Students in the 25% Richest Wealth Quartile with Foundational Reading Skills, 2003–2019

