SMERU Working Paper

The Stock of Highly Skilled Individuals in Indonesia

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ABSTRACT

The Stock of Highly Skilled Individuals in Indonesia

Sandra Kurniawati[+] and Daniel Suryadarma[*]

The most talented individuals organize production processes, discover, and innovate. These roles make talented individuals more important than ordinary labor. This paper is the first step to understand talented individuals in Indonesia. First, we use an international benchmark to estimate the number of students that could be considered as highly skilled. We then examine their background and the schools that they go to. We use three rounds of the Programme for International Student Assessment (PISA). We find that Indonesia has a minuscule proportion of highly skilled individuals. Out of a cohort size of 3.1 million 15-year old students, Indonesia only had around 0.46% or 14,300 individuals with high mathematics skills and 0.06% or 1,900 individuals with high literacy skills in 2015. Our analysis shows that skills are associated with having tertiary-educated mothers and favorable socioeconomic status. These skilled individuals cluster in a handful of schools. These schools have a higher proportion of certified teachers. Students within these schools have similar characteristics, indicating the strong influence of parental choice. Our findings point to the need for Indonesia, and perhaps other similar middle-income countries, to have an active policy to identify and nurture talent.

Keywords: talent, skills, education, Indonesia.

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I. INTRODUCTION

The typical worker is an input to the production process. Meanwhile, the most talented individuals organize the production processes. Also, they discover productivity-enhancing technologies that lead to higher output growth. Benzell & Brynjolfsson (2019) state that digital technology could not replace talent. Inelastically supplied, a scarcity in the number of talented individuals would constrain growth. Firms would be unable to make full use of digital abundance. This notion is related to the interaction between talent and scale (Rosen, 1981; Kaplan & Rauh, 2013). Thus, Benzell & Brynjolfsson (2019) consider geniuses to be more important than ordinary labor. The skills of the brightest individuals are even more critical as economies become knowledge-based (Pritchett & Viarengo, 2009). Cross-country empirical studies find that high intelligence individuals have a larger impact on economic growth than average intelligence ones (Burhan et al, 2014; Rindermann et al, 2015).

The occupations chosen by the talented individuals are also important. Murphy et al (1989) note that countries realize the full benefit of talented individuals when they become entrepreneurs. Social benefits would be suboptimal if talented individuals become workers or, even worse, rent seekers. According to Rosen (1981), talented individuals should work in occupations with low diminishing returns to scale.

The literature we discuss above have two consequences. First, countries must have enough talented individuals. This calls for a focus on identifying and nurturing talent. Second, talented individuals need to be in occupations where their talents would have the largest social impact. To achieve this, the private returns for these individuals must be highest in occupations that would produce the highest social impact. Being an entrepreneur is one way. Another way is to ensure that contracts are set to allow the talented individuals can extract almost their full quasi-rents (Murphy et al, 1989).

Achieving the two objectives above is challenging. On nurturing talent, Card & Giuliano (2016) find that gifted education has no impact on the scores of gifted students. But, a meta-analysis of 26 studies find that summer residential programs have a positive effect on the academic outcomes of gifted students (Kim, 2017).

On optimal occupations. Recent studies examine the determinants of becoming an inventor. Becoming an inventor is arguably an ideal occupation for talented individuals. Aghion et al (2017) analyze data from Finland. They find that while IQ has a positive and large effect on the probability of becoming an inventor, parental income remains crucial. The correlation is particularly steep at higher levels of parental income. Also, the lack of parental support prohibits many high IQ individuals from becoming an inventor. Thus, inefficiencies happen even in the context where education is high quality and completely free.

In the United States, Bell et al (2019) find that the chance of becoming an inventor depends on gender, race, and parental socioeconomic class. They find that environment is a more important determinant than ability to innovate. The finding implies that many talented individuals, especially women and minority groups, fail to fulfill their potential to be inventors. As a whole, society loses.

The literature on talented individuals has almost completely focused on rich countries. An exception is Pritchett & Viarengo (2009), who focus on Mexico. They find that Mexico produces too few highly talented individuals, between 3,500 and 6,000 individuals from a cohort of 2 million 15-year olds. In comparison, South Korea produces 125 thousand, the United States 250 thousand, and

India 100 thousand. Also, the 95th percentile Mexican student is about as smart as the average Korean student.

In this paper, we take the first step to understand talented individuals in Indonesia. First, we estimate their number. We then examine their background and the schools that they go to. We use three latest rounds of the Programme for International Student Assessment (PISA). We focus on performance in mathematics and reading tests. Given that PISA tests the skills of 15-year olds, for the rest of this paper we prefer to use the term 'skilled' rather than talented. The latter is closer to something one is born with. Skills, on the other, is a result of both talent and nurture.[1]

We find that Indonesia has a minuscule proportion of skilled individuals. In 2015, only five out of 1,000 of Indonesians achieved the PISA threshold for high skills in mathematics.[2] Across the whole PISA sample, 7.6% passed the threshold. The rate is even smaller for reading. In 2015, only six out of 10,000 Indonesians passed the PISA threshold for high skills. In absolute numbers, Indonesia only had 14,300 individuals with high mathematics skills and 1,900 individuals with high literacy skills in 2015. The number of 15-year old students that year was 3.1 million. While still extremely low, PISA indicates that the trend is positive between 2009 and 2015.

The small number of highly skilled individuals in Indonesia results in very small sample size in PISA. Therefore, to further understand the background of skilled individuals, we include the sample that pass the PISA threshold for competent in mathematics or reading.[3] Only around 1-2% of Indonesian students are placed at this level, compared to 14-16% across the whole PISA sample.

Our analysis shows that skills is strongly associated with having tertiary-educated mothers and favorable socioeconomic status. Skilled students spent more than one year in early childhood education. They live in large cities, not small villages. Rather than being uniformly distributed across schools, these skilled individuals tend to cluster in a handful of schools. These schools have a higher proportion of certified teachers. Students within these schools have similar characteristics, indicating the strong influence of parental choice.

We organize the rest of this paper as follows. The next section describes the PISA dataset and results for all countries. Afterwards, in Section III, we examine Indonesia's overall PISA performance. Section IV contains our analysis of Indonesia's talented individuals. We provide the conclusion in Section V.

II. THE PISA DATA

PISA is a triennial international survey that tests the skills and knowledge of 15-year old students. Administered by OECD, PISA started in 2000 and until 2015 has been undertaken six times. In total, 88 countries and economies (for example, China and Shanghai participate separately) have participated at least once. The PISA test is representative at the national level.

The skills and knowledge tested by PISA are on numeracy, science, reading, collaborative problem solving, and financial literacy. However, only the numeracy, science, and reading tests have been

[1]We could find no dataset that records the IQ of Indonesians

[2]Specifically, Levels 5 and 6 in PISA. See Section II for further details.

[3]Level 4 in PISA.

undertaken since the first PISA. The focus of PISA is on the application of knowledge and skills for tasks relevant in adult life, as opposed to memorization. This is appropriate given our purpose to measure skills relevant in the labor market.

To measure reading literacy, the assessment focuses on measuring students' ability to use written information in real life situations, while in mathematics it aims to measure how well students can use and interpret mathematical concepts and apply their knowledge in real-life contexts (OECD, 2015). PISA defines seven proficiency levels in reading. These proficiency levels are defined based on three required skills which are ability to find and collect information ("access and retrieve"), ability to process the information to make sense of a text ("integrate and interpret"), and ability to draw on knowledge, ideas, and values beyond the text ("reflect and evaluate") (OECD, 2015 p.161).

In mathematics, PISA's six proficiency levels are established based on three levels of cognitive demand or depth of knowledge (OECD, 2015 p.55). The low depth of knowledge can be defined as ability to carry out a simple task such as recalling a fact or concept. The medium level refers to more advanced skills such as applying the conceptual knowledge to explain real-life phenomena, organizing data, or interpreting simple data sets. Lastly, the high depth of knowledge can be defined as ability to analyze complex information, evaluate evidence, and develop a plan to approach a problem.

In both reading and mathematics, Level 2 is considered as a basic level of proficiency, meaning that students who achieved at this level or above are expected to demonstrate the literacy and numeracy skills that will enable them to participate productively in a knowledge-based society. PISA defines students who performed below Level 2 as low performers and those who performed at Level 5 and 6 as top performers.

Across all participating countries and economies, around 65% of 15-year-old students met the basic proficiency level in mathematics and around 60% in reading in 2015. Around one-third of students scored below Level 2. These students pose a higher risk in terms of their participation in tertiary education and labor market outcomes at age 19 (OECD, 2010). Meanwhile, in the same year, around one in five students achieved Level 4 or above in either reading or mathematics.

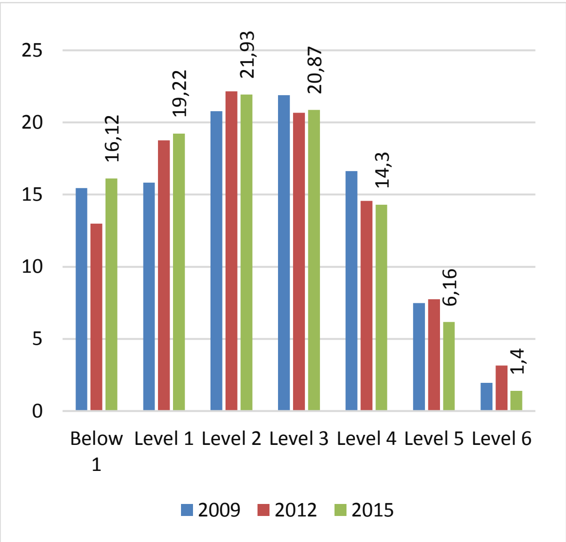

Figure 1. Percentage of Students by Mathematics Proficiency Level

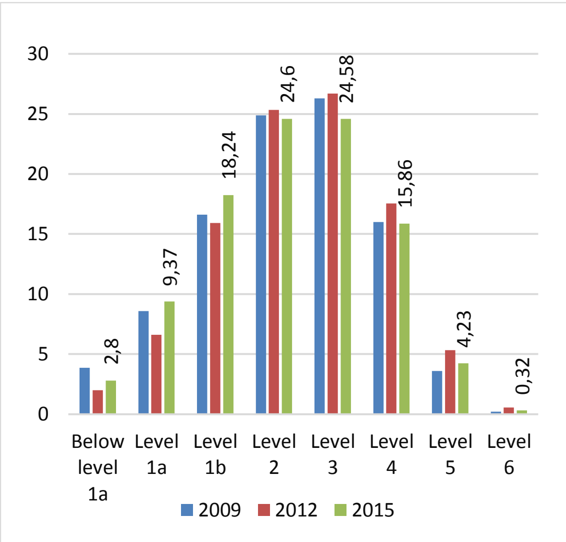

Figure 2. Percentage of Students by Reading Proficiency Level

Source: PISA 2009-2015 (authors' analysis)

Disaggregating participants into OECD and non-OECD countries, we observe a substantial difference in the distributions of student performance between two groups (Figures 3-6). While the share of low performers (below Level 2) in mathematics in OECD countries is around 22%, the share in non-OECD countries is very high at 49%. We find the same outcomes in reading. When it comes to high performers, there is also a large gap between these two groups. The share of Level 4 and above in mathematics in OECD countries (28%) is almost a double share of that in non-OECD countries (15%). In reading, the share in OECD countries (28%) is more than double that in non-OECD countries (12%). These patterns are consistent from 2009 to 2015.

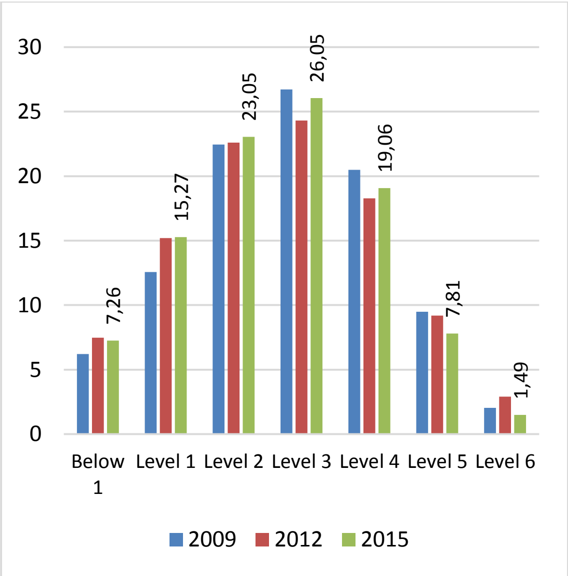

Figure 3. Student Performance in Mathematics (OECD Countries)

Source: PISA 2009-2015 (authors' analysis)

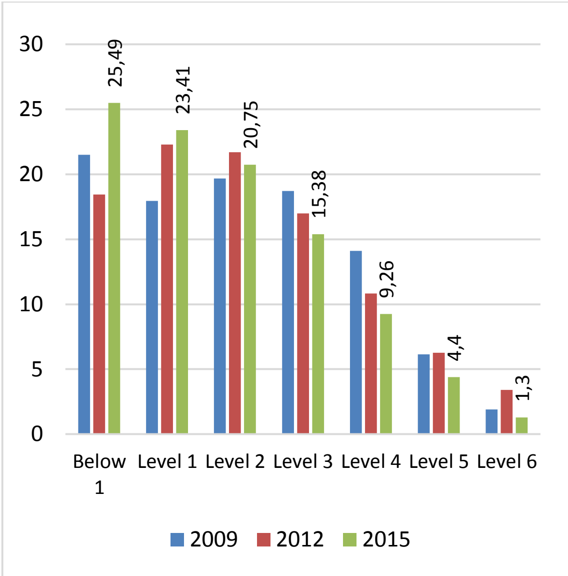

Figure 4. Student Performance in Mathematics (Non-OECD Countries)

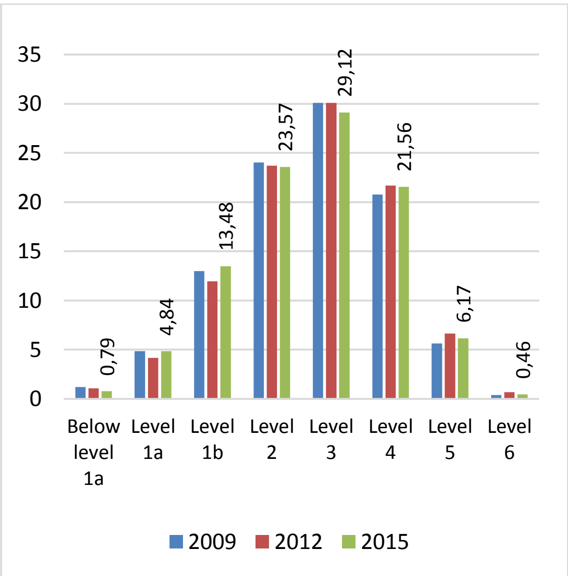

Figure 5. Student Performance in Reading (OECD Countries)

Source: PISA 2009-2015 (authors' analysis)

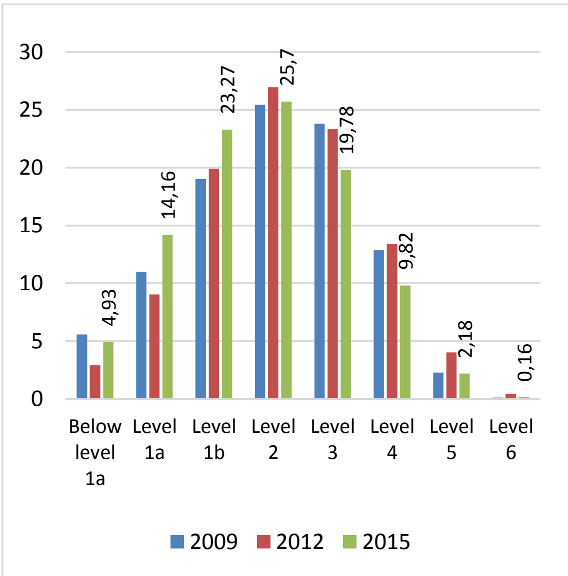

Figure 6. Student Performance in Reading (Non-OECD Countries)

It is also important to note that among non-OECD countries, there is a major difference in student performance distribution between high-performing countries or economies –such as China, Taipei, Hong Kong, Macao, and Singapore– and the rest of non-OECD countries (Figures 7-10). For example, in 2015 only less than 10% of students in high-performing countries or economies did not achieve the basic level in mathematics, while 56% of students in the rest of non-OECD countries scored below this level. In high-achieving countries, around 53% and 35% of the students reached at least Level 4 in mathematics and reading respectively. By contrast, only around 8% of students in the other non-OECD countries achieved this threshold in either mathematics or reading.

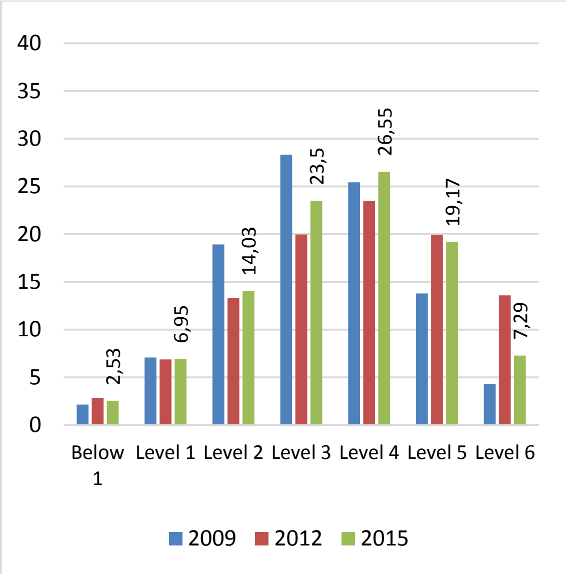

Figure 7. Student Performance in Mathematics (Non-OECD: High Performing Countries)

Source: PISA 2009-2015 (authors' analysis)

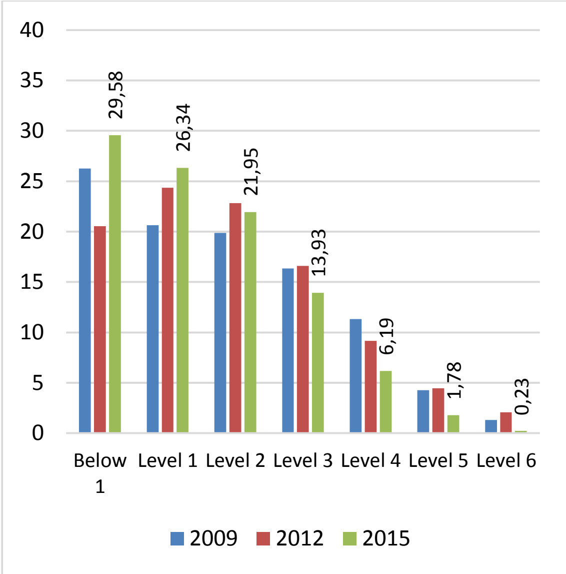

Figure 8. Student Performance in Mathematics (Non-OECD: Other countries)

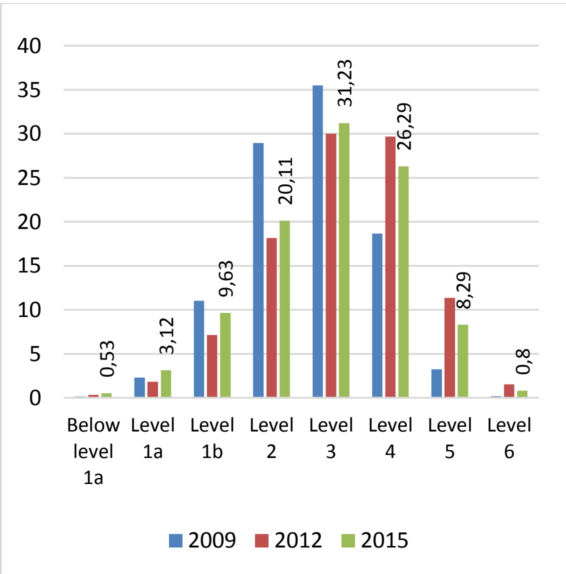

Figure 9. Student Performance in Reading (Non-OECD: High Performing Countries)

Source: PISA 2009-2015 (authors' analysis)

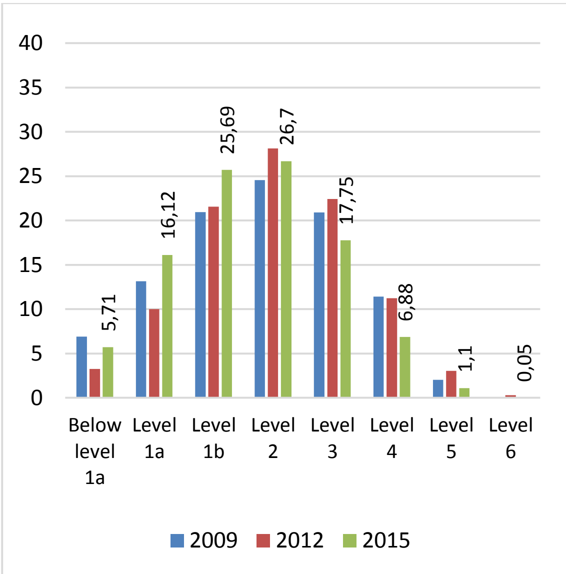

Figure 10. Student Performance in Reading (Non-OECD: Other countries)

III. INDONESIA'S OVERALL PISA PERFORMANCE

The 2009, 2012, and 2015 PISA datasets on Indonesia contain around 17 thousand 15-year-olds studying in 628 schools. We merge student performance data in reading and mathematics with the characteristics of the school that they are enrolled in and their family background.

3.1 Overall Indonesian Student Performance in PISA

Indonesia has a very low share of skilled students in both mathematics and reading (Figures 11 and 12). In 2009, only 54 out of 10,000 Indonesians reached Level 4 and four reached Level 5 in mathematics. The share of reading was slightly higher – around 76 out of 10,000 Indonesian students reached Level 4 but only two people out of 10,000 reached Level 5. Conditions have improved by 2015. Although the vast majority, 72% in mathematics, were still below PISA Level 2, the proportion of Indonesians that could reach Level 4 has increased almost four-fold, to 208 per 10,000, while the rate of those who could reach at least Level 5 was around 46 out of 10,000. However, the increase in the proportion of Level 4 and above in reading between 2009 and 2015 was lower, from 76 to 114 out of 10,000. Despite this improvement, the shares remain extremely low both reading and mathematics.

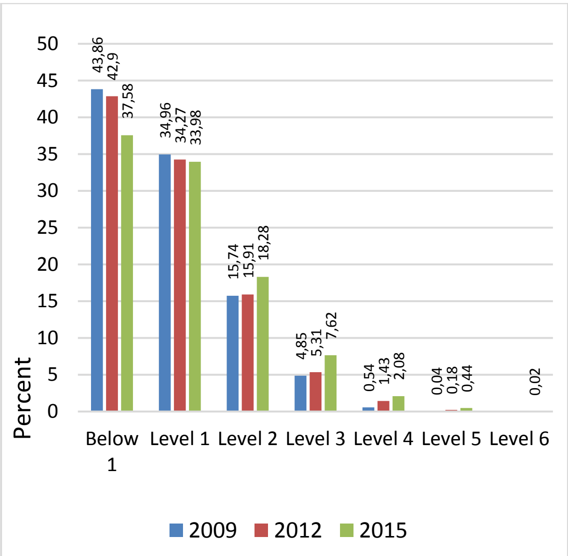

Figure 11. Indonesian Students Mathematics Performance by Proficiency Level

Source: PISA 2009-2015 (authors' analysis)

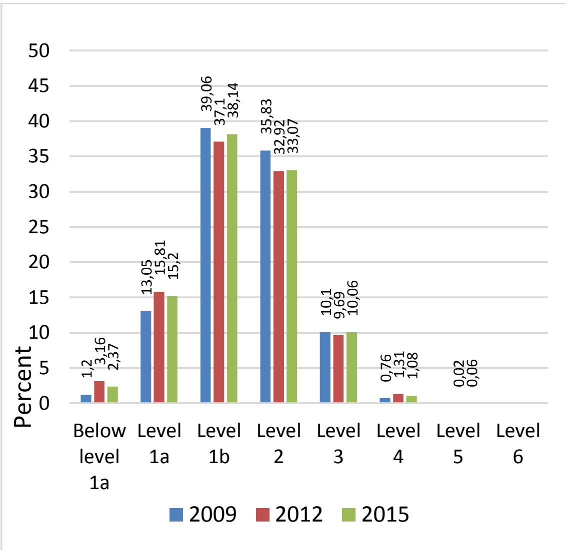

Figure 12. Indonesian Students Reading Performance by Proficiency Level

3.2 Indonesian Students Background Characteristics

Across all students participating in PISA 2009–2015, half of them are female (51%). Figure 13 shows that round 60% of their parents only have nine years of schooling or lower. Around one-third of all students have parents who attended senior secondary school or higher. Figure 14 shows that 68% of students are living in villages or small towns.

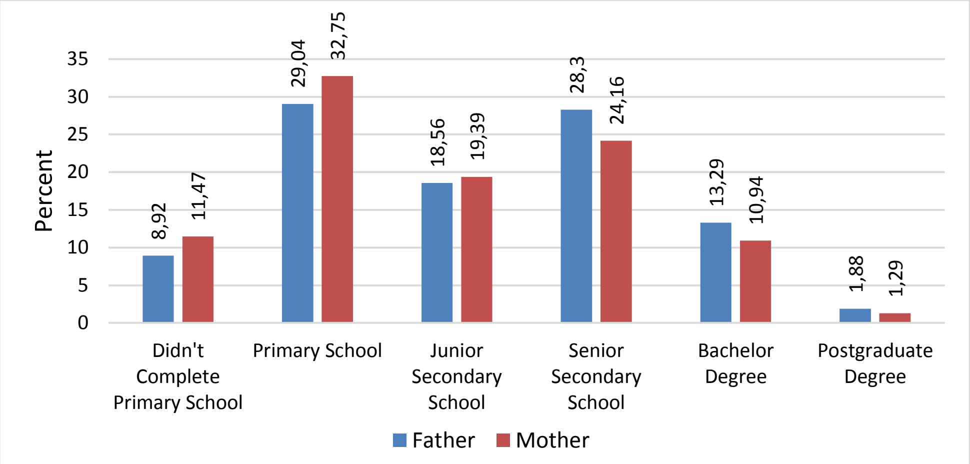

Figure 13. Distribution of Parental Education Attainment, 2009-2015

Source: PISA 2009-2015 (authors' analysis)

With regards to school type, Figure 15 shows that around 58% of the sampled students were enrolled in public school, particularly in small towns and towns. In villages and cities, more than half of the students were enrolled in private schools.

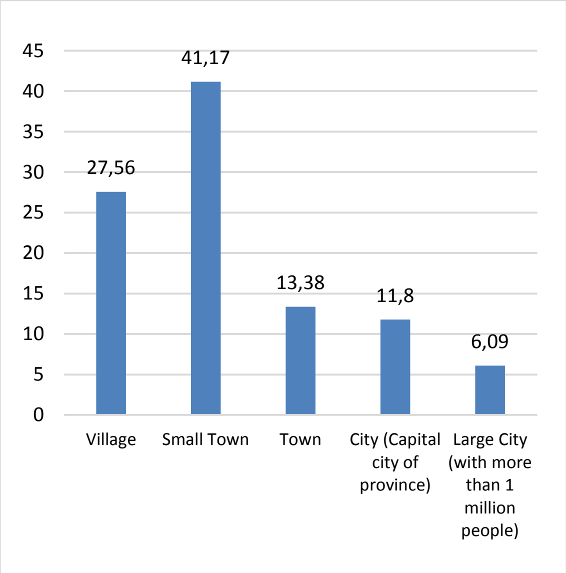

Figure 14. Indonesian Students by Residence, 2009-2015

Source: PISA 2009-2015 (authors' analysis)

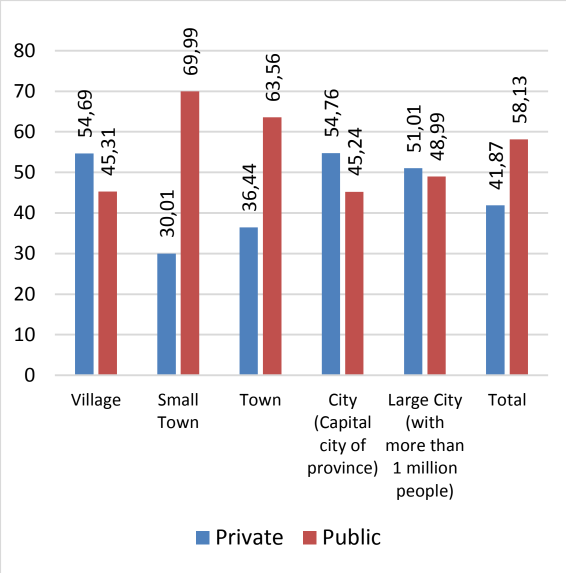

Figure 15. Indonesian Students by Residence and School Type, 2009-2015

Regarding the students' attendance in kindergarten, 45% of all students did not attend kindergarten. Only one in four students attended kindergarten more than one year. The proportion of students attending kindergarten varies by region. In villages and small towns, around 59% and 46% of the sampled students did not attend early-childhood education, whereas in cities less than one-third did not attend kindergarten.

IV. STOCK OF SKILLS IN INDONESIA

In this section, we conduct analyses at the student and school levels for mathematics and reading separately. First, we examine characteristics of schools that have a relatively high proportion of skilled students. In order to get enough sample size, we consider students to be skilled if they scored at Level 4 or above. Schools are categorized as high performing schools if more than 10% of students are skilled. Second, we investigate factors that are correlated with probability of being skilled in reading or mathematics. In the second analysis, we examine the effect of family background characteristics on the probability to be skilled. In this section, we combine PISA 2009, 2012, and 2015 in order to increase the sample size.

4.1 Descriptive Analysis

4.1.1 Schools where Skilled Students are Enrolled In

We find that skilled students in mathematics and/or reading are highly concentrated in a small proportion of schools. The proportion of talented students in mathematics in a school ranges from zero to 63.6%, with an average of 0.6%. In reading, the proportion ranges from zero to 42.4%, with an average of 0.4%. Out of all the schools in the sample, 94% have no skilled students in mathematics, while 96% have no skilled students in reading.

We categorize the schools into three types: schools with no skilled students (Type 1); schools where at most 10% of students are skilled (Type 2); and schools where more than 10% of students are skilled (Type 3). From our sample, 89% are Type 1, 7% are Type 2; and 4% are Type 3 with regards to mathematics. With regards to reading, the schools are even more concentrated: 92% are Type 1, 6% are Type 2, and 2% are Type 3. Tables 1 and 2 below show the descriptive statistics of school characteristics of the three types of schools for reading and mathematics respectively.

Table 1. Descriptive Statistics (Reading)

	Type 1: Schools without skilled students in reading (N=504; 92% of sample)		Type 2: Schools with at most 10% students are skilled in reading (N=31; 6% of sample)		Type 3: Schools where more than 10% of students are skilled in reading (N=14; 2% of sample)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
School characteristics						
Student-teacher ratio	15.67	9.14	16.00	6.76	17.00	2.66
Public school (Yes=1)	0.50	0.50	0.74	0.44	0.71	0.47
School is in a city (Yes=1)	0.12	0.32	0.13	0.34	0.36	0.50
School is in a large city (Yes=1)	0.05	0.21	0.13	0.34	0.50	0.52
Principal authority						
Fire teacher (Yes = 1)	0.34	0.47	0.19	0.40	0.36	0.50
Increase teacher salary (Yes=1)	0.33	0.47	0.06	0.25	0.21	0.43
Allocate budget (Yes=1)	0.79	0.41	0.61	0.50	0.86	0.36
Formulate student assessment policy (Yes=1)	0.75	0.44	0.81	0.40	0.86	0.36
Principal practice						
At least once a month - use of student performance results to develop the school (Yes=1)	0.27	0.45	0.32	0.48	0.50	0.52
At least once a month - promote teaching practices based on recent educational research (Yes=1)	0.35	0.48	0.39	0.50	0.71	0.47
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	0.24	0.43	0.26	0.44	0.64	0.50
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	0.35	0.48	0.39	0.50	0.64	0.50
Teacher characteristics						
Proportion of teacher with professional certification	0.51	0.35	0.76	0.25	0.72	0.26
Proportion of teachers with bachelor's degree or above	0.76	0.26	0.80	0.28	0.75	0.25

Source: PISA 2009-2015

Table 2. Descriptive Statistics (Mathematics)

	Type 1: Schools without skilled students in mathematics (N=487; 89% of sample)		Type 2: Schools with at most 10% students are skilled in mathematics (N=38; 7% of sample)		Type 3: Schools where more than 10% of students are skilled in mathematics (N=24; 4% of sample)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
School characteristics						
Student-teacher ratio	15.55	8.53	15.05	4.56	20.44	17.20
Public school (Yes=1)	0.49	0.50	0.76	0.43	0.71	0.46
School is in a city (Yes=1)	0.11	0.32	0.13	0.34	0.29	0.46
School is in a large city (Yes=1)	0.05	0.21	0.16	0.37	0.25	0.44
Principal authority						
Fire teacher (Yes = 1)	0.34	0.47	0.32	0.47	0.25	0.44
Increase teacher salary (Yes=1)	0.32	0.47	0.26	0.45	0.08	0.28
Allocate budget (Yes=1)	0.78	0.41	0.84	0.37	0.79	0.41
Formulate student assessment policy (Yes=1)	0.74	0.44	0.82	0.39	0.88	0.34
Principal practice						
At least once a month - use of student performance results to develop the school (Yes=1)	0.28	0.45	0.24	0.43	0.42	0.50
At least once a month - promote teaching practices based on recent educational research (Yes=1)	0.36	0.48	0.37	0.49	0.50	0.51
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	0.24	0.43	0.34	0.48	0.42	0.50
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	0.35	0.48	0.34	0.48	0.54	0.51
Teacher characteristics						
Proportion of teacher with professional certification	0.50	0.35	0.69	0.29	0.73	0.26
Proportion of teachers with bachelor's degree or above	0.76	0.26	0.78	0.30	0.77	0.27

Source: PISA 2009-2015

Across all schools, the average student-teacher ratio is around 16. We find no significant difference in student-teacher ratio between high performing schools in reading (Type 3) and the rest. However, in terms of mathematics, the high performing schools have a larger student-teacher ratio, 20 student per teacher. In addition, more than half of high performing schools are located in either city or large city, and around 70% of them are public schools.

With regards to principal authority, only around 25-36% of principals in high performing schools reported that they have authority on firing teachers. Regardless the school type, more than 60% of school principals reported that they are involved in budget allocation and policy formulation on student assessment. Principals in high performing schools also seem to show more engagement in supervising and supporting teaching activities in their schools. For example, around 40-60% of principals in high performing schools reported that they often discuss with teachers and solve problems related to teaching.

In terms of certified teachers, we find significant differences in proportion of certified teachers between school without high achievers and other schools that have. Only around half of teachers in Type 1 schools in either reading or mathematics are certified, while around 70% of teachers in Type 2 and 3 Schools are certified.

4.1.2 Who are the High Achieving Students in Indonesia?

Table 3 shows the descriptive statistics of skilled students. Around half of students skilled in mathematics are girls (Figure 16). In reading, the proportion of girls is even higher – around 71% of top performers are girls. The skilled students also come from highly educated parents. Whereas the average adult Indonesian has around eight years of schooling, 60% of the parents of these skilled Indonesians have bachelor's degree or higher (Figures 17 and 18).

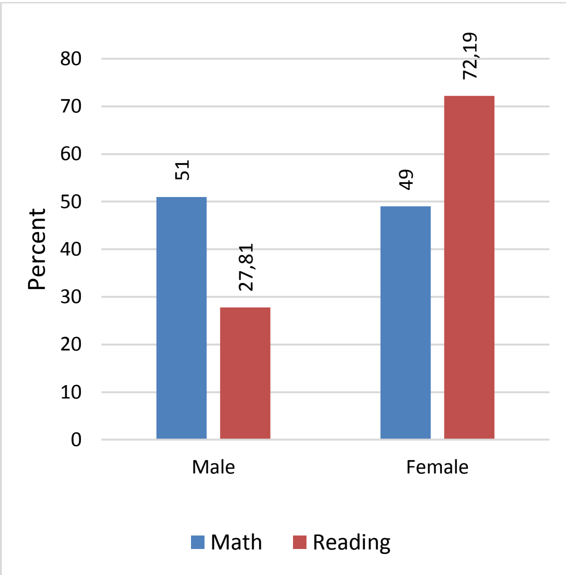

Figure 16. Skilled Students by Sex
Source: PISA 2009-2015 (authors' analysis)

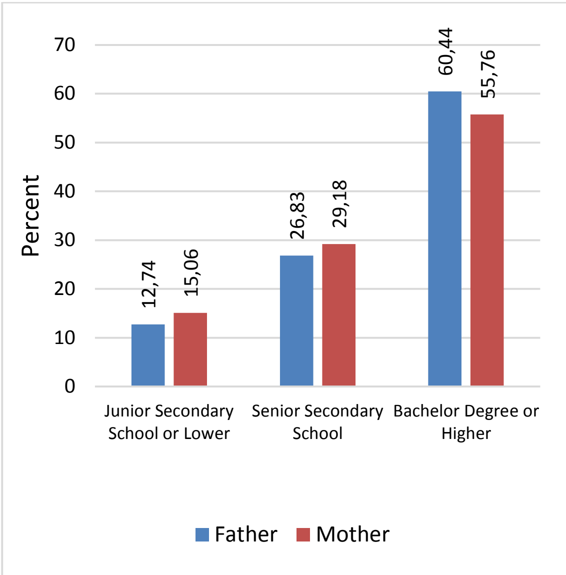

Figure 17. Skilled Students in Reading by Parental Education Attainment

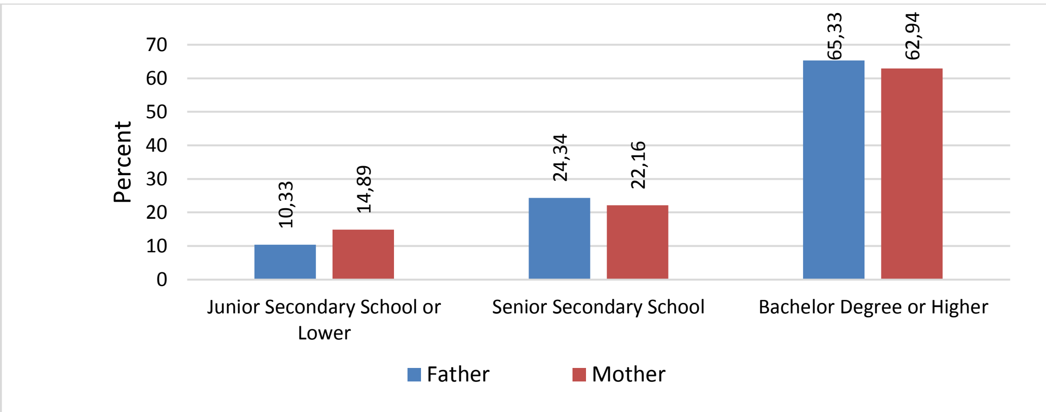

Figure 18. Skilled Students in Mathematics by Parental Education Attainment

In addition, more than half of these highly skilled individuals live in large cities. Figures 19 and 20 show that around 56% and 65% of high-achieving students in mathematics and reading, respectively, live in cities and metropolitan cities. With regards to schools, around 60% of them are enrolled in public schools. In large cities, more than 60% of these students enrolled in public schools (Figure 19). However, in villages and small towns, private schools produced higher percentage of top performers in reading (Figure 20).

Table 3. Descriptive Statistics

Student level summary statistics	Full Sample (N=15,275)		Mathematics Level 4 or Higher (N=288)		Mathematics Level 3 or Lower (N=14,987)		Reading Level 4 or Higher (N=178)		Reading Level 3 or Lower (N=15,097)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Learning outcomes										
Achieves mathematics level 4 or higher (Yes=1)	0.02	0.14								
Achieves reading level 4 or higher (Yes=1)	0.01	0.11								
Individual characteristics										
Current school grade	9.46	0.74	9.96	0.46	9.45	0.74	9.96	0.41	9.46	0.74
Female (Yes=1)	0.52	0.50	0.49	0.50	0.52	0.50	0.71	0.45	0.51	0.50
Attended more than one year of pre-school (Yes=1)	0.26	0.44	0.63	0.48	0.26	0.44	0.68	0.47	0.26	0.44
Home and background characteristics										
Has more than 100 books at home (Yes=1)	0.10	0.30	0.29	0.45	0.10	0.30	0.34	0.47	0.10	0.30
Has a quiet place at home to study (Yes=1)	0.58	0.49	0.80	0.40	0.57	0.49	0.80	0.40	0.58	0.49
Mother completed tertiary education (Yes=1)	0.13	0.34	0.60	0.49	0.12	0.33	0.54	0.50	0.12	0.33
Father completed tertiary education (Yes=1)	0.16	0.37	0.61	0.49	0.15	0.36	0.60	0.49	0.16	0.36
Home resources index	0.02	1.47	2.34	2.01	-0.03	1.42	2.35	2.01	-0.01	1.44

Source: PISA 2009-2015

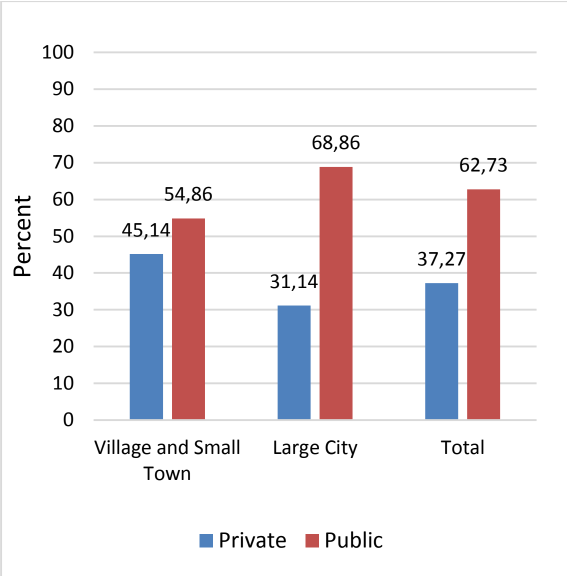

Figure 19. Highly Skilled Individuals in Mathematics by School Status and Residence

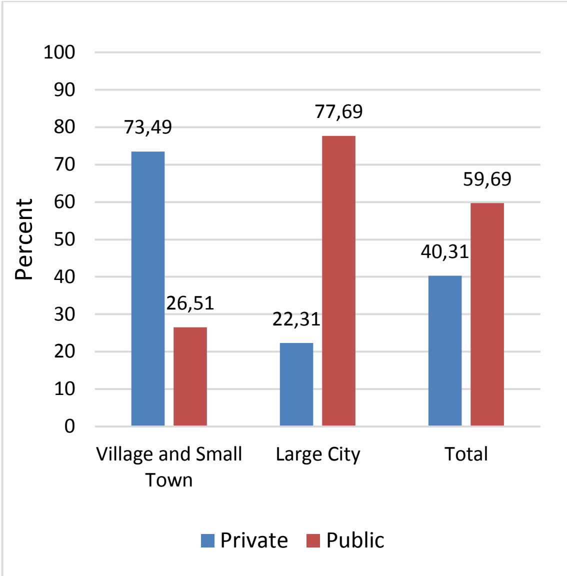

Figure 20. Highly Skilled Individuals in Reading by School Status and Residence

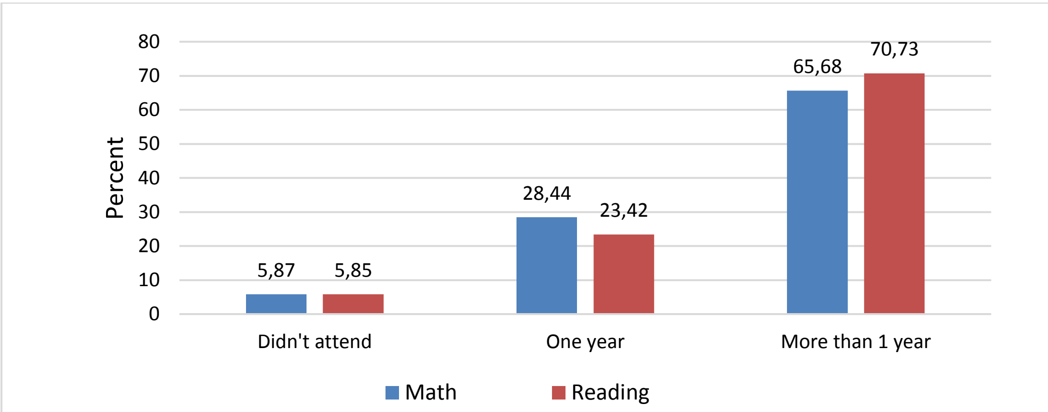

Figure 21. Percentage of Skilled Students by Kindergarten Attendance

Finally, Figure 21 shows that 94% of highly skilled individuals attended at least one year of early childhood education. When we disaggregate by residence, most of the highly skilled individuals in large cities (higher than 70%) attended more than one-year kindergarten. Meanwhile, only around half top performers in villages and small town attended early childhood education.

With regards to parental income, we plot the relationship between fraction of skilled students and family socioeconomic status. Family socioeconomic status (SES) index is constructed by PISA based on parents' highest level of education, parents' highest occupation status, and home possessions as a proxy for family wealth (OECD, 2015). PISA also adjusted the SES index for trend analysis. We use the adjusted index that is comparable over cycles for our analysis below.

Figures 22 and 23 show that in general the higher the SES index, the higher the probability of being a skilled student. The findings are like Aghion et al (2017) and Bell et al. (2019) who find an exponential increase in rates of innovators with parental income. Similar to their findings, we also find that an upward-sloping relationship between skilled students' rates and socioeconomic status is even steeper among families with SES above the 90th percentile.

Among families at the top percentile, there are around 8 in 100 students who are skilled in reading. In mathematics, the probability is higher – around 13 in 100 students are skilled. On the other hand, students from lower than 60th percentile have a negligible chance to be skilled in reading and/or mathematics.

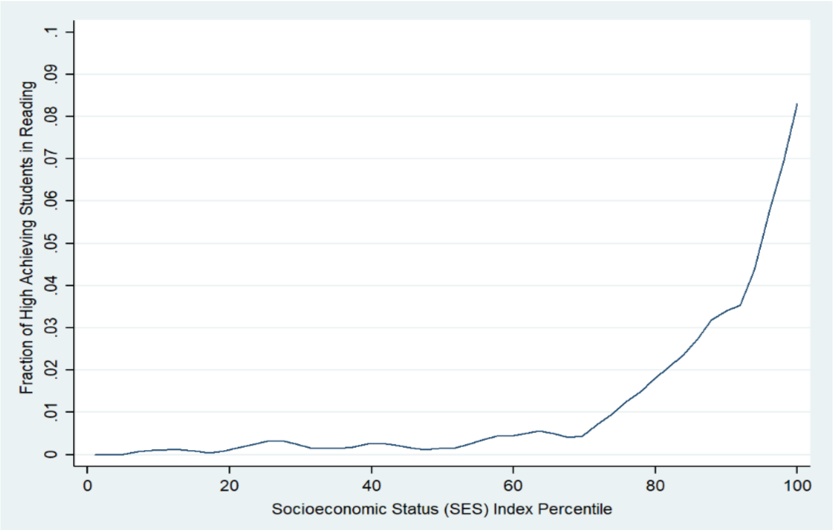

Figure 22. Relationship between Family Socioeconomic Status and Skilled Student in Reading

Source: PISA 2009-2015 (Authors' analysis)

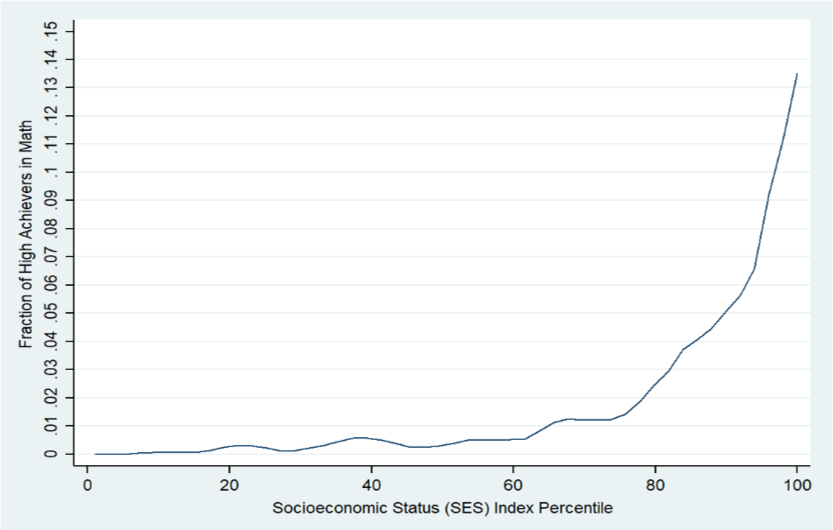

Figure 23. Relationship between Family Socioeconomic Status and Skilled Student in Mathematics

Source: PISA 2009-2015 (Authors' analysis)

4.2 Regression Results

In this section, we estimate the correlates of schools with skilled students. Specifically, we examine the following aspects: principal authority, principal practice, teacher qualification, and basic school characteristics such as student-teacher ratio and location of school. Afterwards, we look at the parental background and home conditions of the skilled students. Given the nature of PISA data, the estimates show correlations, not causal relationships.

4.2.1 Characteristics of schools with skilled students

Table 4 shows the results for mathematics. We find no evidence that principal authority or practice are correlated with the proportion of skilled students in a school. Also, the point estimates of these variables are very small. In contrast, teacher qualifications have a mixed correlation with having skilled students. Schools with a higher proportion of teachers with professional certification are more likely to have more skilled students. The correlation is large. A standard deviation (0.35) increase in the proportion of teachers with certification increases the probability of a school to be a Type 3 by about 1.8 percentage points. As mentioned above, only 4% of schools in our sample are Type 3 in mathematics.

Table 4. Characteristics of Schools with Skilled Students in Mathematics

	Schools without skilled students in mathematics (1)		Schools with at most 10% students are skilled in mathematics (2)		Schools where more than 10% of students are skilled in mathematics (3)	
Principal authority						
Fire teacher (Yes = 1)	-0.031		0.016		0.015	
	(0.035)		(0.018)		(0.016)	
Increase teacher salary (Yes=1)	0.069	*	-0.036	*	-0.033	*
	(0.037)		(0.019)		(0.019)	
Allocate budget (Yes=1)	0.004		-0.002		-0.002	
	(0.034)		(0.018)		(0.016)	
Formulate student assessment policy (Yes=1)	-0.043		0.022		0.020	
	(0.032)		(0.017)		(0.015)	
Principal practice						
At least once a month - use of student performance results to develop the school (Yes=1)	0.002		-0.001		-0.001	
	(0.028)		(0.015)		(0.013)	
At least once a month - promote teaching practices based on recent educational research (Yes=1)	0.000		0.000		0.000	
	(0.026)		(0.014)		(0.012)	
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	-0.037		0.020		0.018	

	Schools without skilled students in mathematics (1)		Schools with at most 10% students are skilled in mathematics (2)		Schools where more than 10% of students are skilled in mathematics (3)	
	(0.033)		(0.018)		(0.016)	
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	0.022		-0.011		-0.010	
	(0.033)		(0.018)		(0.015)	
Teacher qualifications						
Proportion of teacher with professional certification	-0.111	***	0.059	**	0.053	**
	(0.043)		(0.023)		(0.022)	
Proportion of teachers with bachelor's degree or above	0.120	**	-0.063	**	-0.057	**
	(0.055)		(0.030)		(0.027)	
School characteristics						
Student-teacher ratio	-0.001		0.001		0.001	
	(0.001)		(0.001)		(0.001)	
Public school (Yes=1)	-0.068	**	0.036	**	0.032	**
	(0.030)		(0.016)		(0.014)	
School location (ref: in a village)						
School is in a city (Yes=1)	-0.087	***	0.046	***	0.041	**
	(0.033)		(0.018)		(0.017)	
School is in a large city (Yes=1)	-0.149	***	0.078	***	0.070	***
	(0.039)		(0.022)		(0.021)	
Year fixed effects			Yes			
R-squared			0.15			
Number of observations			549			

Notes: *** 1% significance; ** 5% significance; * 10% significance; Multinomial probit regression; Coefficients are average marginal effects; standard errors in parentheses.

Our second proxy for teacher qualifications shows a negative correlation with having mathematics superstars. A standard deviation (0.26) increase in the proportion of teachers with a bachelor's degree, controlling for the share of teachers with certification, is associated with 1.4 percentage-point lower probability to be a Type 3 school. While this seems counterintuitive, the explanation is that teachers need a bachelor's degree to receive certification. Thus, holding the share of certified teacher constant, a higher share of teachers with a bachelor's degree indicates that more of these teachers are not yet certified.

On school characteristics, we find that public schools have a significantly higher likelihood to be Type 2 or Type 3, by about 3.6 and 3.2 percentage points respectively. Finally, schools in a city or a large city have much higher chance to be Type 2 or Type 3 compared to schools in a village.

We now move to schools with reading superstars. Table 5 shows that higher principal authority, specifically to increase teacher salary or to allocate budget, is negatively associated with the probability of being a Type 2 or Type 3 school. Together with the previous results on mathematics, we find no evidence that principal authority or practice has any correlation with the proportion of superstars in a school.

Table 5 shows that higher proportion of certified teachers are positively associated with the probability to be Type 2 or Type 3. A standard deviation increase in this particular teacher qualification increases the probability of a school to be in Type 3 by 1.6 percentage points. This is a very large correlation considering only 2% of schools in our sample are Type 3 in reading.

In contrast to mathematics superstars, public schools are not more likely to be in Type 2 or 3 than private schools. Regarding location, we find that schools in a large city are significantly more likely to have reading superstars.

Table 5. Characteristics of Schools with Skilled Students in Reading

	Schools without students skilled in reading (1)	Schools with at most 10% students skilled in reading (2)	Schools where more than 10% of students are skilled in reading (3)
Principal authority			
Fire teacher (Yes = 1)	-0.030	0.019	0.012
	(0.028)	(0.018)	(0.011)
Increase teacher salary (Yes=1)	0.067 **	-0.041 *	-0.025 **
	(0.032)	(0.021)	(0.012)
Allocate budget (Yes=1)	0.055 **	-0.034 ***	-0.021 ***
	(0.025)	(0.017)	(0.010)
Formulate student assessment policy (Yes=1)	-0.030	0.018	0.011
	(0.027)	(0.017)	(0.010)
Principal practice			
At least once a month - use of student performance results to develop the school (Yes=1)	0.000	0.000	0.000
	(0.022)	(0.013)	(0.008)
At least once a month - promote teaching practices based on recent educational research (Yes=1)	-0.019	0.012	0.007
	(0.020)	(0.013)	(0.008)
At least once a week - take initiative to discuss matters when a teacher has problems (Yes=1)	-0.025	0.015	0.010
	(0.028)	(0.017)	(0.011)
At least once a week - when a teacher brings up a classroom problem, we solve it (Yes=1)	-0.028	0.017	0.011
	(0.027)	(0.017)	(0.010)

	Schools without students skilled in reading (1)		Schools with at most 10% students skilled in reading (2)		Schools where more than 10% of students are skilled in reading (3)	
Teacher qualifications						
Proportion of teacher with professional certification	-0.120	***	0.074	***	0.046	***
	(0.038)		(0.025)		(0.017)	
Proportion of teachers with bachelor's degree or above	0.067		-0.041		-0.026	
	(0.049)		(0.030)		(0.020)	
School characteristics						
Student-teacher ratio	-0.001		0.000		0.000	
	(0.001)		(0.001)		(0.000)	
Public school (Yes=1)	-0.045	*	0.028	*	0.017	*
	(0.026)		(0.017)		(0.010)	
School location (ref: in a village)						
School is in a city (Yes=1)	-0.055	*	0.034	*	0.021	
	(0.029)		(0.018)		(0.013)	
School is in a large city (Yes=1)	-0.158	***	0.098	***	0.060	***
	(0.033)		(0.022)		(0.018)	
Year fixed effects			Yes			
R-squared			0.19			
Number of observations			549			

Notes:*** 1% significance; ** 5% significance; * 10% significance; Multinomial probit regression; Coefficients are average marginal effects; standard errors in parentheses.

4.2.2 Home Conditions and Parental Education Levels of Skilled Students

We now look at the characteristics of skilled students. Table 6 shows the results for mathematics. The difference between Columns 1 and 2 is caused by the inclusion of school fixed effects in the latter.

Column 1 shows that attending more than one year of kindergarten doubles the chance to be a skilled student at the age of 15. Having a tertiary-educated mother triples the chance to be a skilled student. Having a tertiary-educated father has a lower effect, although still positive and large. Among home conditions, having many books at home and living in well-off households is positively correlated with being a skilled student. Given what we know about very high performing individuals, for example inventors in Finland (Aghion et al, 2017) and United States (Bell et al, 2019), these results show that skilled students come from privileged background.

Table 6. Characteristics of Skilled Students in Mathematics

	Whole Sample		Female		Male	
	(1)	(2)	(3)	(4)	(5)	(6)
Individual Characteristics						
Current school grade	0.010***	0.004*	0.007***	0.001	0.013***	0.006*
	(0.001)	(0.002)	(0.002)	(0.004)	(0.002)	(0.003)
Female (Yes=1)	-0.003	-0.008***				
	(0.002)	(0.002)				
Attended more than one year of kindergarten (Yes=1)	0.019***	0.000	0.020***	0.001	0.019***	-0.001
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)
Parental Education						
Mother has tertiary education (Yes=1)	0.040***	0.016***	0.039***	0.014**	0.041***	0.019**
	(0.006)	(0.005)	(0.008)	(0.007)	(0.008)	(0.008)
Father has tertiary education (Yes=1)	0.012***	0.004	0.013**	0.003	0.012*	0.002
	(0.005)	(0.004)	(0.007)	(0.006)	(0.007)	(0.007)
Home Conditions						
Has more than 100 books at home (Yes=1)	0.014***	0.007	0.012*	0.005	0.017**	0.008
	(0.005)	(0.005)	(0.007)	(0.006)	(0.008)	(0.008)
Has a quiet place to study at home (Yes=1)	0.002	0.001	0.001	-0.001	0.003	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Home asset index	0.011***	0.002	0.010***	-0.000	0.013***	0.004**
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-0.097***	-0.022	-0.073***	0.003	-0.123***	-0.039
	(0.011)	(0.022)	(0.015)	(0.034)	(0.017)	(0.027)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
School fixed effects	No	Yes	No	Yes	No	Yes
R-squared	0.071	0.288	0.065	0.339	0.078	0.297
Number of observations	15,275	15,275	7,878	7,878	7,397	7,397
Sample mean of dependent variable	0.019		0.018		0.019	

Notes:*** 1% significance; ** 5% significance; * 10% significance; OLS regression; robust standard errors in parentheses.

When we include school fixed effects, virtually all individual-level estimates become much smaller and lose their statistical significance. The only exceptions are females, who now have 0.8 percentage points lower chance of becoming a skilled student (42% from the mean). The results suggest that there may be a within-school barrier to females becoming skilled. Unfortunately, we cannot further investigate this issue due to data limitations. Also, students with tertiary-educated mothers continue to have a higher chance of becoming skilled. The point estimate, however, is more than halved.

The results indicate that there is little variation in these variables within schools. In contrast, student background appears to be correlated with school choice. For example, there are significantly more students with tertiary-educated mothers in Type 3 schools than in Type 1 schools. This finding indicates that schools in Indonesia are segregated. Students from privileged background are enrolled in a set of schools, and the other students are enrolled in a different set of schools. We find very similar results when we disaggregate the sample by sex (Columns 3 - 6).

Table 7 shows the results for students skilled in reading. We find that females have a significantly higher chance of becoming skilled. The point estimate of 0.9 percentage points is large relative to the proportion of skilled students in reading. We also find that attending more than one year of kindergarten more than doubles the probability of becoming a skilled student at the age of 15. We find similar point estimates for mother education and book availability at home. Meanwhile, father education and home asset ownership also positively affect the probability to be skilled in reading, albeit with a smaller magnitude compared to mother education.

Different from the results in Table 6, the statistical significance and effect size of sex remains robust after we include school fixed effects (Column 2). The positive effect of attending kindergarten remains significant, although the size declines to 0.5 percentage points. All other previously significant variables become very small and statistically insignificant.

Table 7. Characteristics of Skilled Students in Mathematics

	Whole Sample		Female		Male	
	(1)	(2)	(3)	(4)	(5)	(6)
Individual Characteristics						
Current school grade	0.005***	0.002	0.006***	0.003	0.004***	0.002
	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)
Female (Yes=1)	0.009***	0.006***				
	(0.002)	(0.002)				
Attended more than one year of kindergarten (Yes=1)	0.015***	0.005**	0.022***	0.008**	0.006**	0.001
	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)
Parental Education						
Mother has tertiary education (Yes=1)	0.016***	0.001	0.023***	-0.001	0.009*	-0.000
	(0.005)	(0.005)	(0.008)	(0.008)	(0.005)	(0.005)
Father has tertiary education (Yes=1)	0.009**	-0.000	0.010	-0.005	0.008*	0.004
	(0.004)	(0.004)	(0.007)	(0.007)	(0.005)	(0.005)
Home Conditions						
Has more than 100 books at home (Yes=1)	0.014***	0.008*	0.019***	0.012*	0.008	0.002
	(0.004)	(0.004)	(0.007)	(0.007)	(0.005)	(0.005)
Has a quiet place to study at home (Yes=1)	0.000	0.000	0.000	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Home asset index	0.008***	0.000	0.011***	0.001	0.005***	0.001
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Constant	-0.054***	-0.014	-0.056***	-0.011	-0.041***	-0.012
	(0.008)	(0.016)	(0.014)	(0.031)	(0.009)	(0.016)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
School fixed effects	No	Yes	No	Yes	No	Yes
R-squared	0.044	0.198	0.058	0.266	0.026	0.169
Number of observations	15,275	15,275	7,878	7,878	7,397	7,397
Sample mean of dependent variable	0.012		0.017		0.007	

Notes:*** 1% significance; ** 5% significance; * 10% significance; OLS regression; robust standard errors in parentheses.

We also find evidence of sex heterogeneity in the individual and background characteristics of students skilled in reading. First, the 1.7% of female students are skilled in reading, more than double the rate among males. Second, attending kindergarten and home asset ownership has a positive and sizeable effect for both males and females, but the latter is much larger. Similarly, having tertiary-educated mother or book availability at home significantly increases the probability to be a skilled in reading only for females. Once school fixed effects are included, no individual characteristic remain significant for males. Overall, our model can explain between 5.8% to 26.6% of variation among females, but only 2.6% to 16.9% of variation among males. Therefore, comparing across Tables 6 and 7, we have the least evidence on the correlates of becoming skilled at reading among males.

V. CONCLUSION

This study is the first step to measuring the stock of skills in Indonesia. Using an international benchmark, we find that Indonesia has an extremely small proportion of individuals skilled in literacy and numeracy. Although between 2009 and 2015 the PISA results indicate an increasing trend, the absolute number remains very low. Only around 79,000 students out of 3.1 million in 2015 can be considered as skilled in mathematics. Out of that stock, 15,700 individuals have high mathematics skills. The number of individuals skilled in reading is even lower. Only 35,900 individuals could be considered as skilled, and 1,900 of those have high skills.

We find that probability of being a skilled individual is correlated with maternal education attainment and socioeconomic status. Even among the top 10^{th} percentile of family socioeconomic status index, the positive slope between these two variables is steeper. On the other hand, students from the bottom 60^{th} percentiles have a negligible chance to be skilled. Early childhood education attendance and home asset ownerships have sizeable effects on a higher probability of being skilled, particularly for females.

Our regression results indicate that the proportion of high achieving students is associated with proportion of certified teachers. Meanwhile, we find no evidence that principal authority or practice are correlated with the proportion of these skilled individuals in a school. We also find that skilled students are concentrated in a relatively number of schools. Students within these schools have similar characteristics, indicating the strong influence of parental choice.

On the question of whether an individual’s skill levels at the age of 15 come from talent or nurture, unfortunately, we have no data on the former. But our results indicate that nurture is critical in the formation of skills. The nurture could be stronger at home, for example from high income and highly educated parents. Or, it could come from school, for example from high quality teaching. Separately measuring these effects require measuring school value added, which is not available from PISA.

In closing, with such a small stock of skills, the Indonesian policymakers face two challenges. First, an active policy to identify and nurture talent must be in place. Second, ensuring an efficient allocation of skills is critical. The literature shows that in order to realize the optimal social benefit, the most skilled individuals must be engaged in occupations that would give them the highest private returns and simultaneously the highest social returns. This is a huge endeavor requiring policy reforms in health, education, social protection, and labor market sectors.

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