Prospects (2017) 47:175–196
https://doi.org/10.1007/s11125-017-9401-1

Stumbling at the first step: Efficiency implications of poor performance in the foundational first five years

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Published online: 11 May 2017

Abstract This paper highlights patterns in school enrollment indicators that affect the efficiency and effectiveness of education systems in a set of low-income countries: those that have expanded access quickly in the last decade or two, but have not yet absorbed that expansion efficiently. Although the patterns in these indicators are observable in the first few years of schooling, they could constitute a cause of low learning outcomes at the end of primary school. The data show strong empirical relationships between an early primary enrollment bulge, low levels of pre-primary participation, and poor performance on early grade cognitive skills. This work does not attribute causal precedence to these patterns but instead argues that the indicators are reflections of each other, constituting a "knot" of issues undermining the foundations of the affected education systems. The article presents some of the cost implications and suggests that many countries are already paying for pre-primary education without realizing it.

Keywords Repetition · Over-enrollment · Early childhood · Efficiency · Reading · Primary school completion

To understand is to perceive patterns.
—Isaiah Berlin

Although the developing world is rapidly catching up to higher-income countries in primary enrolment (UNESCO 2015), the story is very different when it comes to what children learn. UNESCO (2014) has estimated that approximately 250 million children are

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attending school but not learning the basics. The placement of the median child in poor countries relative to the learning-outcome distribution of children in high-income countries is dismal. Using three different methods, Crouch and Gove (2011) estimated that the median child's performance on international or regional assessments in low- and middle-income countries is somewhere between the first and eighth percentiles of the distribution of learning achievement in high-income countries. Filmer, Hasan and Pritchett (2006) suggested that Indonesian students' average reading ability was equivalent to that of the lowest-scoring 7% of French students, that Brazilian students' average mathematics score was equal to the lowest-scoring 2% of Danish students, and that Peruvian students' average science score was equivalent to that of the lowest-scoring 5% of US students. These findings are striking, considering that Indonesia, Brazil, and Peru are middle-income countries with better learning outcomes than most low-income countries.

This learning crisis is well documented; it has spurred international investment and an explicit focus on learning in the UN's recently adopted Sustainable Development Goals (SDGs). Increasingly, proponents of the education SDG recognize that low levels of learning reflect poor quality of education. The first two targets under the education goal refer to quality, and, for the first time, an SDG mentions early childhood development (ECD) as a route to ensuring primary school readiness. The prioritization of ECD reflects educators' increasing awareness of its importance and of the catastrophic circumstances of an estimated 249.4 million of the world's children under age 5–43% of the total—who are at risk of not reaching their developmental potential because of the preventable effects of poverty (Black et al. 2016).

The global education community has long debated what factors contribute to low-quality primary education. Even before adoption of the Education for All (EFA) goals in 1990, experts warned that focusing on enrolment and completion without paying sufficient attention to learning would lead to a "collapse" in quality (Fuller and Heyneman 1989). As later analyses demonstrated, their concern was well founded. Before the Millennium Development Goals were common parlance, Pritchett's (2001) cross-national study documented the absence of a link between worker productivity and increased years of schooling, arguing that low education quality was the cause. Subsequent reviews of investments by the United Nations Children's Fund (UNICEF; Chapman 2002), the World Bank (Nielsen 2006), and the United States Agency for International Development (USAID; Chapman and Quijada 2009) revealed little evidence of improved learning despite billions of dollars invested and decades of effort. Hanushek and Woessman (2008) further demonstrated that the years-of-attainment indicator alone was not linked to economic development; and a dozen years after Pritchett first reported the challenge of poor quality and low levels of learning, he could still confidently state that "schooling ain't learning" (2013).

However, what is the best method to identify and respond to the warning signals of low quality? Early research on grade repetition (repetition takes place when a child enrolls in the same grade for a second time, whether the child was formally failed or not) as a leading indicator of low levels of learning, pioneered in Latin America, revealed that actual repetition in the early grades was probably at least double that estimated or reported by official agencies and ministries (Schiefelbein and Wolff 1993; in a later section, we proffer some reasons why this might occur). Researchers developed various simulation methods to estimate the true rates of repetition (Crouch 1991; Klein and Costa 1991). This level of concern and discussion, however, has not arisen in some other countries (primarily, Africa and Asia) that seem to be experiencing the same issue, and it was never fully resolved in Latin America. Some agencies have noted the issue of high repetition (for example,

CONFEMEN, in Bernard, Simon, and Vianou 2007; and SACMEQ, in Hungi 2010), but few draw attention to the possibility that repetition in the early grades may be double, triple, or quadruple the officially reported rates in some countries (GPE 2012). The literature on repetition, more fully summarized by Bernard et al. (2007) and N'tchougan-Sonou (2001), has strongly suggested that it is an *inefficient* policy, even if it produces some positive effects in some cases.

Repetition is only one part of the learning crisis: Children in poor countries receive more years of schooling than those in high-income countries but achieve learning at approximately the fifth percentile of children in high-income countries. This article argues that one likely causal factor underlying this learning crisis is a set of interrelated problems in the two years before primary school and in the first three years of primary—corresponding to a five-year window of early education that we call the "Foundational First Five". Evidence has shown that high-quality preprimary education can have substantial impacts on children's early learning (Yoshikawa and Kabay 2015), and yet we observe low levels of preprimary education access and quality in many low- and middle-income countries. These low levels are accompanied by high reported grade 1 intake, resulting, in some cases, in extremely high student-to-teacher ratios. Research on class size in the early years (Mosteller 1995) and common sense suggest that grossly overcrowded classrooms are detrimental to learning. In some low- and middle-income countries, ratios of more than 70 students per teacher or per classroom are not uncommon.

This article documents the over-enrolment "bulge" in grade 1 and (to a lesser but still significant degree) grades 2 and 3, demonstrating through age-for-grade analyses that children are not moving efficiently through the cycle of early primary years. In sum, we offer the following three theories: (1) Children are missing a critical window of early learning opportunities in preprimary years; (2) overage and (possibly) underage children are crowding early primary classrooms and then struggling to learn; and (3) children are repeating early primary grades in high numbers, costing the system in terms of efficiency and outcomes. We argue that countries must tackle these interrelated problems simultaneously, in the Foundational First Five years, in order to achieve sustained improvement in learning outcomes.

Because these problems are linked, attacking them simultaneously may not be as difficult as it might seem. We could not prove that such an approach would address the overall problem of low quality in primary schooling in the affected countries, but the magnitude of the discovered empirical patterns is so extreme that the research community ought to take notice. Country-by-country research and evaluations of experiments could be carried out to further analyze these issues and to drive policies.

Methods

We calculated all data in this article by using direct downloads of UNESCO Institute of Statistics (UIS) data or the World Bank's EdStats system, unless otherwise specified. We used both organizations' free-form query systems to create analytical databases to underpin the article. In all cases, we used the average of the most recent five years to smooth irregularities in the data. We also sourced single-year age-group population data from the World Bank's EdStats free-form query system.

Specifically, we created a dataset with the following data: enrolment in grades 1–6, gross enrolment ratio for preprimary years, gross intake ratio into grade 1, gross domestic

product (GDP) per capita in current international purchasing-power parity (PPP), population of 7-to-12-year-olds, ratio of public expenditure per primary student to GDP per capita, and primary-school completion rate. We created several variables, including the ratios of grade-enrolment data to population of appropriate age for grades 1–6 and the ratio of grade 2 enrolment to grade 1 enrolment. (The EdStats query system is available at the World Bank's website, http://datatopics.worldbank.org/education/).

We present three components of the empirical patterns that appear to constitute the problem:

1. an early primary "bulge" comprising over-enrolment in the first few grades, enrolment drop-off between grades 1 and 2 masquerading as high dropout, and an inflated intake into grade 1 that persists for long periods;
2. a lack of preprimary enrolment; and
3. poor learning outcomes (measured by reading skills) in the first few grades.

In "An early primary bulge" section, we present the data suggesting exceptionally high (but unacknowledged) repetition rates in early primary grades. In "Lack of preprimary education services" section, we describe the low levels of preprimary education services and explain why this weakens foundational academic skills. In "Weak learning outcomes in the first few grades" section, we provide the data on poor learning outcomes, as measured by reading skills in the early grades. In "Explaining the interrelation of foundational variables" section, we discuss how these three phenomena ("foundational variables") work together and suggest some hypotheses that might explain their correlation. In "Efficiency and cost implications" section, we address the cost-efficiency implications of these problems in the foundational variables and the likelihood that education systems are already unknowingly paying hidden costs for preprimary education. Finally, "Implications and suggested steps for further analysis and policy dialogue" section, we describe the implications of these empirical patterns for further research and policy dialogue.

An early primary bulge

A serious problem seems to exist of misunderstood and unreported repetition in the first few grades in countries that have undertaken rapid expansion of enrolment in the last 10–15 years. For the most part, these are sub-Saharan African countries. This trend is similar to that exhibited by Latin America in the 1980s, as documented by Schiefelbein and Wolff (1993) and others. The problem of *acknowledged* repetition continues to be a serious one in many developing countries, as reflected by Bernard et al. (2007) in a report focusing on Africa. We argue that one also sees large-scale, *unacknowledged* repetition in a certain substantial group of countries, and we assert that this repetition strongly correlates with other issues that constitute a set of linked problems.

Before we continue, two technical explanations are in order. First, the fact that the most relevant age group in some countries might be the population aged six for grade 1 or age seven for grade 2 is not very important. The difference in cohort sizes between age cohorts separated by one year is, on average, only approximately 3%, even in the poorest countries, which typically have faster-growing populations; this is not enough to substantially alter the reported results. Second, the country data that we reference were from 2008 to 2012, as downloaded from the UIS and EdStats systems noted earlier. Different datasets with different terminal years would yield slightly different lists of countries. The list of countries that we selected is available upon request.

We established the empirical pattern by sorting the database countries according to the ratio of grade 1 enrolment to the population aged 7. Doing so identified 39 countries with this greater than 1.3; that is, 39 countries *exceeded* a 30% over-enrolment cutoff. We chose the 30% cutoff because it was high enough to merit attention and likely not the result of measurement error. Additionally, it was low enough to capture the relatively large number of countries we believe suffer from this over-enrolment problem. In Table 1, below, we give the medians of the key ratios for these countries.

Education planners or commentators working on education issues in developing countries sometimes misunderstand the implications of these indicators. We present, below, three examples of such misinterpretation.

First, education policymakers and planners at times ascribe very high gross intake ratios to late or early enrolment (for example, Uganda Ministry of Education 2011, p. 49; Federal Democratic Republic of Ethiopia 2010, p. 31), although such ratios have persisted for many years; therefore, underage or overage enrolment cannot be their primary cause. Once a child begins school, regardless of whether she was too young or too old, she cannot enter again for her first time. Second, planners and policymakers do not acknowledge inconsistencies between key ratios and official repetition rates. For example, reports in Mozambique showed repetition rates as low as 5% or 10% (Mozambique Ministry of Education 2012, p. 57), although the ratio of grade 1 enrolment to the population of appropriately aged children was as high as 1.77. Additionally, in the same country, data indicated reductions in repetition because of automatic promotion; but, at approximately the same time, the ratio of grade 1 enrolment to the appropriately aged population increased—suggesting that schools de facto ignored the automatic-promotion policy. (We downloaded dynamic trend data for this long-term trend from the UIS database at http://data.uis.unesco.org/. When *trends* are noted in this article, the data were taken from this database.) Third, commentators sometimes assume that ratios of enrolment in later grades to enrolment in earlier grades (e.g., grade 2 to grade 1), either contemporaneously or over time, indicate dropping out, although the ratios of enrolment to population in the later grades exceed or are very close to 1. South Africa Ministerial Committee (2008) describes a debate—eventually resolved—on this issue in South Africa.

What are the dynamics of these ratios? Why do they imply that unacknowledged repetition is an underlying problem? A gross intake ratio as high as 1.27 and a "bloated" ratio of grade 1 enrolment to the appropriately aged population might actually reflect catch-up entry in a system that previously had high levels of under-intake. A country could be emerging from conflict or have instituted free education or simply be beginning to build schools in previously underserved areas. Any of these reasons could explain a few years of bloated intake in the lower grades.

However, the ratios noted above for 2008–2012 have persisted for many years. For the same set of countries with data available in earlier periods, the median gross intake ratio

Table 1 Medians of key ratios in countries with a ratio of Grade-1 enrolment to population >1.3

Ratio or indicator	Median
Grade-1 enrolment to population aged 7	1.50
Grade-2 enrolment to grade-1 enrolment	0.82
Grade-2 enrolment to population aged 8	1.28
Gross intake ratio into primary schooling	1.27
Preprimary gross enrolment ratio	0.24

Source: Calculated from downloaded World Bank EdStats database

was already 1.31 in the five years prior (2003–2007) to 2008–2012 in our database. This in itself might not be unexpected if the ratio of enrolment to population had been very low in the earlier period, requiring "catch-up". However, that was not the case, because the ratio of grade-1 enrolment to the appropriately aged population was already extremely high (1.67) in 2003–2007. Going back even further, the ratio of grade-1 enrolment to the appropriately aged population and the gross intake ratio were 1.53 and 1.31, respectively, in 1999–2003. Thus, the bloating of intake and over-enrolment in grade 1 has persisted in these countries for at least 15 years, and the bloated ratios cannot be attributed to catch-up or to overage and underage entry, simply because catch-up cannot be a permanent phenomenon.

The only reasonable explanation appears to be unreported repetition. Alternatively, this discrepancy could be attributed to bad data. However, bad data from fraudulent over-reporting are not likely a major cause, as discussed below; whereas, bad data resulting from students reentering grade 1 and then being reported as new, rather than as reentering or repeating, are a likely cause. Three case studies from Malawi, Mozambique, and Rwanda help illustrate the dynamics.

In Malawi, which may be considered an archetypal case, the ratio of grade 2 to grade 1 enrolment was 75% in 2008–2012. Therefore, commentators and donor agencies in the 2000s classified Malawi as having a high dropout rate, even in the early grades. However, the ratio of enrolment in grade 1 to any appropriately aged population (for example, 6 or 7 years old) was very high (1.9), indicating that 90% more children were in grade 1 than in the target population. Similarly, 64% more children were enrolled in grade 2 than in the target population, which does not signify children dropping out between grades 1 and 2. Moreover, Malawi has had an average official intake ratio of approximately 1.65 (65% more children going into grade 1 than are in the available population) for approximately 10 years. It is a physical impossibility that these are new children or that underage or overage entry accounts for this ratio. Indeed, sustaining such a high intake rate for just a few years would capture any lagging children needing to be taken in after just 2 or 3 years, regardless of whether they were too young or too old.

Here, we use the term "churning" to refer to unacknowledged repetition because it is a less awkward expression and gives a visual sense of how much waste this problem entails. The only logical explanation for this data disconnect is churning: a large number of children enrolling in grade 1 (some of whom are likely underage), swelling the ranks, remaining in grade 1 approximately two years (many expecting to do so, formally or informally), and then churning again in grade 2 (although at a lower rate). Thus, grade-2 enrolment is much lower than grade-1 enrolment not because of dropping out but because less churning happens in grade 2.

UNICEF's Multiple Indicator Cluster Survey (MICS) shows that the difference in children's average age between grades 1 and 2 is 1.7 years, confirming the approximate magnitude of the problem. In other words, on average, children age 1.7 years in grade 1, suggesting an average churn of 70%, which is more or less consistent with the reported ratio of enrolment to population (1.9), based on our calculations using reported data from the Malawi National Statistical Office and UNICEF (2008, p. 313). (In an ideal system, children should age precisely 1 year per grade and not churn at all). The MICS data also confirm that, essentially, all children are enrolled by age 13—contradicting the popular idea that substantial dropping out occurs in the early grades in countries such as Malawi. By enrolling 90% more children in grade 1 and 64% more children in grade 2 than there are in the relevant populations, Malawi might feel as if it cannot afford preprimary education, even though, in a sense, it is paying for it through inefficiency, as we discuss below.

In Mozambique, on average, children age 1.6 years during grade 1 (basing our calculations on the MICS data reported in Mozambique Instituto Nacional de Estatísticas 2009, p. 162). The officially reported intake ratio has been approximately 1.5 for more than a decade. Thus, in any given year, 50% more children than are in the available cohort are taken in. This is impossible, because at the beginning of the enrolment uptick that occurred around 2000, too few never-enrolled children were available to support such high over-intake for more than 2 or 3 years (Crouch 2011). The ratio of enrolment in grade 1 to the appropriately aged population was 1.7 in our World Bank database; however, the official repetition rate was only approximately 4%, which is not possible. There is no explanation for the occurrence of such high over-enrolment other than very high (probably largely informal) repetition.

In Rwanda, officials have consistently reported the intake rate to be approximately 170% over the past 10 years or so. The total grade-1 enrolment is twice the appropriately aged population. Additionally, the apparent drop off between grades 1 and 2 is 30% (the ratio of grade-2 enrollment to grade-1 enrolment is approximately 70%), whereas the ratio of grade-2 enrolment to the appropriately aged population is very large (152%). These findings are not sensible if taken at face value; again, the only explanation seems to be unacknowledged repetition.

The question naturally arises: Could these patterns be simply attributable to bad data? The countries with alarming indicators for the variables under discussion are also relatively poor, and this might correlate with weak statistical systems. However, a hint that the reported ratios cannot all be caused by bad data (or that all data from disparate sources are equally bad) appears in the above calculations of how many years children age while they are in grade 1. As discussed below, some of the pattern is indeed the result of bad enrolment data, but the contribution of bad data is likely more subtle (and more meaningfully relevant to policy) than random misreporting or purposeful and fraudulent misreporting.

The demographic data could also be bad: Single-year age group data are known to be fairly unreliable in many countries; it is reasonable to suppose that poorer countries would have less-reliable demographic data. However, the database we used provides already smoothed and analyzed population data (sourced from the World Bank EdStats data query system, in turn sourced from the UNESCO Institute for Statistics) instead of raw census data. More importantly, the strong patterning of the key ratios suggests that bad demographic data can only partially explain the results. The ratio of grade-2 to grade-1 enrolment does not include demographic data in the denominator but exhibits fairly strong, opposing correlations with two ratios that do: the ratio of grade-1 enrolment to the population of age 7 (negative) and the pre-primary gross enrolment ratio (positive), as shown in Table 2, below. The fact that these relationships exhibit quite patterned but opposite trends—that is, high correlations between the variables—suggests that problems in the demographic denominators are not a strong cause of the observed patterns.

In addition, it is interesting to compare the database we used, which includes administrative data for the numerators and demographic data for denominators (except for the ratio of grade-2 to grade-1 enrolment), with household survey data, which extract the numerator and the denominator from the same source. Table 3, below, shows three key ratios from two sources—the database we used and household survey data from UNICEF's MICS surveys. The ratios highlight four illustrative countries exhibiting the archetypal patterns described here, as well as South Africa, a middle-income case that has also relatively recently shown the archetypal pattern. We would have preferred to compare more countries, but not all countries carry out all rounds of the MICS surveys, so the time-

Table 2 Internal correlations among key early-year variables

	Grade-1 enrolment to population of age 7	Grade-2 enrolment to grade 1 enrollment	Preprimary gross enrollment ratio	Gross intake ratio into grade 1	GDP per capita, PPP
Grade-1 enrolment to population of age 7	1				
Grade-2 enrolment to grade-1 enrolment	−0.64***, −0.61***	1			
Preprimary gross enrolment ratio	−0.27***, −0.17**	0.47***, 0.38***	1		
Gross intake ratio into grade 1	0.86***, 0.84***	−0.55***, −0.49***	−0.16*, 0	1	
GDP per capita, PPP	−0.25***, NA	0.34***, NA	0.46***, NA	−0.28***, NA	1

Notes: NA = not applicable because one cannot use GDP per capita in a partial correlation that already accounts for GDP per capita. A second value in a cell indicates a partial correlation when GDP is considered or controlled for.

*** $p < 0.01$; ** $p < .05$; * $p < .01$

Source: Calculated from downloaded World Bank EdStats database

phasing of the comparison would not work out. One could, in principle, analyze the Demographic and Health Surveys (DHSs), but these surveys do not publish data on enrolment by age and grade—one would have to tap the original databases. In a future publication, we plan to look at these comparisons more systematically.

The average values are illustrative; evidently, a sample of just five countries is insufficient to obtain a robust average. These values do suggest that, at least for these countries, the data sources are not very different, although the differences are larger in some countries and for some of the variables. The data for the ratio of grade-2 to grade-1 enrolment show the smallest differences between the created database and the household survey data. Thus, demographic data irregularities (problems in the denominator) could constitute a relatively small part of the problem: the one variable without a demographic denominator exhibits the best agreement between the two data sources. If one interprets Malawi as a possible anomaly, the data suggest that overreporting enrolment—not just misclassifying re-enrolment as new entry—is a problem. Indeed, the survey data tend to be approximately 10 to 15 points lower than the administrative data. However, the surveys show significant overenrolment in the archetypal countries discussed. For example, even in the household surveys, overenrolment in grade 1 was 78%.

One last piece of evidence suggesting that these patterns are not completely attributable to overall overreporting of enrolment is how strongly patterned the data are toward overenrolment in the early grades. Table 1, above, lists the ratios of enrolment to population in the first 2 grades as the median values across all 39 countries, with a high (>1.5) ratio of enrolment in grade 1 to population aged 7. Because we included all grades and all 39 countries in Figure 1, below, it shows the degree to which the pattern of overenrolment is biased toward the early grades and the degree to which the pattern is

Table 3 Comparison of data sources

Country	Data source	Ratio of grade-1 enrolment to population aged 7	Ratio of grade-2 enrolment to population aged 8	Ratio of grade-2 to grade-1 enrolment
Burundi	Database for this paper	1.88	1.42	0.72
	MICS2005	1.80	1.30	0.68
Lao PDR	Database for this paper	1.85	1.33	0.73
	MICS2012	1.64	1.25	0.80
Malawi	Database for this paper	1.97	1.51	0.75
	MICS2006	2.40	1.63	0.67
Mozambique	Database for this paper	1.77	1.58	0.87
	MICS2008	1.49	1.29	0.93
South Africa	Administrative and demographic data (2003)	1.65	1.25	0.88
	Household survey data (2003)	1.56	1.13	0.86
Average	Database for this paper or other "administrative" data (for South Africa)	1.82	1.42	0.79
	Household surveys	1.78	1.32	0.79

Note: Database created for this article; see description in main text

Source: Lao PDR MICS2012 was calculated from the Lao Ministry of Health and Lao Statistics Bureau (2012, p. 379). Malawi MICS2006 was calculated from the Malawi National Statistical Office and UNICEF (2008, p. 313). Mozambique MICS2008 was calculated from the Mozambique Instituto Nacional de Estatísticas (2009, p. 162). Burundi MICS2005 was calculated from the Burundi Institut de Statistiques et d'Études Économiques (2008, Tables DQ.1 and DQ8). South Africa Administrative Data were retrieved from the South Africa Department of Education (2005, p. 8) and by downloading and analyzing StatsSA population projections. South Africa household survey data were obtained by downloading full database for the General Household Survey 2003 (Statistics South Africa 2003).

uniform across all 39 countries. The curved center line is a polynomial fit through the medians of all the ratios of enrollment to population. The ratio for grade 1 exceeds the mean ratio across all grades (1.15) by 30%; whereas, the ratio for grade 6 is 25% below the mean. It is important to note that for approximately half of these countries, the ratio of enrolment to population dips below 1 only in approximately grade 6 and can exceed 1.2 as late as grade 3, which is one reason we include "five" in the phrase "Foundational First Five". Even discounting for a reasonable amount of repetition in grade 6, in around half of these countries, few dropouts appear to occur before approximately grade 6.

Lack of preprimary education services

Countries with substantial churning in grade 1 largely coincide with those having very low preprimary enrolment ratios. Here we must define the gross enrolment ratio for preprimary education, because many preprimary programs do not necessarily have a clear grade structure. The UIS indicator for preprimary gross enrolment is total preprimary enrolment, regardless of age, divided by the population "officially" suitable for preprimary enrolment. Thus, the population that is "officially suitable" for publicly provided ECD centers may be

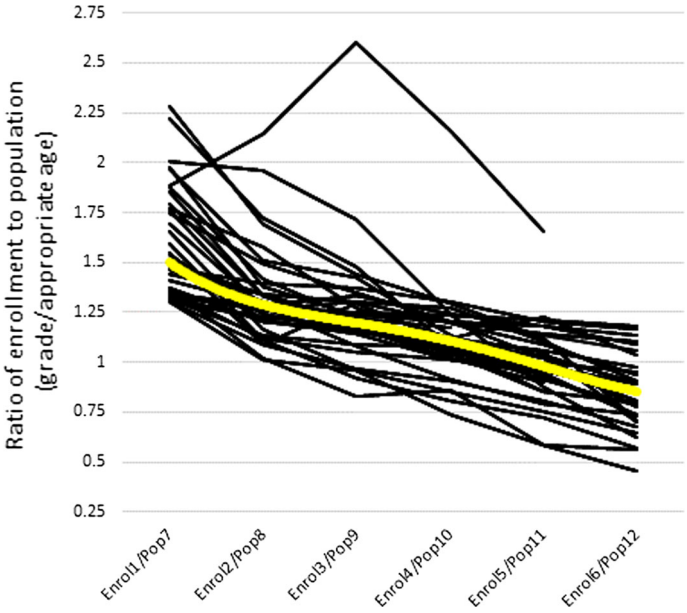

Figure 1 Ratios of enrollment to population in the six first primary grades, for all countries included in the database
Source: Calculated from downloaded World Bank EdStats database

enrolled in any type of center. The ratio can exceed 1 not only because of overage and underage enrolment, but also because nonpublic centers might cater to a broader age range than served by public centers.

For the 39 countries with grade-1 churn exceeding 30% according to our calculations, the preprimary-school enrolment ratio was only 24% on average. In general, preprimary education services available in lower-income countries tend to be concentrated in urban areas, serving wealthier families. The rural poor have extremely limited access. (The UNESCO Global Monitoring Report offers a companion interactive data visualization tool at http://www.education-inequalities.org/indicators, "Access and completion: Pre-primary education attendance", that can be sorted by "most deprived", among other variables.) For the 20 countries with a churn exceeding 50%, on average, the preprimary-school enrolment ratio is 17%. For the sake of comparison, according to our data the simple (unweighted) worldwide average value of the preprimary enrolment ratio is approximately 63%.

Low levels of preprimary service provision are not surprising, because the poorest countries have the least resources for education services considered "nonessential". Fortunately, the perspective among governments and donors is shifting due to growing global evidence about the importance, for school success, of supporting young children's emergent cognitive and noncognitive skills. For example, the Program for International Student Assessment (PISA) results in 2012 revealed that, across Organisation for Economic Co-operation and Development (OECD) countries, 15-year-old students who reported having attended preprimary for more than 1 year scored 53 points higher in mathematics (the equivalent of more than 1 year of schooling) than students who had not attended preprimary school (OECD 2014, p. 12).

The literature on preprimary education is well known, and summarizing it is beyond the scope of this paper. (For very recent and complete summaries and recommendations, see

Barnett and Nores 2012; Engle et al. 2011; Yoshikawa and Kabay 2015; and Young 2014.) The literature shows that high-quality interventions are available, with effect sizes ranging from 0.5 to 0.7 (on a variety of relevant health and cognitive outcome measures), in developing country contexts (Rao et al. 2014). For our purposes, the critical point is that studies have demonstrated that preprimary participation improves children's cognitive development and promotes school readiness. A meta-analysis of 37 studies of center-based preschool programs revealed a reliable, positive effect on cognitive development (Rao et al. 2014). Children who do not receive adequate cognitive stimulation do not develop to their full potential. Our understanding of human development suggests that children's ability to master new material increases over time; for example, an average 3-year-old cannot do what an average 4-year-old can do. Children's developmental progression indicates that underage children are unprepared to master grade-1 material even under the best circumstances, which, of course, these contexts are not.

To establish that these ratios are strongly "patterned", to imply a set of related problems (not obvious based on Table 1), and to show that the problems are somewhat independent of the overall level of development, recall that Table 2 lists the pairwise correlations among the variables discussed above and their correlations with the GDP per capita. Table 2 also shows, as the second entry in each cell, the partial correlations between these variables considering, or controlling for, GDP per capita.

Nearly all of these relationships are strong and statistically significant. In interpreting the table, note that bivariate correlations are equivalent to effect sizes, in terms of the "standardized coefficient" or "beta" coefficient as used in various statistical analysis packages, such as Stata. Thus, these relationships are also important in substantive terms, using a conservative cutoff of 0.25 for an effect size worth reporting, as in the US Department of Education's What Works Clearinghouse (2015). The churn in grade 1 (ratio of enrolment to population) is highly negatively correlated with the drop-off in enrolment between grades 1 and 2 and positively correlated with the intake ratio. The drop-off between those grades, in turn, is highly positively correlated with the availability of preprimary enrolment and is highly negatively correlated with the very high intake.

Controlling for GDP per capita, as a proxy for overall development, only moderately affected these correlations. When we controlled for GDP per capita, the statistical reliability of the relationships decreased slightly, but the relationships remained statistically significant at the 0.01 level or better. The only exceptions were the correlation between the ratio of grade-1 enrolment to population of age 7 and the preprimary gross enrolment ratio, which was significant but only at a lower level; and the correlation between the preprimary gross enrolment ratio and intake into grade 1, which became nonsignificant.

Preprimary enrolment is negatively associated with the overenrolment and churn in grade 1; in other words, preprimary enrolment lessens those problems. An increase of one standard deviation in preprimary enrolment is associated with a reduction of 0.27 standard deviations of churn in grade 1, and increasing from none to complete preprimary enrolment is associated with a 21% reduction in the grade-1 churn. Because the average churn across *all* countries (not just low-income countries) is only 15%, these are large effects. For the poorest countries, the percentage effect is naturally lower because the churn in these countries is closer to 30%. To exemplify these differences, countries with both high churn and low preprimary enrolment, such as Uganda (with approximately 74% churn in grade 1 and approximately 14% preprimary enrolment), may be contrasted with countries exhibiting the opposite situation, such as Algeria (only 8% churn and 70% preprimary enrolment).

Preprimary enrolment is positively associated with the ratio of grade-2 to grade-1 enrolment and negatively associated with the apparent drop-off between these two grades. One standard deviation in preprimary enrolment is associated with 0.47 standard deviations in apparent drop-off, and increasing from zero to complete preprimary enrolment (as measured by the enrolment ratio) is associated with a 13% decrease in drop-off. Considering that the average drop-off is 6% across all countries (not just poor countries), these effects are also large. Uganda and Algeria can likewise be used to typify the contrast: Uganda has approximately 30% drop-off between grades 1 and 2 and a preprimary enrolment ratio of approximately 14%. In contrast, Algeria has no drop-off and a preprimary enrolment ratio of approximately 70%. It is also interesting to consider the case of Ghana, a relatively poor country, which has expanded preprimary enrolment (to approximately 100%) and has a relatively low drop-off between grades 1 and 2 (only approximately 8%). As we explain in the next section, however, this picture may not be as rosy as it seems.

Overall development (using GDP per capita as a proxy) does condition these effects but only slightly in most cases, as noted previously. However, it is interesting to observe how all the variables move together in response to GDP per capita, which clearly exerts some effect. To analyze this relationship graphically, we sorted all the countries according to their GDP per capita and graphed the key variables by income quintile. Figure 2, below, shows that much of the churning in grade 1, excessive intake, and very low preprimary enrolment are problems typical of (but not entirely exclusive to) the lowest two quintiles of countries. In Figure 2, as one moves from the lowest income quintile to the next, the slopes of all the lines are very similar to each other—although some are negative, and some are positive. These similar slopes, along with the correlations above, highlight the existence of a "knot" of interrelated problems, but we cannot go so far as to argue that low preprimary enrolment is *causing* excessive primary enrolment. The slopes subsequently begin to differ,

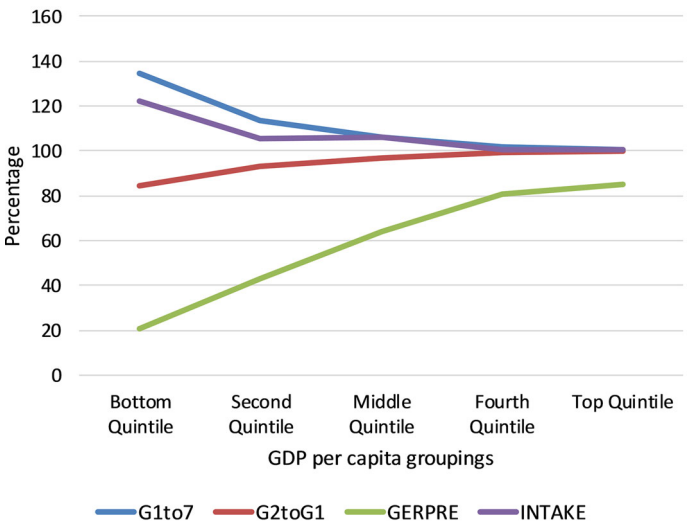

Figure 2 Relationship between foundational year variables and GDP per capita
Notes: G1to7 = Grade-1 enrolment to population of age 7, G2toG1 = Grade-2 enrolment to grade-1 enrolment, GERPRE = Preprimary gross enrolment ratio, INTAKE = Gross intake ratio into grade 1
Source: Calculated from downloaded World Bank EdStats database

starting with the shift from the second to the third quintile, suggesting that these phenomena are particularly intertwined in the poorest 40% of countries.

Essentially, a large intake rate, a bloated ratio of enrolment in grade 1 to population, and a high drop-off between grades 1 and 2 all indicate the same thing, or nearly so. They are also highly conditioned by the lack of preparation for school resulting from inadequate preprimary enrolment. Taken together, these weak foundations predict low levels of learning in the first few grades, as demonstrated in the next section.

Weak learning outcomes in the first few grades

Another manifestation of weak foundations, in addition to churning and repetition, is the lack of learning of even the most basic skills in the first few grades. Reading, math, social-emotional skills, and self-regulation are the building blocks of future academic success. Rigorous, reliable, and internationally comparable measures of some domains, particularly social-emotional skills, are lacking, but strong data are available on reading skills in the early grades. These data reveal that the learning crisis begins early.

Several studies show that, in poorer countries, approximately half of the children in grade 2 cannot read a single word in sentences as simple as this, in English: "Tom wakes up very early. Today is the first day of school", or the equivalent in a local language. Figure 3, below, shows the distribution of the results of studies across a set of 53 country/language combinations (21 countries and 31 languages, with some countries having more than 1 language and some languages more than 1 country). To draw attention away from "league table" considerations, we have not mentioned specific countries; instead, we show an arbitrary identification code for each country/language combination. The studies were in

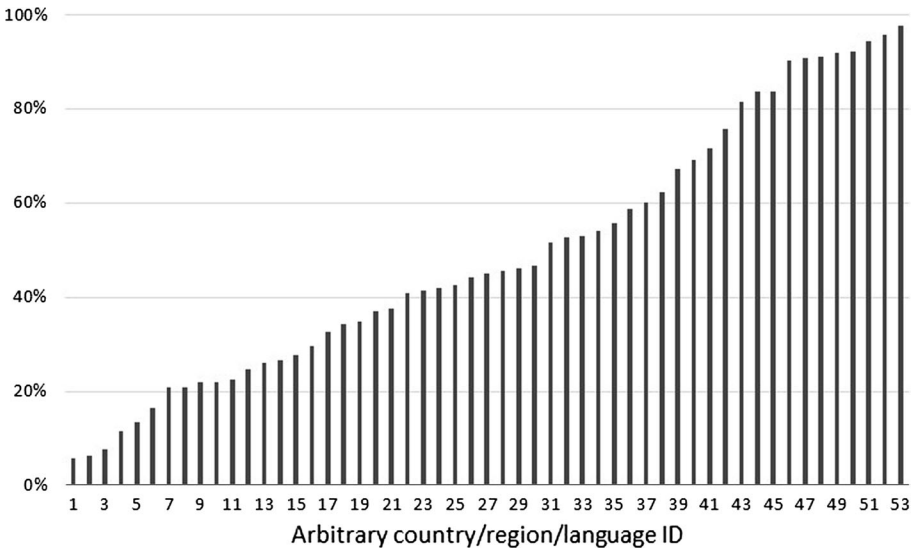

Figure 3 Percentage of grade-2 students unable to read a single word
Notes: Graph presents 53 country and language compilations, each represented by an arbitrary identification code rather than by name.
Source: Compilation of datasets from early-grade reading studies, maintained by RTI International

the Early Grade Reading Assessment (EGRA) "family"—but were not necessarily formally called EGRAs (see Dubeck and Gove 2015 for a description of the EGRA)—and took place between about 2007 and 2014.

The median percentage of children unable to read at all was 50%. The countries in question are generally among the poorest; furthermore, some of the studies were subnational and administered only in the countries' poorer regions. Thus, one cannot claim that all of these studies are representative of developing countries in general. However, they are likely representative of the situation affecting the poorest two quintiles of countries or the poorest two quintiles of the population, even in some middle-income countries.

Other studies originated or inspired by the Pratham Education Foundation, such as the Annual Status of Education Report (ASER) in India and Uwezo in East Africa, have drawn similar conclusions about low levels of learning in the early grades. For example, in Uganda, Tanzania, and Kenya, even by grade 3, in 2011, "[t]wo out of three pupils … are not able to pass basic tests in English, Kiswahili or numeracy at the Standard 2 level" (Uwezo n.d.). In India, in 2011, approximately 40% of grade-3 children were unable to read a grade-1 paragraph (Pratham 2013, p. 66). For more data on ASER and Uwezo, see Uwezo and Hivos/Twaweza, East Africa (n.d.), Uwezo and Hivos/Twaweza, East Africa (2013), Uwezo and Hivos/Twaweza, East Africa (2012) and Pratham (2014).

The various studies tended to estimate that approximately half the children in grade 2 (in these countries or regions) could not read at all or could not read the simplest texts. Thus, the learning crisis originates and is detectable much earlier than suggested by studies in upper primary—such as the Trends in International Mathematics and Science Study (TIMSS) and the Progress in International Reading Literacy Study (PIRLS), conducted among somewhat older children, after the "Foundational First Five".

Explaining the interrelation of foundational variables

In summary, tightly associated are: low levels of preprimary education enrolment, inflated grade-1 intake rates, churning, overenrolment (repetition, essentially) in grade 1, and a large ostensible dropout between grades 1 and 2. Levels of learning in the foundational years also tend to be very low, for the countries where data could be found. These issues are often confusing to countries and donors, which may drastically underestimate the real repetition rate and thus insufficiently account for it during education sector planning. These data also suggest that, by having ratios of enrolment to the appropriately aged population of 1.50 and 1.28 in grades 1 and 2, respectively, these countries may, to some extent, already be paying for preprimary education, either explicitly (when enrolment numbers drive funding formulae) or implicitly (in the form of inefficiency and waste).

We hypothesize that in countries that lack preprimary education, large numbers of children are enrolling in grade 1 and then churning there for several years without learning much before moving to grade 2, where they churn again in smaller but still significant numbers. It is likely that the continued (but lower and declining) overenrolment in grades 2 and 3 results from lack of preparation for school and low levels of learning in grade 1. In addition, we know that, for many of the countries examined, children in grades 2 and 3 continue to age more than one year per grade, suggesting substantial repetition in those grades as well.

This continuous overenrolment and churning of (in some cases) underage children would explain the unabated high intake numbers that are incongruous with cohort

population levels. Children who enter grade 1 too young and/or without having had the opportunity to develop foundational skills in an age-appropriate preprimary education setting are at an extreme disadvantage for learning. Underage children are not developmentally ready to master grade-1 material. This, together with the consequences of severe overcrowding in grade-1 and grade-2 classrooms, contributes to the abysmal, well-documented learning outcomes. These weak foundations, in turn, contribute to the learning crisis in the primary education cycle as a whole.

Several possible factors may contribute to the grade-1 bulge. Incentives to exaggerate enrolment may occur in systems that budget on a per-student basis. In such cases, it may be easier, or less risky, to simply allow real underaged children into grade 1 than to invent "ghost" students. Additionally, parents may simply need free childcare; shunting underaged children into grade 1, even without much learning going on, might be an expedient solution from their perspective. Finally, school-level authorities may not officially fail students who enroll but attend desultorily; and if those students subsequently reappear in the same grade the following year, authorities may report them as "new" rather than as repeaters. Or, some countries may place the weakest teachers in grade 1 or 2, contributing to repetition because of ineffective teaching. In general, little learning occurs—teachers and parents may simply expect children to repeat until they learn some rudiments, even when the official policy is one of automatic promotion.

In the following section, we describe the efficiency and cost implications of the trends informing our hypothesis.

Efficiency and cost implications

Above, we argue that, because of the nature of the problems in the Foundational First Five years, many countries are already paying for some preprimary education, either without realizing it or under other line items of their budgets, explicitly or through inefficiency and poor results. In this section, we describe how these inefficiencies are captured and present data for supporting our argument. Although a rigorous quantification of this cost is beyond the scope of this article, we were able to make useful approximations. Below, we lay out three approaches to this cost-efficiency analysis.

First approach: Using estimates of overenrolment

Using the same databases constructed for all the estimates so far, the logic for our first approach is as follows.

- Taking the countries whose grade-1 churn (ratio of grade-1 enrolment to 7-year-old population) exceeds a conservative 30%, the median churn in these countries is 50% in grade 1 and 28% in grade 2.
- Given that these countries' median proportions of enrolment in grades 1 and 2, out of total primary enrolment, are 29% and 20%, respectively, then 20% (0.50*0.29+0.28*0.20) of the total enrolment in the primary grades corresponds to the churn in the first two grades.
- Because the average duration of primary schooling is approximately 6 grades in these countries (5.9, to be precise), the churn corresponds to the cost of approximately 1.2 grades of schooling (5.9*0.2); this cost could be formally invested in preprimary schooling instead.

Rwanda, which allows for an approximate calculation of cost, is a case in point. For the time period in our database, Rwanda had 128% more children in grade 1 than in its population of relevant age (that is, the ratio of grade-1 enrolment to the population of appropriate age was about 2.28). Grade-1 enrolment was 28% of total primary enrolment—however, in a system of six grades, it should be about 17%. To put things in financial perspective, during the period in question, Rwanda spent about 34% of its education budget on primary schooling. Grade-1 enrolment accounted for 28% of total enrolment, and about 56% of grade-1 enrolment is overenrolment—therefore, eliminating that overenrolment would save about 5% of the primary education budget (and even more by also ending overenrolment in grades 2 and 3). Since Rwanda spent only about 0.2% of its education budget on preprimary, ending such overenrolment would have allowed it to vastly increase spending for primary education.

Second approach: Comparator countries

However, the calculations are not as simple as above, for many reasons. First, earlier grades are more crowded than later ones, and countries tend to place their less-costly teachers in earlier grades; thus, the savings are not linear. Second, depending on how a country allocates funding, resourcing of schools may not be sensitive to overenrolment, and, therefore, churning's costs may not be explicitly fiscally recognized; instead, it may be captured "only" in low learning and inefficiency.

A second approach offers a way to double-check the above calculations without assuming linearity of cost or explicit funding effects from overenrolment.

- In the "high-churn" countries identified, the median share of primary schooling in total educational expenditure was 46%.
- When we discounted this share by the 20% of churn as a proportion of total primary-school enrolment, as explained above (under the implicit assumption of linearity), without the churn, the share of primary schooling in total cost was 37%, not 46%.
- Currently, the median GDP per capita (in current PPP terms, averaging the 5 most recent years in the constructed database) in those countries is $2,500.
- We constructed a set of comparator countries with average values as close as possible to that level of GDP per capita but that we restricted to having "non-churning but high-enrollment characteristics". Meeting this restriction required a grade-1 enrolment-to-population ratio between 0.9 and 1.15, a grade-2 to grade-1 enrolment ratio exceeding 0.9, and an intake ratio above 0.95 but below 1.1. For these countries, the share of primary schooling in total educational expenditure was 38%, which is in very good agreement with our other estimate (37%).

As desired, this result does not depend on assuming nonlinearity; instead, it simply depends on approximating the costs in countries that do not churn their students. This finding confirms the estimation that churning (conservatively) costs the equivalent of approximately 1.2 grades in the 39 or so countries with the worst churning, with the number of countries depending on the years used.

Third approach: Effects on completion

A third approach to understanding the efficiency implications is to determine how these variables affect the efficiency with which school systems use funding and resources to "produce" completion. A straightforward way to do this is to determine the relationship

between the primary-school completion rate and expenditure per pupil: how much of the variation in completion rates, across countries, is "explained" by variations in funding, and how much is "unexplained" by variations in funding. The unexplained variation is a measure of inefficiency, since it measures the degree to which funding does *not* explain completion. One can then ask, whether the foundational factors we have selected, in turn, explain that inefficiency.

As a measure of expenditure, we used public per-pupil spending in primary school as a proportion of GDP per capita, a fairly standard measure of fiscal effort and expenditure. Unfortunately, we observed very little relationship between primary-school completion and per-pupil expenditure as a share of GDP per capita. The proportion of the variation in the completion rate explained by expenditure was only 0.09 (although the effect of the measure of expenditure was statistically significant, with $p < .01$). In other words, the variance in expenditure explains only 9% of the variance in completion rates.

Nor did efforts to create a proxy for a data envelope using quantile regression (or even quantile regressions of nonlinear transformations of the variables) result in any useful fit. To explain further, a data "envelope" is the line that joins together the highest (or lowest) points in a scatterplot. Given a scatterplot showing expenditure per pupil on the horizontal axis and the completion rate on the vertical axis, the envelope line would indicate the maximum completion being achieved by any country in the diagram for each expenditure level. Thus, it would represent the line of maximum efficiency. Other countries' distance from that line could be taken as a measure of their inefficiency. Quantile regression approximates this type of analysis by fitting a line not through the central trend in a scatterplot but through, for example, the top 15% of the points, thus approximating a data near-envelope.

In the end, because expenditure explained such a low proportion of the variation in completion, in other words, because inefficiency was so high, there was no point in trying to understand whether the foundation factors explain the inefficiency. Instead, it made more sense to see whether the foundation factors directly "explain" the variation in completion. That is: do our foundational factors explain completion? Additionally, is there a *single*, summary foundational-years factor that helps drive completion?

Presenting quite high internal correlations among the four foundational variables, Table 2 shows that the variables do cohere: there seems to be a single, latent factor that one call a "foundation years factor". However, to formalize the analysis of this coherence and determine whether a clear case exists for an overall, underlying foundation years factor that explains completion, we conducted a principal components analysis of the four variables across all countries in the database (not just those with high churning). To better focus on inefficiency implications, for the ratio of grade-1 enrolment to population of aged 7, we took only the "excess" of this ratio over 1 and used a similar cutoff for the gross intake ratio into grade 1.

As one would expect, given the high internal correlations among the four foundational variables, a reasonably coherent and important principal component does exist that enables us to create a summary variable, as shown in Table 4, below.

This summary variable signals "dysfunctionality". It takes on higher values for higher excesses of grade-1 enrolment to population aged 7 and intake into grade 1, and lower values for higher ratios of grade-2 enrolment to grade-1 enrolment and preprimary gross enrolment ratio. The variable thus seems to constitute a logical summary: it shows clear and strong contrasts between the underlying variables for which high values indicate dysfunction and those for which high values indicate efficiency.

Table 4 Principal component coherence of foundational factors

Proportion of variance in the primary-school completion rate accounted for by the principal component	0.67
Factors	Coefficients in principal component
"Excess" of grade-1 enrolment to population of age 7	0.55
Grade-2 enrollment to grade-1 enrolment	−0.53
Preprimary gross enrolment ratio	−0.36
"Excess" of gross intake into grade 1	0.54

Source: Calculated from downloaded World Bank EdStats database

The balance in the coefficients is quite good. Using the coefficients to create a summary variable and regressing the primary completion rate on the summary variable reveals that the summary variable exerts a substantial impact on completion: the effect size is −0.58 (negative because the summary variable signifies dysfunctionality or inefficiency) at a significance level of $p < 0.001$. The summary variable itself, which is a linear combination of the four variables indicated above, explains 34% of the variance in the completion rate.

That 34% is far more than the expenditure-effort variable explains. Adding expenditure or finance, as measured by the public per-pupil spending in primary school as a proportion of GDP per capita (either by itself or in interaction with the summary variable) to the equation predicting the primary completion rate adds 9% (from 0.34 to 0.43) to the total explanatory power of the equation. That said, the expenditure variable does not achieve statistical significance by itself or when interacted with the summary variable. Thus, a combination of the Foundational First Five factors explains completion much more effectively than expenditure per student does, signaling that these factors account for a lot of the internal efficiency or inefficiency of these systems. ("Internal efficiency" refers to the student-years of effort required to produce a completer. A high level of student-years of effort per completer is inefficient and is usually caused by repetition or dropping out. The inefficiency lies in the fact that the repeaters and dropouts use up resources that do not lead directly to completion.)

A strong caveat

We note here that adding one or two years of preprimary schooling to the inefficiency and lack of learning currently occurring in the first two or three grades will not accomplish much if it is of low quality. It would be a step in the right direction, however, to reduce the excessively high student–teacher ratios suffered presently in grade 1, by opening another classroom for the younger children.

Table 2, above, shows that preprimary enrolment correlates with lower rates of grade-1 repetition when we controlled for GDP. This held true even though the quality of preprimary services in these countries is often quite low. But again, expansion of preprimary access alone—without attention to quality—is insufficient to move the needle on learning outcomes. Countries should aim to have young children attend school in developmentally appropriate, child-centered classrooms with their same-age peers, not sitting in the back of a classroom with older children, unable to keep up with content that is developmentally beyond their grasp. The most important aspects of quality in preprimary

education are stimulating and supportive interactions between teachers and students, and effective use of curriculum (Yoshikawa and Kabay 2015). Governments must develop their capacity to meet these conditions.

Implications and suggested steps for further analysis and policy dialogue

In this article, we argue that the education systems of a large number of countries are built on very weak foundations, particularly regarding the following: low preprimary enrolment, inflated intake into grade 1, churning in grades 1 and 2, inefficient persistence in the first few grades, and many children not developing essential skills as late as grade 3. We also argue that the cost of improving the Foundational First Five years is already being paid for—but without good results—through large-scale waste and non-learning in those crucial years. Our evidence suggests that policymakers could dramatically change this situation by investing in preprimary education of high quality.

Further analysis is warranted. Although we have been very careful in our choice of datasets, official statistics may be biased, and demographic data may be poor. However, the issues analyzed here are so numerically significant and so patterned that mere data bias is unlikely to explain all, or even most, of the phenomena noted. Nevertheless, further research could be done in at least two directions. First, researchers could conduct country-by-country case studies to confirm or question the data. Second, they could lead studies to better understand why the patterns exist, including regarding incentives to exaggerate enrolment or parents' need for childcare, as discussed above.

These various factors may combine in complex ways that educators should explore. As of this writing, we are carrying out a detailed analysis of household and school data in two districts in Uganda, to dig more deeply into the relationships among repetition and its reporting, aging in school, parents and teachers' perceptions of repetition, and decision making about preprimary enrolment. Case studies like this one and further research on these dynamics are likely necessary to underpin policy dialogue and reforms to improve the Foundational First Five. Also as of this writing, at least one development agency has shown interest in the possibility of carrying out case studies of some countries—possibly Chile, Colombia, Indonesia, Laos—that appear to have successfully dealt with the "knot" of foundational problems. Among other things, these countries have improved preprimary-care provision.

In addition to further research, we call for policy dialogue with governments and donors to examine the complex interaction of these variables in their countries. They must wrestle with several central questions: Who are the children making up the grade-1 bulge? How many are underage and would be better served in an age-appropriate setting? How can governments increase their capacity to provide age-appropriate, high-quality early learning in the preprimary years? What are the real repetition and dropout rates in the early grades? Critically, what are the costs to the education system of this inefficiency in the Foundational First Five years? Is there fiscal inefficiency that they could calculate and redirect it toward quality preprimary education? Or is the inefficiency manifested "solely" as waste and lack of learning?

We hope that this article serves as a starting point for researchers, donors, and policymakers to dig into these issues and take concerted steps to improve the Foundational First Five.

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