Learning in Schools:

Lessons from School-Aged Children in Nigeria using a Pedagogical Production Function

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Abstract[1]

While there is a growing amount of information on the flat-learning curves in many developing countries, little is known about the drivers of poor learning outcomes in these countries. In this diagnostic study, we use data from Africa's most-populous country, Nigeria, to examine the extent to which learning actually takes place in schools. We use a unique dataset that tests children at different ages in and out of school. The analysis uses a pedagogical production function calibrated to match in-school learning in order to assess the roles of curriculum pace, centredness, and teaching ability, in explaining the flat in-school learning profiles we uncover. Our findings show that 53% of students do not meet the expected competency levels at the end of the primary school cycle. The findings further show that making the curriculum less ambitious and targeting teaching to students at the right level can potentially increase performance rates.

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1. Introduction

Education systems in several developing countries are in a deep learning crisis. The progress indicators for assessing the status of the global goals on inclusive and quality education for all, shows a significant gap in expected literacy and numeracy proficiency levels, and worsening basic learning outcomes for children in several developing countries (World Bank, 2018; Bold et al. 2017; Kaffenberger and Pritchett, 2017). In the new World Bank (2019) measure of learning performance, 87% of in-school and out-of-school children aged 10 in sub-Saharan African are below the learning poverty line, meaning they are unable to read and understand a simple story about everyday life. It is increasingly recognized that the learning crisis is not just about access to education, but modalities of learning in school, as the majority of those in school are not learning at their age-appropriate level. This suggests that education curriculum and learning are worlds apart. Banerjee et al. (2016) and Kaffenberger and Pritchett (2020) have argued that the learning problem is an instance of curriculum misalignment, as children's skill level is below the grade or curriculum they are exposed to.

We provide an illustrative case of curriculum misalignment using the Nigerian education system. The cross-country experience of the learning crisis is exemplified in the Nigerian education system with problems on multiple fronts. The country has the largest number of out-of-school children, estimated at 10.5million by UNESCO (2019), despite basic education being free and compulsory. Similarly, learning competency among children in school is alarmingly low. Adeniran, Ishaku and Akanni (2020) estimated that 17% of in-school children in Nigeria do not meet their age-appropriate proficiency in literacy and 31% fall below minimum learning competency in numeracy. To illuminate on cause and potential interventions to these problems, we use a novel dataset, the Nigerian Education Data Survey (NEDS, 2015), that tests in-school and out-of-school children at different ages and construct a learning profile for recent cohorts of primary school children.

The learning profile illustrates the significance of curriculum misalignment in the Nigeria education system in two ways. First, despite the mastery of the content in the assessment expected at Grade 2, the majority of the students are still not competent up to the end of primary education. Secondly, as assessment instruments move from testing simple to harder concepts, performance level dropped significantly across grade levels. While more than 80% of Grade 6 children can identify numbers, only less than 50% can solve double digit addition or subtraction, which they ought to have mastered at Grade 2. This suggests the foundational skills needed for higher grades are absent, as such the age-appropriate performance level plummeted. The learning profile yields other valuable insights into the different dimensions of exclusion from quality education and on the key vulnerability factors. While the gender disparity in education performance is absent, we found significant differences in performance along rural-urban, north-south regions and wealth quintiles.

Another contribution of the study is the development of potential pedagogical function (PPF) from the learning profile. The PPF is a recent innovation to the study of learning profiles developed by Kaffenberger and Pritchett (2020), which uses key parameters in the learning process to generate the expected learning trajectory for a hypothetical student cohort. This simple tool can be extended in many ways to answer critical questions on the effectiveness of different education reforms and interventions to improve learning outcomes. Along this line, we use the PPF calibrated to match in-school learning in Nigeria in order to assess the roles of curriculum pace, centeredness (targeted to student abilities), and teaching ability, in explaining the abnormally low in-school learning.

The simulation exercise found that when learning is centered on the skill level of the most disadvantaged students, the pass rate for all children exceeds the set benchmark at the end of primary education. This implies that one solution to poor learning in schools requires an assessment of the skill distribution among students and tailoring the curriculum to their base skill and ability. The Teaching at the Right Level (TaRL) system is one approach to school organization that incorporates this idea of centering learning, but its adoption in Nigeria is low and at a slow pace. The second effective way to improve learning based on our analysis is through teaching more to more pupils which means increasing teaching time per pupil. In our simulation, this has the potential to improve pass rates by 19% compared to the baseline. This can be achieved either through expanding the number of teachers in the classroom, or blended learning in which technology supports independent learning with some guidance from teachers. In essence, the study identifies two key reforms to the education system in Nigeria that will improve learning after the primary school cycle, that is making the curriculum less ambitious and support for the education workforce to improve quality and quantity of teaching.

The study contributes to the extant literature in two significant respects. One, the learning profile underlines key vulnerability criteria for exclusion from quality education in Nigeria, which includes: location (northern region and rural area), economic status and school type (public school). Contrary to previous studies and dataset (Adeniran et al., 2019; Multiple Indicator Cluster Surveys, 2017, Demographic Household Survey, 2013), we do not find gender gap in learning. However, a major difference in our work to these studies is the type of dataset used. While we use a contemporaneous survey, the previous studies use the adult retrospective survey. This may suggest that either the schooling system has improved but with the lag in adult retrospective survey this is not captured or that gender learning gaps emerge outside of school. Two, the use of learning profile and PPF is a recent innovation in the education literature (see Kaffenberger, 2021, Kaffenberger & Pritchett, 2020, 2021) and it has not been applied to the Nigerian dataset. Building and expanding on this growing literature is major contribution of this paper.

The paper comprises five sections. Section 2 gives a detailed description of the data used for this study. In section 3, we construct learning profiles for Nigeria to capture the depth of the learning crisis and the various dimensions of learning inequalities. Section 4 discusses the foundational basis of PPF and illustrates its key building blocks and link to the learning profile. The fifth section discusses the approach the study takes in matching the PPF to the Nigerian learning profile and basic assumptions on the learning process. In section 6, we apply this approach in analyzing the learning trajectory for in-school and out-of-school children in Nigeria and simulate the impacts of various policy interventions. Finally in Section 7, we provide policy recommendations based on the implications of our findings.

2. Data Description: Nigerian Education Data Survey

National Education Data Survey NEDS is a periodic dataset on the current state of the Nigerian education system. It includes information on student performance, school conditions and parental involvement. We use NEDS (2015) which evaluates both literacy and numeracy competencies, to generate a contemporaneous learning profile. The survey covers the entire basic education system in Nigeria (pre-primary, Primary and Junior Secondary School), including in-school and out-of-school children. Our analysis is targeted at pre-school, primary school and out-of-school children aged 5 to 11 years. This age bracket captures the official primary school age. In total, the analysis covers a nationally representative sample of 51,180 children.

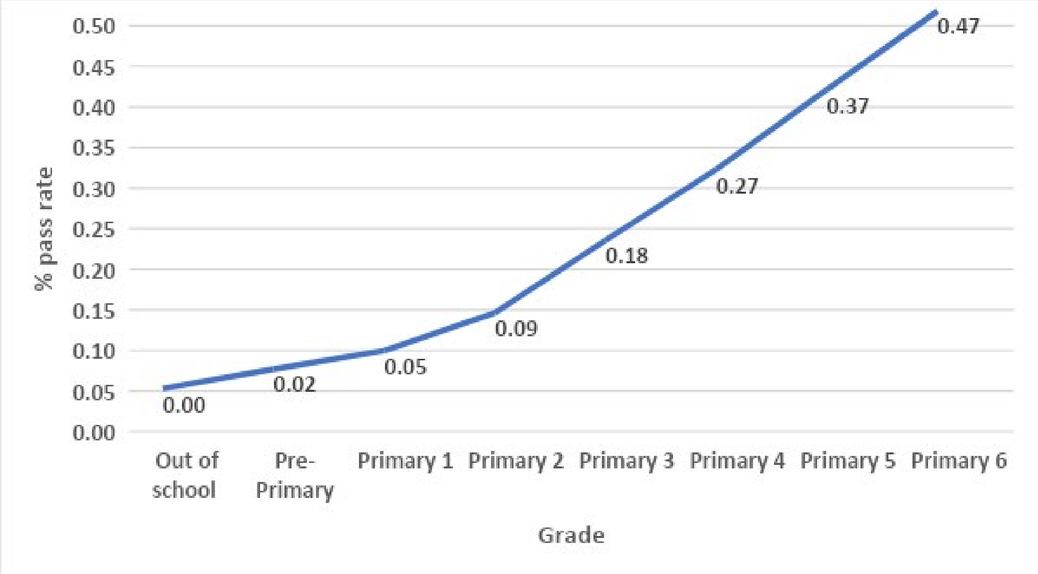
The NEDS assesses literacy based on children's ability to identify words correctly and read single short sentences in English, an official language in Nigeria, or their mother tongue. Children that can read and answer correctly at least one of the three interrogative sentences displayed by the enumerators are deemed to demonstrate competency in comprehension. For the numeracy assessment, they were first asked to identify randomly displayed numbers. Thereafter, the enumerator asks the child to add two single digit numbers, which sum to less than ten. Those that can correctly sum the numbers are considered to have basic numeracy competencies. Also, children that are able to add or subtract at least one double-digit problem are considered to demonstrate advanced numeracy skill.

The numeracy and literacy assessments cover a total of 13 questions. Rather than separating performance into numeracy and literacy, we combine the two into a composite index. The composite index is a simple sum of all correct answers to the 13 questions asked. We set a benchmark or pass mark as being able to correctly answer 11 correct questions. The rationale for the benchmark is to avoid penalty on Primary 1 children that are not expected to have reached minimum competence in two of the 13 questions. We recode the dataset based on the benchmark as follows,

$$Performance = (1\ for\ pass\ if\ composite\ score > 11, 0\ for\ fail\ if\ composite\ score\ \leq 11\ )$$

A descriptive analysis of the performance across grade based on the new composite index is shown in Figure 1. The average performance increases at higher-grade level as expected, but overall performance is still very low. Only 47% of the Grade 6 children meet the set benchmark, implying the majority lacks foundational skills in literacy and numeracy even after at least six years of education. At Grade 2, which is the age-appropriate level for most of the concepts tested, only 9% of the students meet the benchmark. The improvement from one level to the next reflects a flat learning curve and absence of a remediation plan to ensure those left behind are catching up to advanced materials.

Figure 1: Pass rate (%) by grade



3. Overview of poor learning outcomes in Nigeria

Nigerian education follows a linear progression of pre-school (at least a year), primary (6 years), junior and senior secondary (6 years combined) to university (4 years). The first ten years (pre-primary, primary and junior secondary) are free and compulsory according to the Universal Basic Education Act (2004). The expected proficiencies in numeracy and literacy at the end of the primary education are summarized in Table 1. Mastery of letter identification and reading words and simple sentences are expected at the end of Grade (Primary) 1. This should extend to ability to comprehend simple sentences after Grade 2 and complete competences in literacy and communication after primary education. Similarly, for numeracy, the national education policy envisages that schoolchildren will be proficient in the identification of numbers and could perform single digit additions and subtractions at the end of Grade 1. Mastery of double-digit arithmetic is expected at Grade 2 and ability to apply arithmetic knowledge for practical experiences using word problems should be attained after primary education.

Table 1: Expected Numeracy and Literacy at Key Grade Level in Nigeria

GRADE	MINIMUM NUMERACY SKILL BASED ON SCHOOL CURRICULUM	MINIMUM LITERACY SKILL BASED ON SCHOOL CURRICULUM
Goal of pre-primary: effective transition from home to work		
Pre-primary or at age 5	✔ Simple addition of numbers	✔ Reading (words) ✔ Pattern making
The goal of primary: to inculcate literacy, numeracy and the ability to communicate effectively		
Primary 1 or at age 6	✔ Addition of numbers 1-10 ✔ Subtraction of numbers 1 -10	✔ Identification of letters ✔ Reading (sentences)
Primary 2 or at age 7	✔ Addition of whole numbers up to 200 with and without carrying	✔ Reading (fluency) ✔ Comprehension (basic)

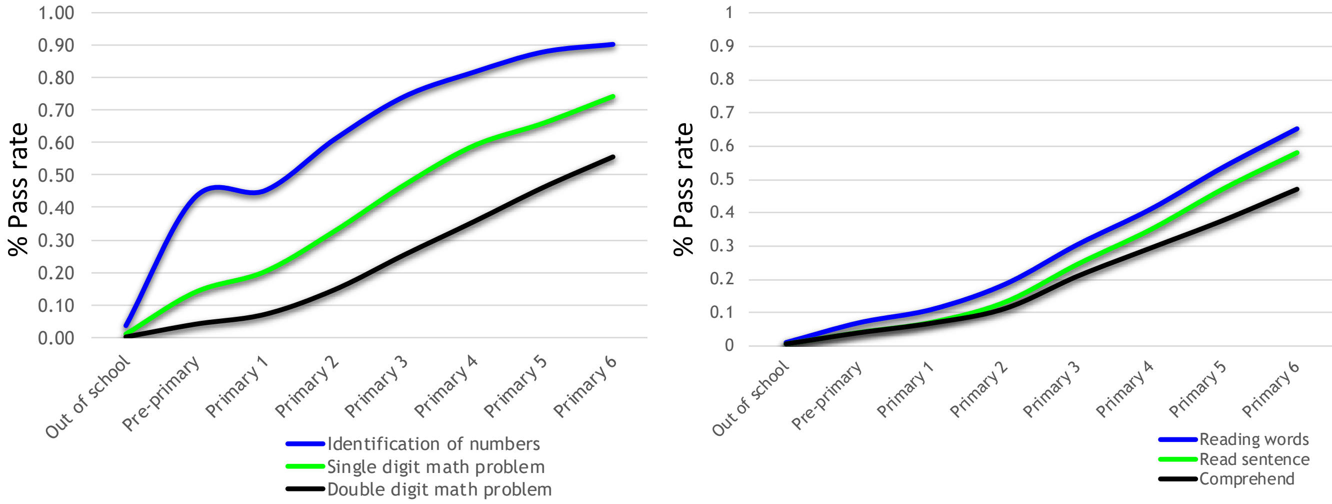
	✔ Subtraction of whole numbers up to 200 with and without borrowing	
Primary 3 or at age 8	✔ Addition of whole numbers with and without carrying ✔ Subtraction of whole numbers into and without borrowing ✔ Word problems on addition and subtraction of whole number	✔ Comprehension (advance)
Primary 4 or at age 9	✔ Addition of whole numbers including word problems ✔ Subtraction of whole numbers including word problems	✔ Composition ✔ Essay writing
Primary 5 or at age 10	✔ Combination of addition and subtraction ✔ Word problems on addition and subtraction	✔ Grammar & Styles ✔ Composition
Primary 6 or at age 11	✔ Word problems on addition and subtraction	✔ Grammar ✔ Composition ✔ Comprehension (advance)
Goal of Junior Secondary Education: to provide the child with diverse basic knowledge and skill for entrepreneurship and educational advancement		

Source: Authors' computation from National Scheme of Work (2017) and National Policy on Education (2013)

While several assessments and surveys have also pointed to the chronic crisis facing the Nigerian education system (Ogbonna, 2016, Federal Ministry of Education, 2011), our unique contribution is to illustrate the state of degradation using contemporary data that covers current in-school and out-of-school children. This provides an up-to-date picture of the learning profile. Based on the most recent survey for 2015 (refer to figures 2), a majority of the children in school are not acquiring expected mastery at the age-appropriate grade. At Grade 1, only 10% of in-school children can correctly identify letters. At Grade 2, only 11% can read words and only 15% can comprehend simple sentences. While the number improves significantly towards the end of primary education, still 20% of those in Grade 6 are still unable to read words and 30% unable to comprehend simple sentences. The results improve slightly for numeracy, but the central issue of poor learning is still evident. At Grade 1, only 15% can identify numbers and at Grade 2 only 20% can perform single digit addition. At Grade 6, while most students can identify numbers, less than half of children enrolled in schools or age 11-years, are able to solve double-digit math problems. Evidently, in the Nigerian context like most developing countries, schooling is not translating into learning.

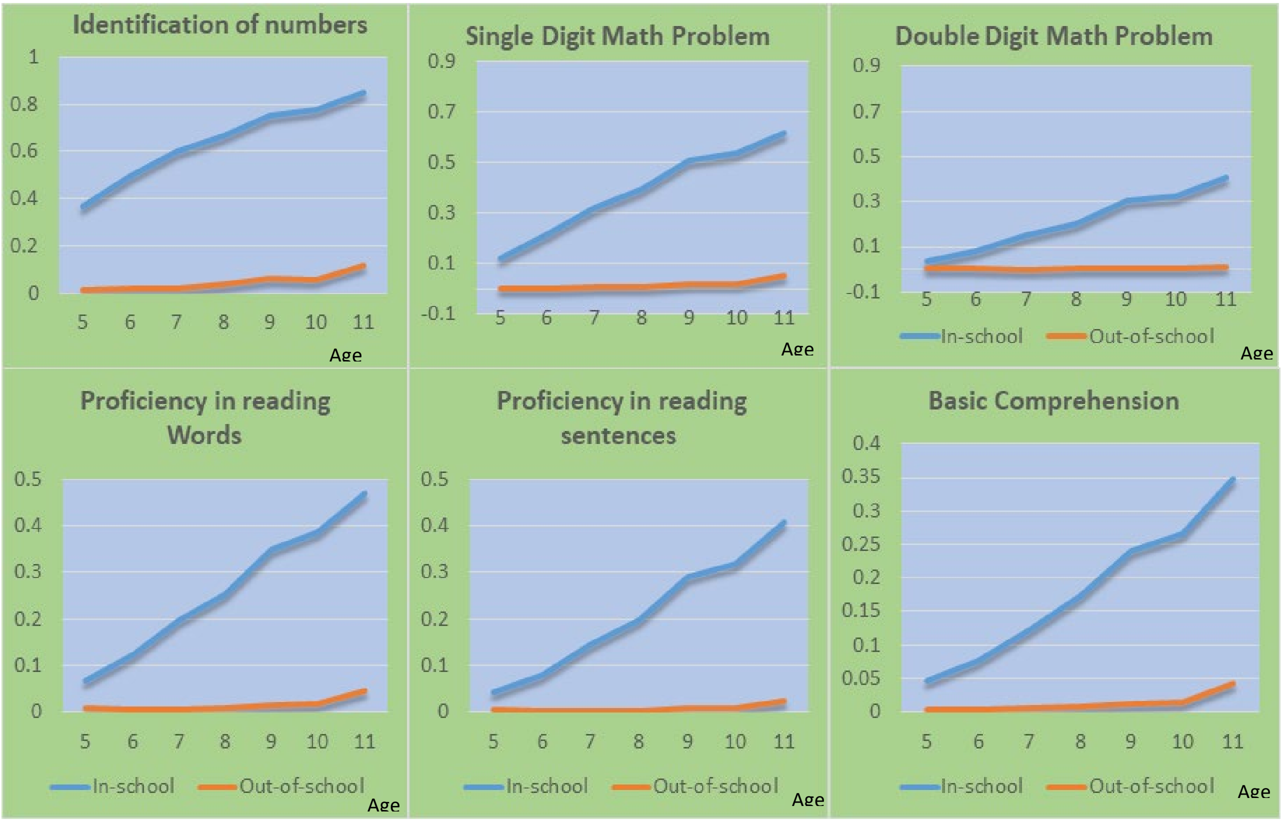
Figure 3a: Competence in numeracy by grade

Figure 3b: Competence in literacy by grade



Source: Author's elaboration of NEDS

Figure 4: Performance in numeracy and literacy assessments by age group



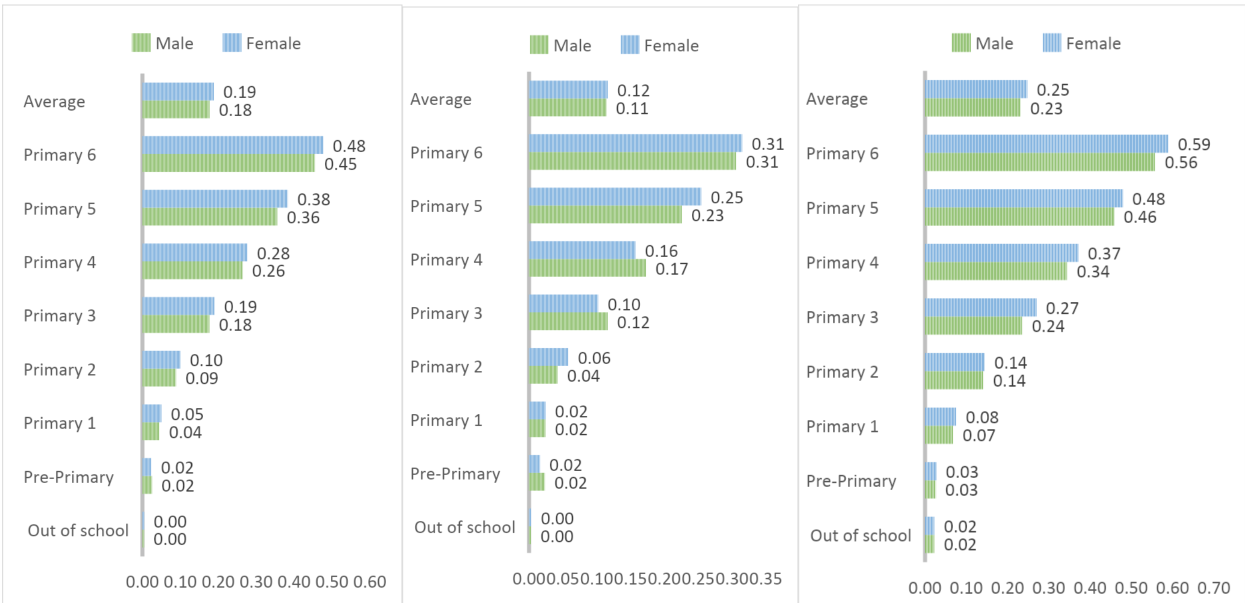
Source: Author's elaboration of NEDS

The above notwithstanding, school continues to offer some value. The value addition from school can be also gleaned from comparing learning for in-school and out-school children. At every age and grade level analyzed, those in school have higher numeracy and literacy on average than those out of school. In fact, the performance gap widens between the two groups at higher grade and age levels. This underscores the fact that despite the poor learning outcome in the schools, putting children in school is still better than excluding them from school. However, it will be more socially and economically optimal if schooling indeed translates into learning as this is the goal of every education stakeholder (parents, teachers, school administrators and government). More so, chronic and accumulated learning deficits have implications for human capital development and notably long-term economic growth prospects. For instance, according to the World Bank Human Capital Index for 2020, on the average, children born in Nigeria complete 10.2 years of schooling by age 18, but the learning that would have occurred at that age is equivalent to half the years of schooling attained.

A disaggregation of the key results further elicited important dimensions of educational exclusion in Nigeria. We found no gender differences in the performance of in-school children. Using the composite index, the pass rate for females is 19% compared to 18% for males (Figure 2a). Even when the result is disaggregated by region, especially in Northern Nigeria where gender differences in performance are expected to be high, the pass for females is 12% compared to 11% for male (Figure 2b). This result is consistent with other learning profiles in Nigeria that are based on in-school children (see Federal Ministry of Education, 2011, Universal Basic Education, 2017). However, learning profiles constructed from adult retrospective learning profiles like Demographic Health Survey show a significant gender difference in education.

Figure 4: Gender differences in performance

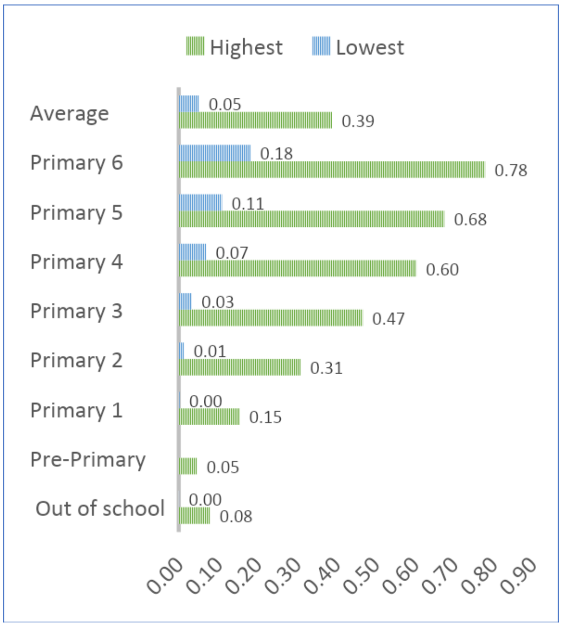
(a) National **(b) North region** **(c) South region**

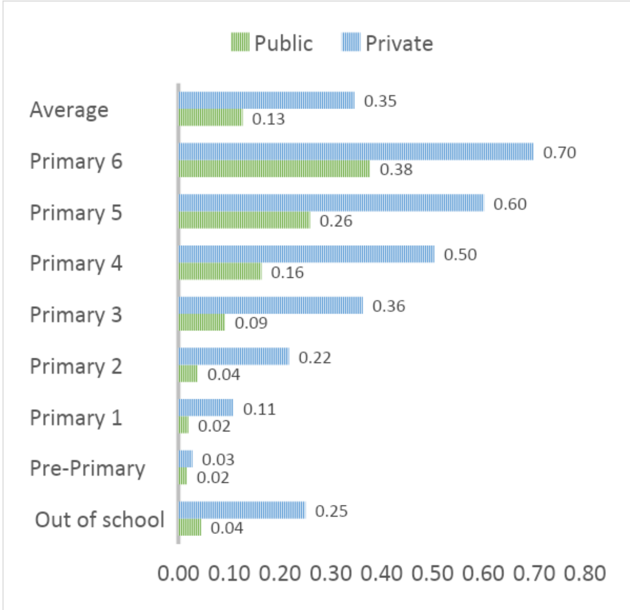


We found significant disparity in performance across locations and school-typesk (Figure 5), with the average pass rate greater in urban (25%) than rural (12%) areas, southern region (24%) than the northern region (12%) and in private schools (35%) than public schools (13%). For example, improving performance in government schools to the level in private schools will raise pass rates by 22% and by as much as 12% if south-north differences in performance is eliminated. Inequalities in learning also mirror wealth inequalities due to a larger share of children in public schools from the lower wealth quintiles. It is also notable that the northern region also accounts for the vast population of out-school children in Nigeria (Antoninis, 2014); hence the region faces twin deficits in quality and quantity of education.

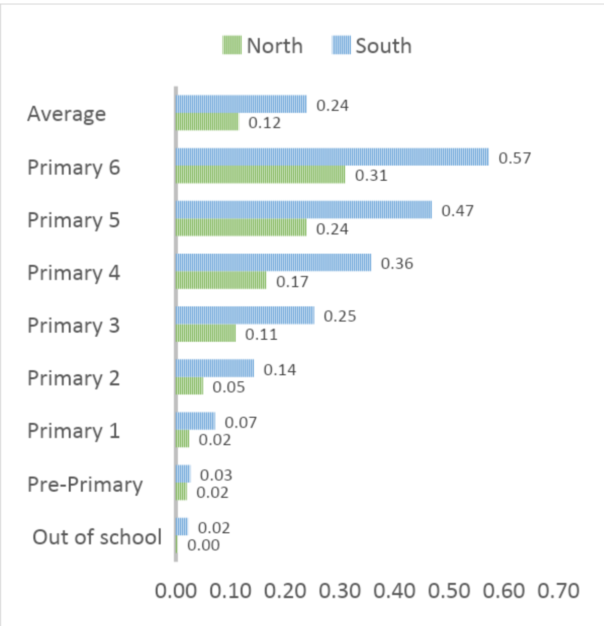
Figure 5: Decomposition of performance along different dimensions

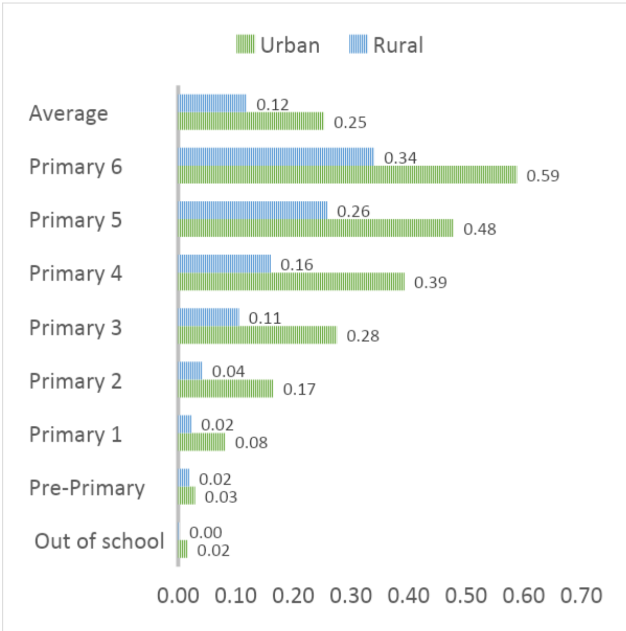
(a) Wealth: Top versus bottom wealth quintiles (b) School Type: Private vs Public school





(c) Region: North vs South (d) Location: Rural vs Urban





Another revealing insight and more fundamental issue that the analysis illustrates is the challenge around curriculum mismatch in Nigeria. If the majority of the children are not learning at the age-appropriate level, then what happens at higher-grade level when faced with a more difficult curriculum? The school system has an age-grade structure implying for instance that most Grade 2 students are expected to be 7 years and once they complete the current grade, they progress to the next. The school system takes getting older and exposure to a curriculum as learning and therefore moves them up to a higher curriculum. This approach to the school system has been shown to amplify the potential learning loss as foundational skills for higher education is absent (Pritchett & Beatty, 2012).

While the NEDS dataset is not set out to measure curriculum mismatch, evidence for mismatch can be gleaned from the survey. First, on the various assessment questions/instruments, there is none in which 100 percent proficiency is attained at any grade level, indicating some pupils are left behind as the curriculum moves ahead. It is worth noting that for some of the children left behind; they simply drop out of school. The data indicates that "poor school quality" is cited as the third highest factor for dropping out of school. Secondly, as assessment instruments move from testing simple to harder concepts, performance level dropped significantly across grade levels. While more than 80% of Grade 6 children can identify numbers, less than 50% can solve double digit addition or subtraction, which they ought to have mastered at Grade 2. A plausible explanation for the trend is that with the foundational skills needed for higher grades absent, the age-appropriate performance level plummeted.

The next central question that this study therefore sets out to address is the link between the learning crisis in Nigeria and curriculum misalignment. We demonstrate this by showing that the trajectory of learning profiles in Nigeria match the learning gap generated from a curriculum misalignment model calibrated using the NEDS dataset. We thereafter examine the potentials of key education innovations and reform processes. For instance, governments at various levels have been recruiting more teachers to reduce class size and ensure more student-teacher interaction. In a system dealing with curriculum misalignment issues, it will be crucial to understand how effective such interventions will be. Another reform is the introduction of teaching at the right level approach into the Nigerian school system. Five states (Borno, Adamawa, Yobe, Kano and Kebbi) are currently piloting this approach in their school systems. Again, the model we develop will shed some light on how much improvement this can possibly deliver against the curriculum alignment issue is worth investigating. It is important to point out that our analysis using the PPF is at best a forecast of possible pathways for reform.

4. Learning as a systematic process: The PPF Framework

In understanding the effectiveness of schooling or outcomes that influence quality education, it is relevant to view learning as an interconnected process. The concept of using learning profiles to monitor and evaluate the quality of education is important in the sense that learning profiles reveal the correlation between learning achievement and other interconnected issues. This means that learning trajectories can be used to simulate possible gains from a variety of policy options or reforms. Disaggregated learning profiles also allow for analysis and comparison of learning across student groups such as by gender or by wealth, to reveal excluded groups or those left behind.

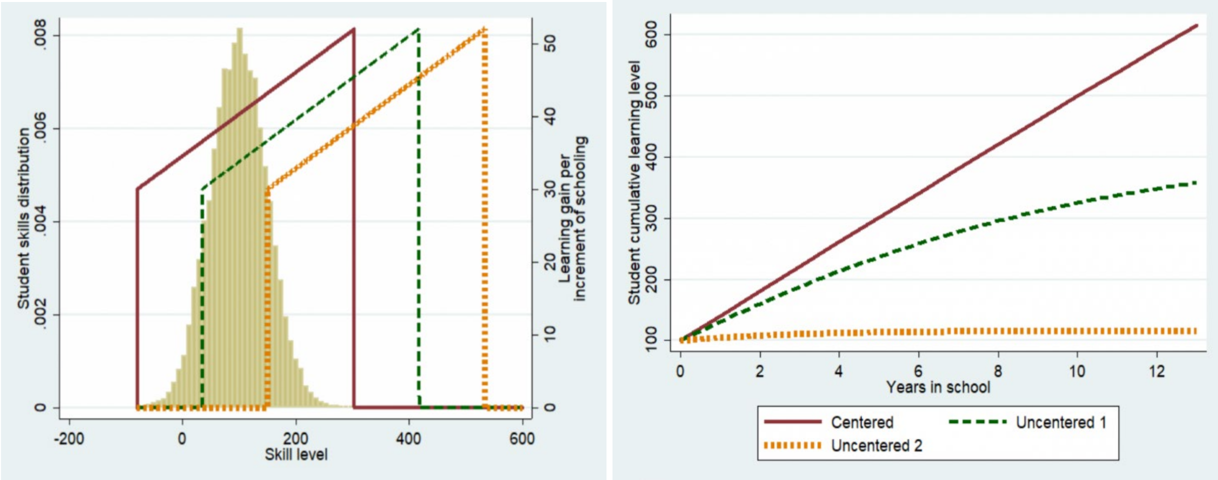
Kaffenberger & Pritchett (2020) propose a novel approach-the PPF, which is rooted in the concept of learning profiles. The PPF models the learning process; taking into consideration specific contexts and factors that influence the learning process, including portraying the reality that learning experiences often differ across student distributions. It simulates the average amount of learning that occurs for a child in a cohort at each point during an increment of schooling. To achieve this, the PPF begins at the initial skill distribution of students in a cohort and incorporates the prospects of students' abilities to gain or lose from the same curriculum or teaching, depending on their pre-existing skill level. The underlying assumption is that the more curriculum is centered on students' skill levels the higher the students benefit from the instructional process and instruction. However, with the skill distribution not uniform, what students gain from instruction will vary. By implication, these variances could result in different learning experiences/gains for students in the same class over the course of schooling. With the PPF, we can pinpoint which elements of the teaching process can explain or alter the learning profile, which will further guide simulations of the effects of difference changes to the instructional process. This involves adapting the model to fit different scenarios. Examples include simulations to determine whether students' competence levels and pace of instruction are aligned, or the potential effects\ of varying the skill level on which classroom instruction is centred.

To illustrate how the PPF works, we explore the graphical illustration in Kaffenberger & Pritchett (2020, see Figures 6 and 7) which captures the core properties/features of the PPF. The height of the PPF refers to the learning peak from additional schooling, the width indicates the level of student abilities at each grade, and the range of the PPF is the extent of student abilities that benefit from the instructional process. These elements are generally influenced by the minimum skill level at which teaching is centred around and how much students at various points in the distribution learn. The ultimate objective is to have as much intersection as possible between these elements, so that more learning can take place.

For instance, the width of the PPF graphs in Figure 6 indicate the variance in skill levels of pupils in the same grade. These variances can be due to diverse/heterogeneous backgrounds.

Figure 6: PPF and corresponding learning profile indicating if instruction and average skill level in a classroom are aligned.

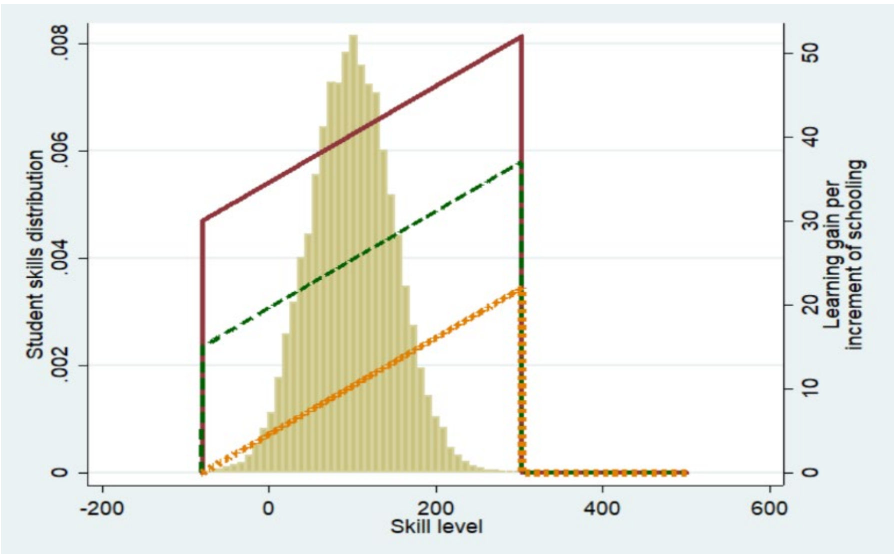
PPF *Learning Profile*



Source: (Kaffenberger & Pritchett, 2020)

From the above, where skill levels and instruction are less aligned, a greater number of students will not understand instructions delivered and hardly learn, meaning that they will be left behind and no longer covered by the PPF range, thereby causing a rightward shift as shown in the green and yellow graphs. This may occur if current competence level is way below class average. The more diverse the skill level is per grade level or class, there is a greater tendency that more children will fall outside the range of the PPF. Therefore, if teaching is targeted or centred in a manner that is well-matched with students' skill levels in a class, this could potentially mean more cohort learning (red graph).

Figure 7: PPF showing variations in incremental learning per school year



Source: Kaffenberger, M., & Pritchett (2020)

Figure 7 illustrates different possible points of additional skills that can be acquired by a cohort during a school year. The height of the PPF or learning gains can move up from yellow to green, and further to red, if all other parameters remain constant, and more effective teaching/instruction is introduced (an example is through boosting teachers' capacities so that instruction time becomes more effective and translates into greater learning for students).

Although research findings vary on the degree of impacts that aspects of schooling processes such as class-size, teacher experience, curricula and instruction time have on students' learning achievements, there is growing empirical evidence to suggest that certain inputs can significantly improve learning rate. One of such changes to the pedagogical process that would be investigated further in this paper involves adapting the curriculum to suit pupils' abilities, dedicating time to basic skills rather than concentrating solely on the curriculum; and focusing on students' learning at each grade rather than pass rates. Often, existing curricula require teachers to base instruction on top performers as opposed to the actual distribution of student skills. When this happens, low performers are unable to keep up with the curriculum pace and start falling behind. Learning outcomes are driven by the initial distribution of student skills, and an instructional process that imparts some level of learning for a child at each point in that distribution.

Another input that would be explored in this study is the impact of additional instruction time and quality on learning outcomes. Several studies which compared differences in students' education performance also suggest that increased instruction quantity and quality have a positive influence on learning proficiency (Andersen, et al., 2016; Evans & Popova, 2016; Woessmann, 2016; Rivkin & Schiman, 2015; Joo, et al., 2010), although the magnitude of learning gains would vary depending on setting or context. For example, Andersen, et al. (2016) conducted randomized controlled trials in Danish primary schools to determine how different educational resources such as instruction time can improve student learning. The groups that received additional instruction time in school posted better scores in the national reading tests, implying that adjusting the length of teaching and ensuring that instruction is delivered effectively, can be valuable for enhanced learning.

5. Modelling, calibration and simulation of learning profiles using the PPF

5.1 PPF parameters and modelling scenario

In determining what the PPF would look like, we consider the test scores computed from NEDS which range from 0 to 13, and conclude that no learning takes place for students with the maximum score since students cannot score above 13. Therefore, the PPF must take a value of 0 for pupils with scores above 13. Further, we find a group of students that never improve through the years (see Table 1A in the annex). The PPF also takes a value of 0 for pupils at the bottom of the incoming skill distribution. The skill distribution is based on the distribution of test scores for students in the incoming cohort. Based on this analysis, we conclude that the PPF has an inverse U-shape with peak learning somewhere between 0 and 13 in the incoming skill distribution, and learning drops off away from the peak. We call the location of this peak the centre of the PPF, c^p. Formally, we model learning (L) for pupil, i, in grade, p, as:

$$L\left(s_i, h^{(max,p)}, c^p, r^p\right) = \begin{cases} h^{(max,p)} - \left[r^p * |c - s_i| * h^{(max,p)}\right] & if \quad 0 \leq s_i \leq 13 \\ 0 & if \quad s_i > 13 \end{cases}$$

s_i - represents the skill of the incoming students

$h^{(max,p)}$ - is the maximum amount of learning that can take place at grade level p

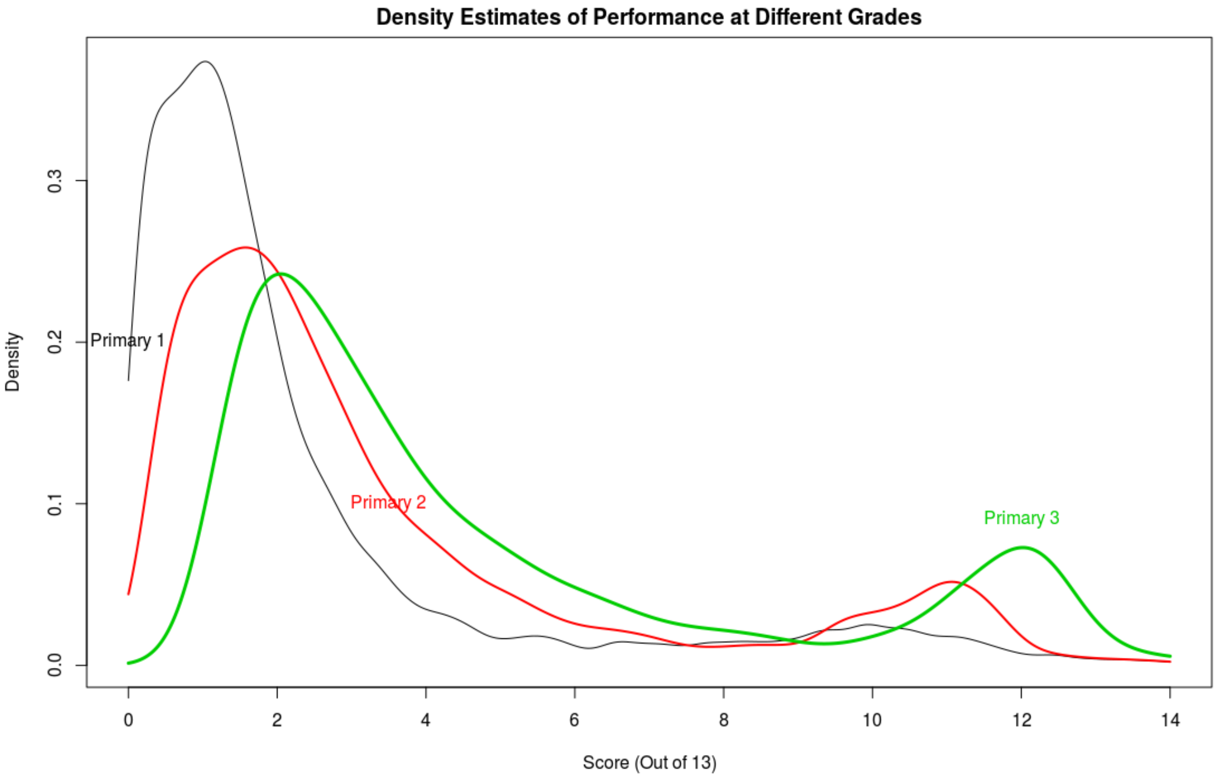
c^p - denotes the skill level that gains the most amount of learning

r^p – is the parameter that tells us how quickly learning drops off from the peak and it represents the range of the PPF.

Hence, this is a PPF where learning is not uniform but rather, dependent on students' preparedness such that teaching better could mean different things. The PPF will help us understand the implications of a variety of adjustments such as increasing *h*, that is teaching more, increasing *r*, that is decreasing the rate at which learning drops off from the centre and hence teaching to a broader set of students, or changing the target of instruction, that is changing *c*. The skill level is taken directly from the skill distribution of incoming students. Maximum learning and the slope of the PPF at each grade, $h^{(max,p)}$ and r^p, are jointly calibrated to match the mean and standard deviation of learning after each grade. The centre of learning, c^p, is calibrated at Primary 1 so that the pass rate after this grade matches that in the data. Thereafter, c^p, is calibrated to shift at the same rate as mean learning. That is, the target of the curriculum changes with the average change in test scores, and the change in the centre of learning can be interpreted as the pace of the curriculum. Note that, if the centre is lower than the calibrated level, then pass rates might be too high relative to the data as more students learn through the school cycle. Similarly, if the centre is too high, then the pass rate will be low relative to the data. The pass rate at the end of the primary school cycle guides the calibration exercise. We verify that the calibration works by examining pass rate after Primary 6, that is the end of the primary school cycle, and are able to match the pass rate in the data.

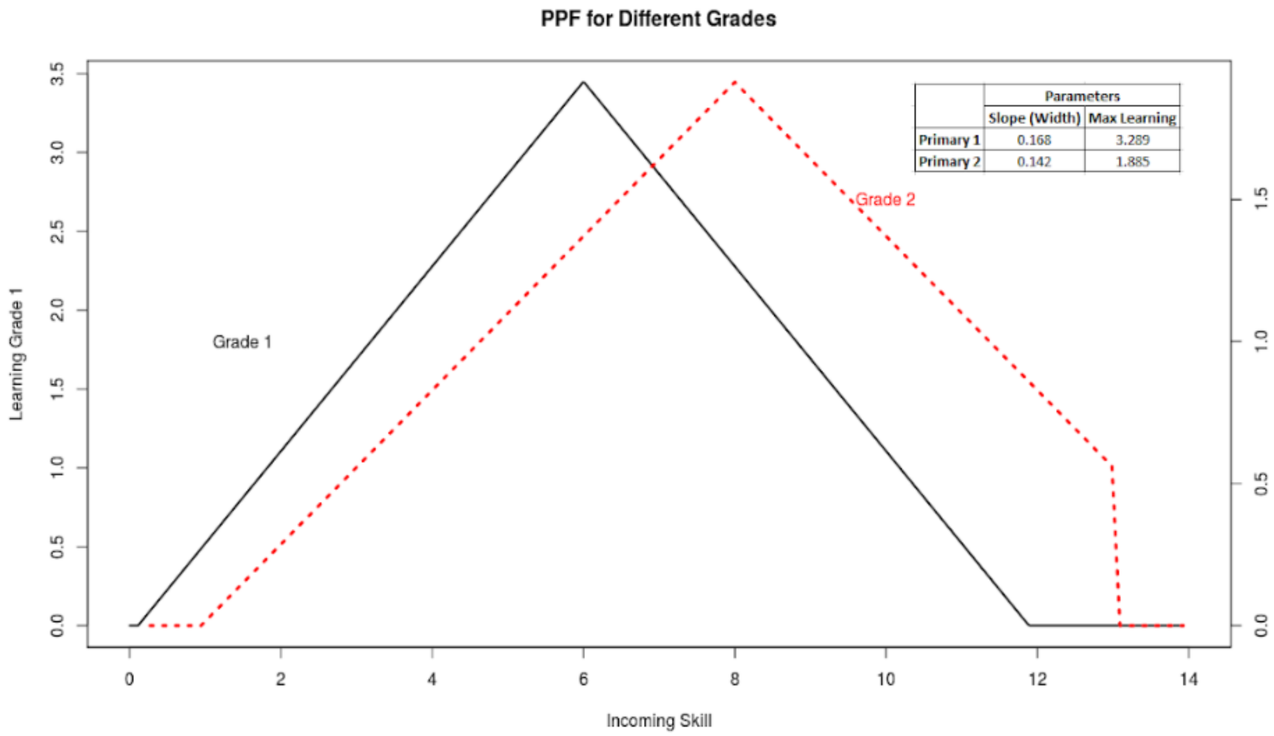
Based on these initial parameters, we illustrate the learning crisis in Nigeria as an instance of curriculum mismatch by fitting the PPF model with the learning profile from NEDS (2015). The skill distribution function for grade *p* is assumed to be the skill distribution for those who are currently in grade *p*. Density estimates of performance at different grades, as shown in Figure 8 indicates a right-skewed distribution, peaking at between a score of 1 and 2. This implies that the majority of the children reached their peak performance at mean score below 3, correctly answering 3 out of the 13 questions. The performance at lowest entry level, Grade 1, is set as the baseline skill distribution.

Figure 8: Skill Distribution Function



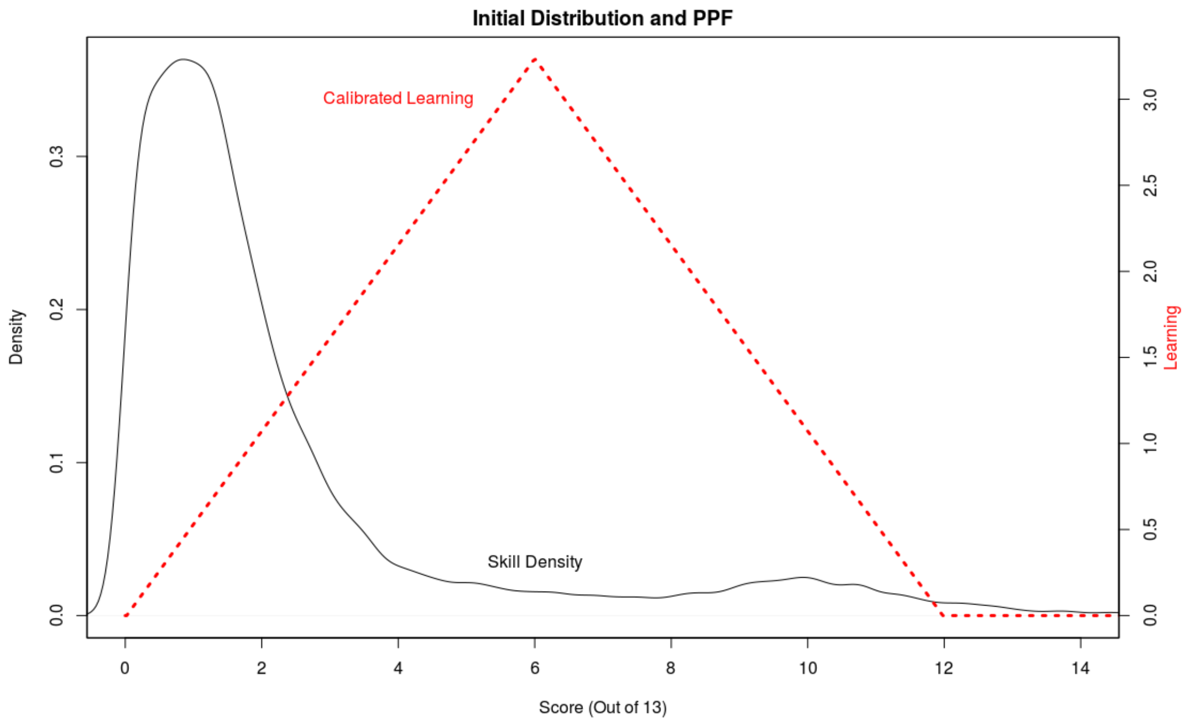
The other side of learning modelling is the PPF and this is similarly illustrated in Figure 9 for Grades 1 and 2 based on the parameters in the embedded table. The PPFs have an inverted U shape, with learning dropping off as we move away from the centre of the distribution from the maximum learning. The maximum learning in both cases is below the set pass mark of 11.

Figure 9: Performance for different grades



In Figure 10, we match the skill density function and PPF together to demonstrate the learning mismatch in the Nigerian school system. The position of the PPF which illustrates the state of instruction is farther to the right than that of the skill distribution and the two-curves intersect only marginally for those at the left tail of the skill distribution (low performers). The fact that the two distributions slightly overlapped reflects a huge mismatch such that majority of the students are not learning at the age-appropriate level.

Figure 10: An illustration of Curriculum Misalignment



5.2 Simulating Policy Changes

Based on the characterization of the PPF and skill distribution in Nigeria, there are several policy interventions that can be simulated and examined. The key is to identify the specific parameter of the PPF that will be influenced by the policy shocks. We explore four policy interventions and evaluate their impact on mean test score and pass rate. The interventions evaluated and the rationale for our choices are discussed below:

i. Expanding school access: This assesses the quality and quantity nexus in education planning. It reflects the education landscape pre-SDG in which emphasis is placed on school access rather than quality. In the Nigerian context, a wide range of educational reform initiatives have been introduced over the past years, which have improved access to education. According to the United Nations International Children's Emergency Fund (UNICEF 2018), net enrollment rate for primary school aged children stood at 67% in 2018; this is up from 62% in 1999. Simulating how learning outcomes change when access improves will indicate the interlinkages between access and quality of education and the need to address both simultaneously. This is very pertinent for Nigeria with the highest number of out-of-school children globally at over 10 million schoolchildren. This makes expanding school access an important policy priority, but at the same time, how this affects learning outcomes must be considered.

ii. Targeted teaching across children's skill level: As already established, there is a wide disparity in skill level of children for a given grade. Given this, teaching tends to be focused on high performing children. We simulate an alternative teaching approach that targets both low and high performing children. This is equivalent to increasing the range of the PPF.

iii. Teaching more to more pupils: This relates to increasing the quantity of instruction time provided to children. This can be achieved either through increasing time, frequency of lesson periods or augmented learning using technology to expand learning period and interactions between teachers and students.

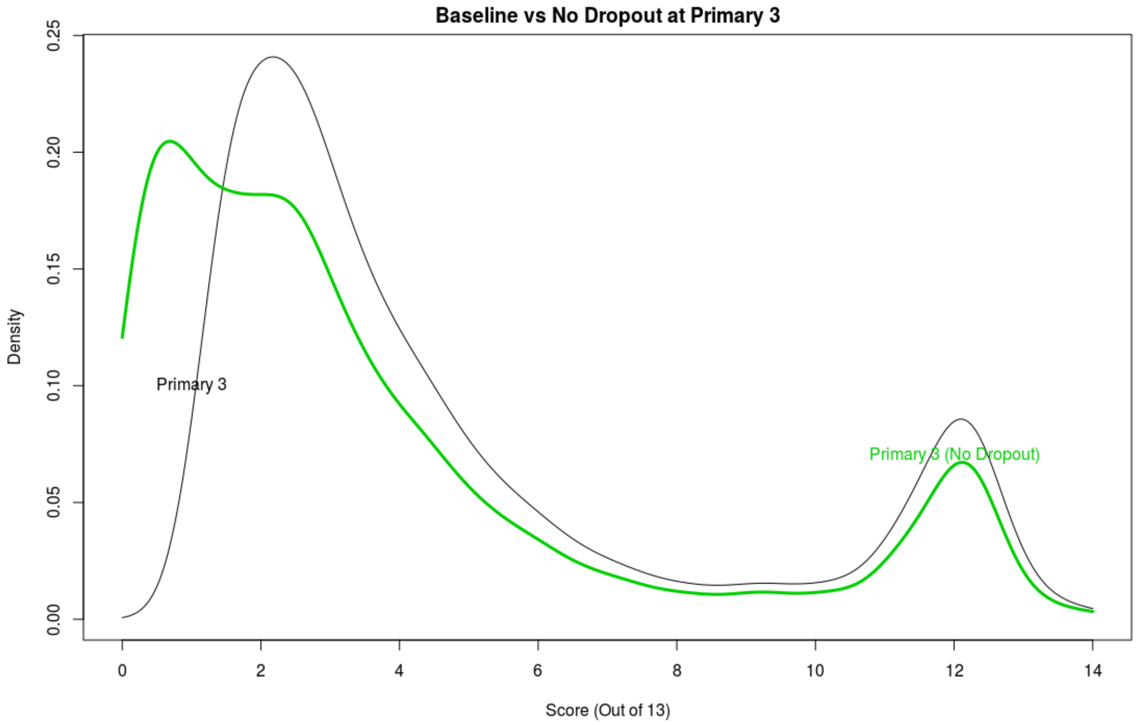
iv. Slowing down the pace of curriculum: If curriculum is far ahead of children's skill level, slowing down the curriculum pace is another policy option. This required that instead of using an age-grade structure in teaching, the school system is structured to specific skill levels. The skill level targeted could vary—class mean or lowest performer. One of the recent education reforms that embodies this principle is Teaching at the Right Level (Banerjee, et al., 2016). TaRL entails carrying out an assessment aimed at determining pupils' current learning levels, and matching instruction to learning styles based on similar skill levels. Students are grouped into classes according to their learning levels as opposed to their age or grade. Instead of following a rigid curriculum, this approach requires teachers to focus on meeting students' learning needs by teaching at their current competencies for arithmetic, reading, writing, and comprehension. TaRL has been introduced to a few schools in Nigeria through a pilot scheme comprising selected schools in Borno State (UNICEF, 2019). The intention is to improve the general education outcomes for children in the worst performing states. Considering that the strategy is relatively new to the country, adoption is still low. The simulation exercise explores, at a general level, the possible impact of slowing down the pace of the curriculum.

6. Results

6.1 Effect of expanding school access

Figure 11 shows that expanding access and including dropouts cannot improve learning. Specifically, absorbing the cohort dropping out of school back into the system reduces the mean scores by 1.09 and overall pass rate by 3 percentage points from the baseline. The impact is trivial because pupils at the bottom of the distribution do not necessarily learn more. In essence, expanding school access needs to be complemented with measures to improve quality in order to avoid quality-quantity trade-off.

Figure 11: Performance when there are no dropouts

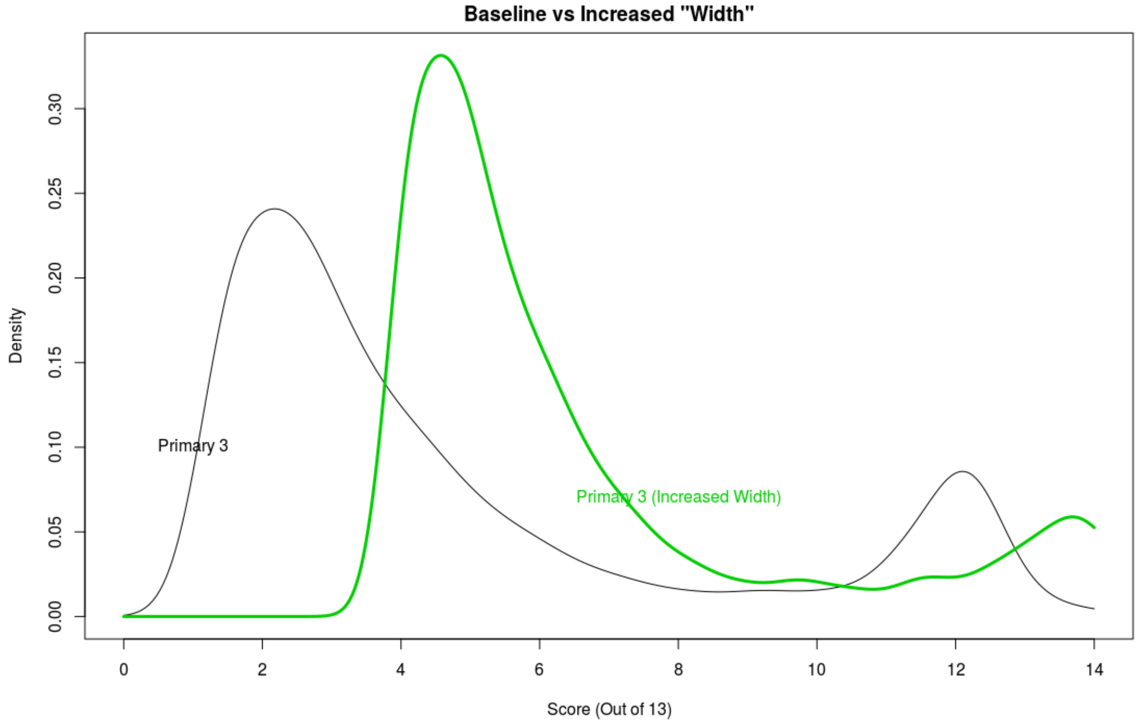


Simulations	Mean Score	S. D.	Pass Rate after Primary 2
Baseline	**4.79**	**3. 60**	**0.13**
Full (No Dropouts)	3.70	3. 62	0.10

6.2 Targeted teaching cross children's skill level

Increasing the range (width) of the PPF has a different outcome. Figure 12 shows that when teaching is delivered to students with broader skills coming in, it can improve mean test scores. However, this only has a marginal impact on pass rates because increasing the width primarily affects the mass at the bottom of the distribution. They improve but not enough to pass at great numbers. Teaching to a broader set of students will improve pass rates after Primary 6 as students are able to keep up throughout the cycle, hence better than baseline.

Figure 12: Performance change from increased width (range of PPF)

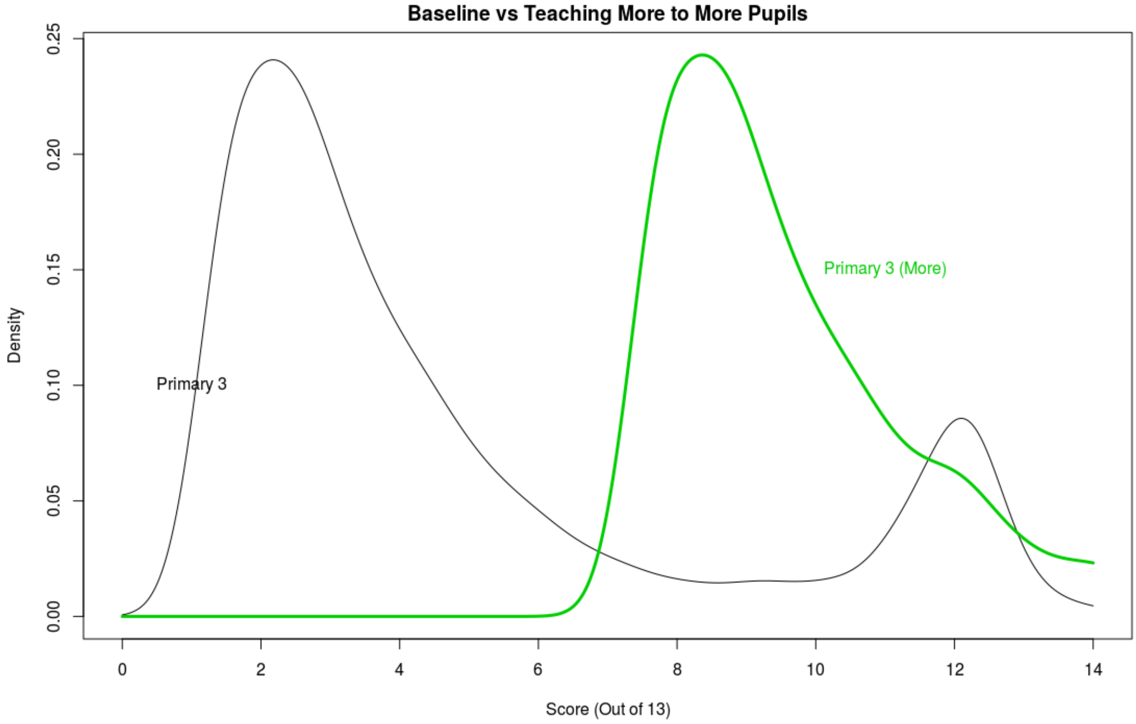


Simulations	Mean Score	S.D.	Pass Rate after Primary 2
Baseline	**4.79**	**3.60**	**0.13**
Full (No Dropouts)	6.71	3.13	0.15

<u>*6.3 Teaching more to more pupils*</u>

The allocation of more teaching resources to pupils is similar to the impact above, except that the pass rate is clearly much higher as shown in Figure 13. The mean score increased the highest under the scenario. Obviously, this is easier said than done as it is difficult to improve teaching this much. A practical challenge of translating more teaching into significant learning gains is the uncertainty of the response from both students and teachers (Andersen, et al., 2016). For additional instruction to yield results, students' ability to develop a longer attention span, teachers' effective use of additional time, combined with other factors, need to be taken into consideration.

Figure 13: Baseline Result vs Additional Teaching

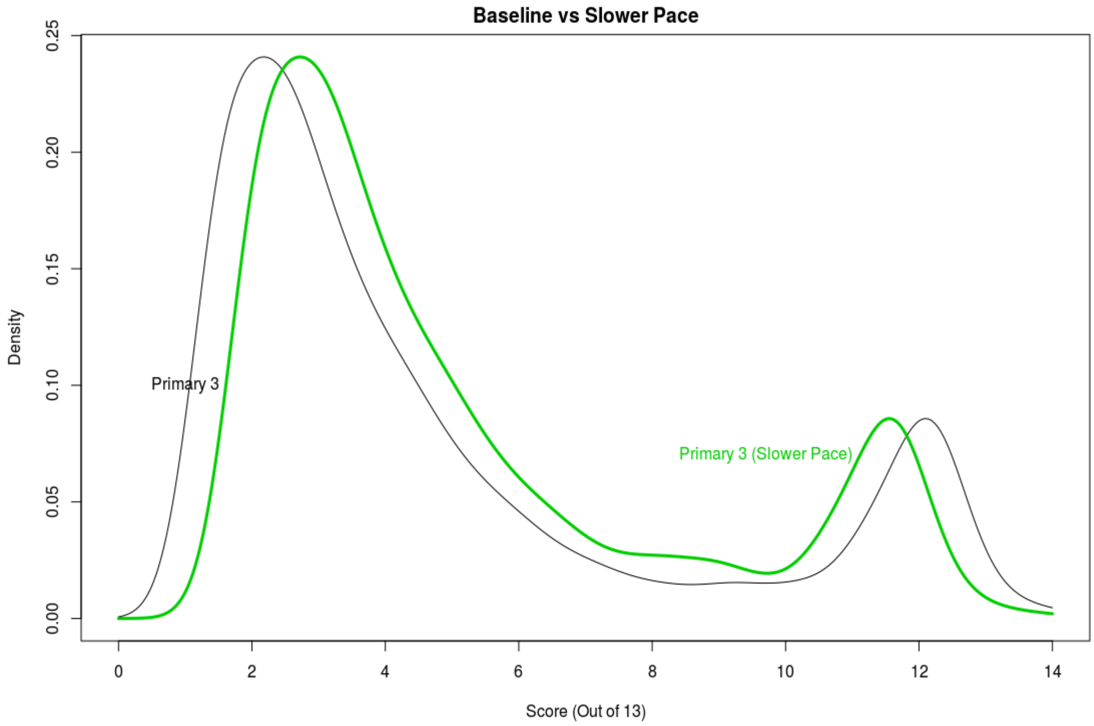


Simulations	Mean Score	S.D.	Pass Rate after Primary 2
Baseline	**4.79**	**3.60**	**0.13**
Full (No Dropouts)	10.63 ↑	2.98	0.32 ↑

<u>*6.4 Slowing down the pace of curriculum*</u>

Figure 14 shows the effect of slowing down the pace of the curriculum and targeting learning at 2 points below the baseline. We see a slight improvement in mean scores and a decrease in pass rates. Once again, this is because the slower pace benefits students at the bottom of the distribution who do not learn enough at that grade to pass.

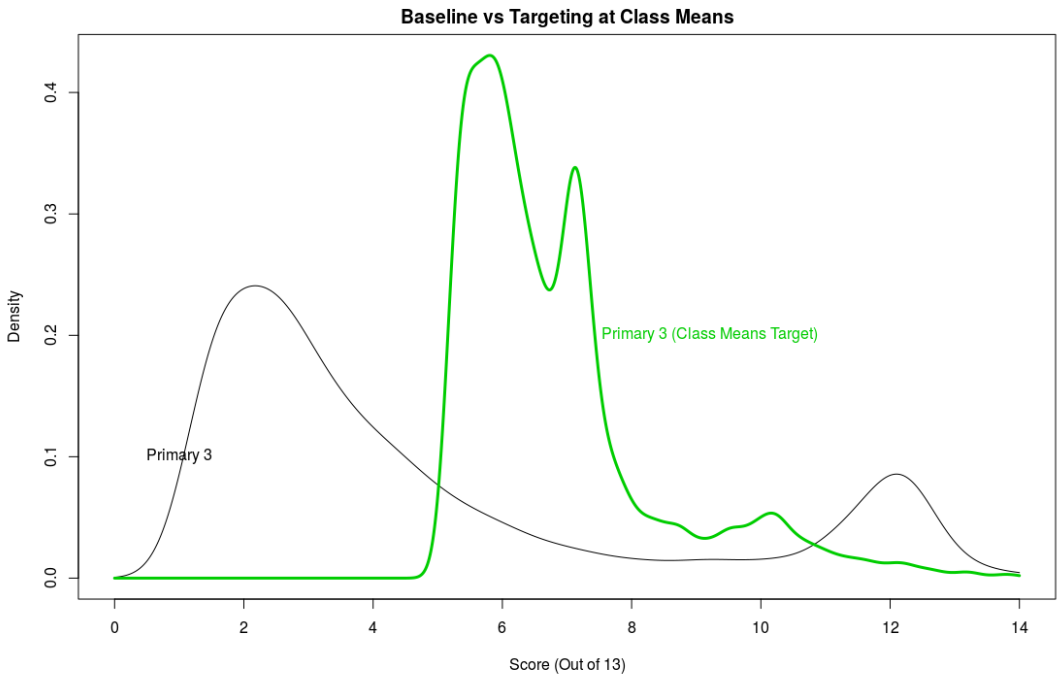
Figure 14: Baseline Result vs Slower Pace



Simulations	Mean Score	S.D.	Pass Rate after Primary 2
Baseline	**4.79**	**3.60**	**0.13**
Full (No Dropouts)	5.13 ↑	3.23	0.12 ↓

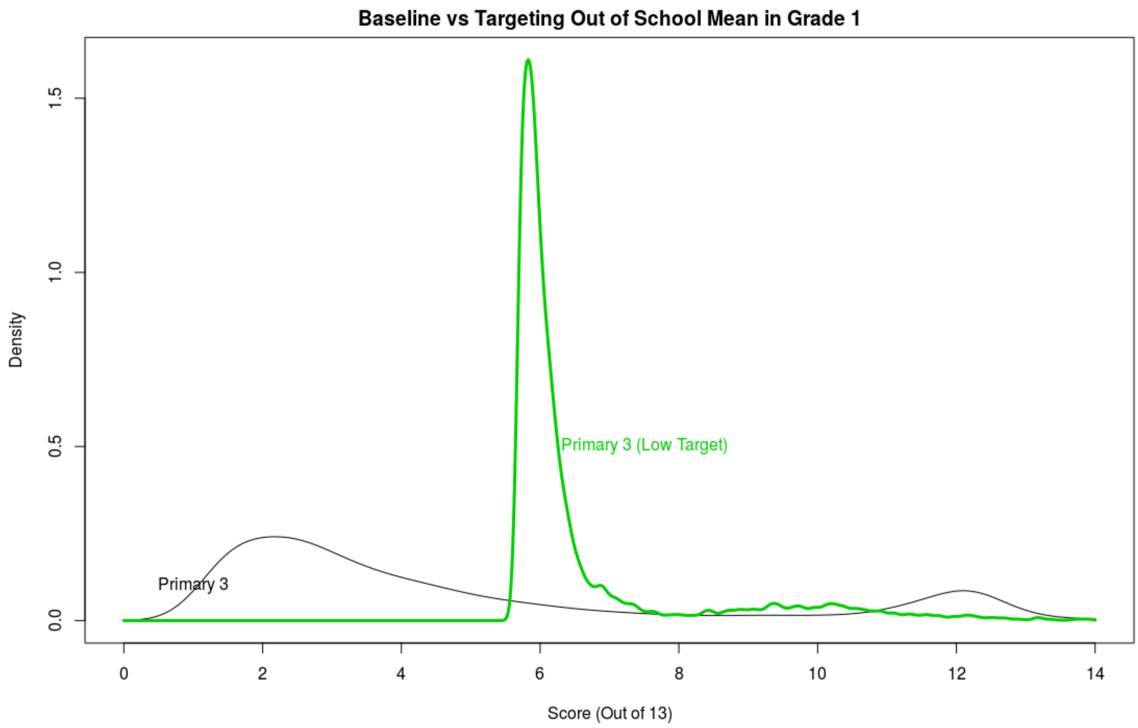
Figures 15 and 16 allow for even slower curriculum, targeting the incoming class mean and the mean of out-of-school children. Both have the effect of increasing mean scores but reducing pass rates drastically as only children at the lower end of the skill distribution benefit; depicted by the shift in density of scores. While this initially looks like a failure (Figure 16 and the first Table below), it becomes clearer when slowing down beats the baseline over the primary school cycle because it lets students follow the material, and guarantees that all student passes the exam at Primary 6 (Figure 16 and the second Table below). The density of scores shifted right with peak score increasing from 2 to 6, implying most children initially left behind are experiencing improved academic performance over the school cycle.

Figure 15: Baseline Result vs Targeting Class Mean



Simulations	Mean Score	S.D.	Pass Rate after Primary 2
Baseline	**4.79**	**3.60**	**0.13**
Full (No Dropouts)	6.86	1.58	0.03

Figure 16: Baseline Result vs Targeting Out of School Mean



Simulations	Mean Score	S.D.	Pass Rate after Primary 2
Baseline	**4.79**	**3.60**	**0.13**
Full (No Dropouts)	6.60	1.58	0.03

Simulations	Mean Score	S.D.	Pass Rate after Primary 6
Baseline	**4.79**	**3.60**	**0.13**
Full (No Dropouts)	13.19	1.58	1.00

Based on the simulations, the PPF analysis yields valuable insights. Teaching and curriculum strategies adopted in the country are apparently not very effective. The current learning deficit is primarily driven by the fact that most students are left behind by the curriculum. Therefore, there is a need for significant changes in the learning process. One simple change to improve learning in this context would be to reduce the pace and target the curriculum at a lower level. While it might mean that most students will not be able to grasp the current tests, it means that all students will eventually be able to pass at the end of the primary school cycle.

7. Implication of findings and policy recommendations

The study shows that the learning crisis in Nigeria is majorly attributable to curriculum pace. We reach this conclusion based on the simulations conducted, as overall performance rate increased by 52% compared to the baseline, when learning is centred on the skill level of the most disadvantaged students. Essentially, learning profiles that were more centred on student abilities produced more learning, as opposed to less centred profiles which forced a greater proportion of students out of the range covered by the PPF. This implies that the conventional school structure that centres curriculum on age/grade based on the assumption that skill dispersion is small among children of similar ages/grade levels does not hold in this context.

One approach to set the education system on the right track would be to conduct an assessment of the skill distribution among students and tailor the curriculum to their base skill and ability. The TARL system is one method of school organization that incorporates the idea of centred learning. It can be used to address the potential drop in pass rates with a curriculum slow down, so that all students can benefit, instead of initially lower ranked students benefiting at the expense of initially higher ranked students.

Another effective way to improve learning profiles based on our analysis is through increasing teaching time per pupil. In our simulation, this has the potential to improve pass rates. This can be achieved either through expanding the number of teachers in the classroom, or blended learning in which technology supports independent learning with some guidance from teachers.

In essence, the study situates the locus of reform of the education system in Nigeria at making the curriculum less ambitious and supports improving the quality and quantity of teaching.

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Performance Distribution at Different Grade Level

Score	Primary 1	Primary 2	Primary 3	Primary 6	All in-school children	Out-of-school children
0	35.87	21.35	11.62	4.09	19.73	84.35
1	14.64	11.73	8.74	2.23	10.23	5.45
2	13.11	13.71	10.04	4.75	11.26	2.94
3	9.38	11.39	11.18	5.6	9.7	1.52
4	7.04	9.19	10.12	4.39	8.42	1.09
5	7.07	9.66	11.65	9.15	9.23	0.95
6	4.92	9.28	12.23	12.27	9.55	0.88
7	1.96	3.22	4.52	6.8	3.79	0.35
8	1.09	1.69	2.75	3.85	2.23	0.26
9	1.07	1.31	2.53	4.03	2.08	0.27
10	1.08	1.81	3.04	5.72	2.76	0.33
11	1.11	2.09	4.18	9.75	3.43	0.38
12	1.08	2.15	4.86	16.43	4.76	0.67
13	0.57	1.41	2.56	10.95	2.84	0.57
Mean	2.37	3.47	4.79	7.84	4.21	0.60
Standard deviation	2.83	3.23	3.60	3.92	3.78	1.99