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Unpacking Factors Influencing School Performance

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Executive summary

Executive summary

Education and its contribution to human and social development are at the centre of the Republic of Zambia's vision of becoming a prosperous middle-income nation by 2030. The Government aims to provide quality and relevant lifelong education and skills training for all children. Recognizing that children's learning outcomes generally remain low, in its recent 2017–2021 Education and Skills Sector Plan (ESSP) the Government prioritized raising learning outcomes through strategies that addressed gaps in education system quality, access, equity and efficiency.

Zambia's Ministry of Education recognizes the importance of ensuring that education policy is informed by rigorous evidence, and has collaborated with the United Nation's Children's Fund (UNICEF) since 2015 to strengthen evidence-based decision-making by improving the quality and use of existing education data. This collaboration, named Data Must Speak (DMS), expanded in 2021 to include innovative positive deviance research which aims to identify and ultimately scale local solutions that are already making a difference in improving learning in Zambian schools. The first step of this multi-stage research is to analyse existing national education data to understand which school context and resource factors influence school performance in Zambia. This report summarizes the results of this secondary analysis, which leveraged six recent years (2015–2020) of data from the country's Education Management Information System (EMIS) and grade 7 national examination results.

Stage 1 of the research utilized multivariate regression analysis to model the relationship between various school-level factors influencing grade 7 national performance in Zambian schools. Understanding these relationships can help inform government policies to improve learning.

Key findings include:

Learner characteristics influencing exam performance

Gender is associated with exam performance, although the relationship is mixed and the difference relatively small. Boys perform slightly higher than girls in mathematics and, for several earlier years, in Zambian languages. Girls perform slightly higher than boys in English and have overtaken boys in Zambian languages in recent years.

Although repetition rates in Zambia are generally very low, **having a higher proportion of repeaters in classrooms is associated with lower school exam performance.**

Teacher characteristics influencing exam performance

Professional teaching qualifications are positively associated with student exam performance. With all other things equal,

[1] The minimum qualifications required for becoming a primary school teacher in Zambia are a grade 12 School Leaving Certificate or a General Certificate of Education with five credits or higher, including English, mathematics and a science subject. According to government guidelines, teachers must also have a minimum three-year diploma from an accredited teacher training college. No degree is required for primary teaching, but it is needed for secondary grades. In reality, teachers may not meet these criteria, either because they are older employees (and were first employed when the requirements were different) or because they are hired (particularly on temporary contracts) to address shortages or urgent needs.

students perform better when taught by teachers with at least a teaching diploma as compared to those with only a secondary school leaving certificate.[1] Currently, 50 per cent of primary school teachers have a diploma as their highest qualification, as compared to 38 per cent who have only a certificate. The remaining 12 per cent have a degree or higher.

Greater availability of teacher resource books is marginally associated with improved performance in mathematics exams, but not in English or Zambian languages.

Schools with a higher proportion of temporary or contract teachers have marginally better exam performance. More research is needed to understand whether this association may be the result of different accountability structures that contract teachers face, or other factors. Currently only 6 per cent of Zambian teachers fall within the temporary/contract category; the remaining 94 per cent are permanent teachers.

Student exam performance is associated with teacher gender in different ways. An increase in the proportion of male teachers in a school is positively associated with boys' performance across subjects; for girls, having more female teachers in a school is associated with improved performance in some subjects. While further research is needed to understand why teacher gender interacts with learner outcomes in this way, these trends suggest that gender norms or expectations may be influencing interactions between teachers and learners.

Headteacher characteristics influencing exam performance

Schools with female headteachers outperform schools with male headteachers in all subjects. Though the performance difference is marginal in size, this relationship is in line with a growing body of research from other countries. Further research to understand what these female leaders are doing differently could potentially identify positive behaviours and practices for improving learning.

School characteristics influencing exam performance

Learner contact hours are positively associated with exam performance, highlighting the importance of instructional time for learners.

Class size and pupil-teacher ratio are both negatively, albeit marginally, associated with school performance, meaning schools with bigger classes or more students per teacher perform lower in exams.

Infrastructure and resources related to the teaching and learning environment are positively associated with exam performance. Schools with libraries, sufficient learner textbooks and sufficient seats for students perform better across all subjects.

Sanitation facilities (toilets) and the presence of menstrual hygiene products are positively associated with exam performance.

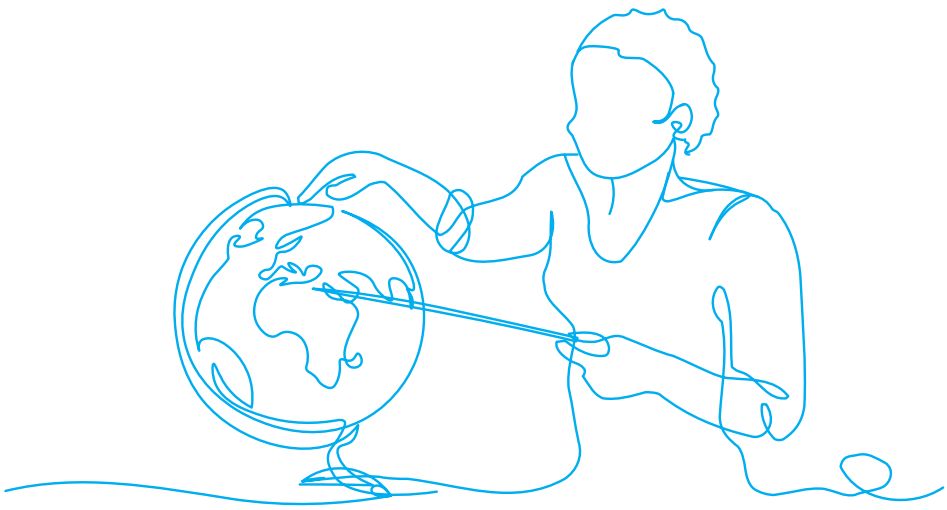
Other characteristics influencing exam performance

Urban schools outperform their rural counterparts. Persisting gaps in performance based on location underscore the importance of continuing to embed equity-focused policies and programmes in education planning.

Private schools outperform public and grant-aided schools by large margins (over 11–13 raw exam points) in mathematics and English. However, for Zambian languages there are mostly no significant differences between private and other types of schools, suggesting this subject may be valued differently within or across types of schools.

These findings have implications for education policy in Zambia, including the Government's ongoing efforts to address teacher shortages and improve teacher allocation. They also highlight the importance of fostering further discussion around the role of gender-responsive pedagogy, language of instruction, libraries, effective options for remedial learning, and further efforts to improve equity in education outcomes. Finally, these insights present pathways for future research and exploration to further understand the education landscape in the country.

The primary data collection (in and around schools) planned for future stages of the DMS research will enable investigation into the root causes of some of these relationships identified in **Stage 1**. It will also enable the Ministry to move beyond the limitations of nationally available education data to understand in more detail the school-level behaviours and practices that may be affecting performance in Zambian schools. Together with the findings presented in this report, the DMS research aims to paint a more nuanced picture to inform policy for improving school performance in the country.



1. Introduction

Introduction

Quality, relevant lifelong education and skills training for all are key priorities of the Zambian Government for advancing human and national development. Although the country has made significant advances in expanding access to education over the past decades, improvements to the quality of education have not kept pace. International and national learning assessments repeatedly indicate that Zambian children are not developing the foundational reading and numeracy skills they need to access more advanced learning. For instance, only 2 per cent and 5 per cent of 15-year-olds in Zambia reached proficiency levels in mathematics and reading respectively (Organisation for Economic Co-operation and Development [OECD] and Zambia, Ministry of General Education [MoGE] 2017).

Improving learning outcomes has been a key focus of the Zambian Ministry of Education (MoE) and is a priority objective within its 2017–2021 Education and Skills Sector Plan (ESSP), which also identifies the need to 'ensure that education policy and practice is based on sound and rigorously developed evidence' (Zambia, MoGE and Ministry of Higher Education [MoHE] 2017).

Within this context, MoE is leveraging an innovative research partnership with UNICEF to identify and scale local solutions that are already making a difference in improving learning in schools. The Data Must Speak (DMS) positive deviance research is implemented under the umbrella of the global DMS initiative, launched in Zambia in 2015 with the goal of strengthening evidence-based decision-making at various levels of the education system by improving the quality and use of existing education data. The research is based on the premise that even in the most challenging contexts, there are some diamonds, or 'positive deviant' schools, that outperform their peers which operate in similar contexts and with similar resources. The performance of these positive deviant schools is likely due to school-level behaviours and practices, for example school management and pedagogical approaches or school-community relationships. Unfortunately, little is currently known in Zambia about which schools are positive deviants and what school-level behaviours and practices contribute to their improved outcomes. This means that the Government lacks the necessary evidence to learn from these on-the-ground, local solutions for improving outcomes and to incentivize and scale up these behaviours and practices in lower-performing schools.

Through a multi-stage, mixed-methods design, the DMS positive deviance research seeks to address low school performance in Zambia by reducing this knowledge gap and tapping into existing local solutions. The country-level research is divided into four stages, as depicted in **Figure 1**. **Stage 1**, the focus of this report, aims to identify the factors influencing school performance in Zambia. It leverages existing data sets to draw lessons that can inform education policy and decision-making. In **Stage 2**, the same data sets are utilized to identify 'positive deviant' schools that are performing significantly better than peer schools in identified school typologies (i.e. similar contexts and with comparable resource levels). Next, **Stage 3** of the research aims to understand which school-level behaviours

and practices contribute to improved school performance among positive deviant schools. Field data collection with various school-level education stakeholders allows the team to investigate the influence on school performance of these factors that are not currently captured in the Education Management and Information System (EMIS) data, such as teachers' classroom practices, relationships between teachers and learners, parental involvement, teachers' professional development opportunities, and other programmes such as nutrition and early childhood programmes. Finally, **Stage 4** will aim to identify concrete actions based on findings from **Stages 1 to 3**, to scale up the positive deviant behaviours and practices of the higher-performing schools and incentivize the schools that have low performance.

This report is divided into six sections and presents the key findings of the **Stage 1** quantitative analysis on factors affecting school performance and their implications for education policy in Zambia. Section 1 introduces the Data Must Speak positive deviance research in Zambia. Section 2 provides a brief overview of the Zambian education system and context. Section 3 describes the analytical framework for the secondary data analysis, including the methodology, research questions, data used and limitations. Section 4 presents the key findings on how various learner-level, teacher-level, school-level and other characteristics are related to school performance. Section 5 synthesizes emerging policy areas for further exploration, and section 6 concludes by summarizing the discussion.

Figure 1: Stages of the DMS positive deviance research

Stage 1

Analysis of resources and context associated with school performance
(Quantitative research)

Stage 2

Identification of positive deviant schools and school typology
(Positive deviance)

Stage 3

Understanding school-level positive deviant behaviours/practices
(Behavioural sciences)

Stage 4

Investigating levers for optimum scale
(Participatory implementation research & scaling science)

2. Education context

Education context

The Zambian education system is led by the central MoE alongside provincial, district and school-level governance and management structures. The system encompasses early childhood, primary, secondary and tertiary education. Children aged 3–6 typically participate in two years of nursery school and two years of reception within the framework of early childhood education (ECE). A child's subsequent learning trajectory is seven years of primary school, followed by two years of junior secondary school and three years of senior secondary school. Higher education includes four years of university or a variety of technical and vocational training options. Zambia runs a three-term school system, with the terms broken up by three-to-four week-long holidays. This translates to about 40 weeks of the school academic year, running from January to December.

The education sector is the largest social sector in terms of government budget allocation in Zambia. However, while the education budget has nominally increased since 2015, its share of the overall government budget has dropped from 20.2 per cent in 2015 to 11.5 per cent in 2021, and it is now well below the 15–20 per cent standard the global education community adopted in its commitments towards achieving Sustainable Development Goal 4 by 2030 (Nalishebo 2021). Primary education has been free since 2002, although until recently households were still required to cover certain fees and costs. A new policy instituted in late 2021 extended free education to secondary school level and eliminated all extraneous school fees.

Zambia has an established long-running, secure examination system managed by the Examination Council of Zambia (ECZ). For primary and secondary school education, the ECZ conducts public examinations at grades 7, 9 and 12. Grade 7 results determine which secondary school learners are eligible to attend, while grade 9 and 12 examinations respectively certify the end of lower and upper secondary school and provide pathways into vocational or tertiary education.

Apart from annual public examinations, Zambia typically implements a sample-based National Assessment System (NAS) once every four years at grade 5 as a diagnostic tool to assess the health of the education system. At a regional level, Zambia participates in the Southern and Eastern Africa Coalition for Monitoring Education Quality (SEACMEQ),[2] while at the international level the country participated in the Programme for International Student Assessment for Development (PISA-D) in 2017.

2.1. The state of education over time

Few children in Zambia access ECE, with only 11.2 per cent of the target age group enrolling in 2020 (Zambia, Ministry of Finance and National Planning [MoFaNP] 2022). Lack of equitable access and poor-quality provision are core challenges in this sector. Private sector actors and non-governmental organizations previously played a large role in ECE provision, but with the expansion of public provision since 2014, government centres accounted for 62.2 per cent of ECE enrolment in 2020 (Zambia, MoFaNP 2022).

[2] SEACMEQ is a large-scale educational assessment system periodically conducted at grades 2, 5 and 9 to provide empirical evidence on pupils' learning achievement. The latest available results are from 2011.

Access to primary education in Zambia continues to grow in terms of numbers of learners and schools, but enrolment rates have stagnated since 2014 and are not keeping pace with population growth. Net primary school enrolment was down to 81.8 per cent in 2020 from a high of 95.8 per cent in 2006 (Zambia MoFaNP 2022). Only 63 per cent of learners transitioned from primary to junior secondary school in 2020, due in part to the limited number of grade 8 places available (Zambia, MoE 2020; Zambia, MoGE and MoHE 2017). Transition to senior secondary school is even more limited, with repetition rates particularly high at the transition from grade 9 to 10 (Zambia, MoGE and MoHE 2017). Only 32 per cent of learners completed grade 12 in 2020 (Zambia, MoE 2020).

Learning outcomes are generally poor at all levels, with children consistently not meeting grade-level expectations. The 2016 NAS results indicated a decline in learning achievements, with grade 5 children receiving average scores of 34.9 per cent in English and 36.9 per cent in mathematics (Zambia, MoGE 2017). Only 2 per cent and 5 per cent of 15-year-olds in Zambia respectively reached proficiency levels in mathematics and reading (OECD and Zambia MoGE 2017). Key factors identified as contributing to these challenges include:

- limited space in schools, resulting in large class sizes that teachers do not have the capacity to teach effectively
- low teacher skills and preparedness, with less than 40 per cent of teachers routinely preparing lesson plans
- teacher absenteeism of around 20 per cent
- poor oversight of teaching and learning, which reduces effective learning time, and
- insufficient funding received by schools per child (Zambia, MoGE and MoHE 2017)

2.2. Government policy priorities

Education in Zambia is guided at a high-level by the Government's Vision 2030, a long-term plan to attain prosperous, middle-income nation status by 2030, and the Eighth National Development Plan (8NDP) 2022–2026, which prioritizes improving education for building the necessary human and social development needed to achieve the Vision 2030. Within the sector, ESSP 2017–2021 and the Early Childhood Education and Skills Sub-Sector Plan (ECESSP 2021–2025), as well as international commitments made under Sustainable Development Goals 4 and 5, guide policy and implementation. The overall objective of the ESSP is to raise learning outcomes through four main priority areas:

Priority 1

Improve the education system's efficiency by instituting robust oversight and management systems, ensuring evidence-based education management, and providing an adequate policy and regulatory environment.

Priority 2

Improve quality by ensuring that qualified teachers are equitably available in sufficient numbers across all regions, with robust mechanisms to continuously update their skills and make sure that they are teaching, and matching the supply of teaching and learning resources with curriculum requirements across subject areas (vocational, academic, and science, technology, engineering and mathematics [STEM]).

Priority 3

Improve access through improving the supply of educational infrastructure and providing alternative opportunities for learning.

Priority 4

Improve equity through mitigating barriers to the entry and ongoing participation of vulnerable learners in education, and addressing the requirements of children with special education needs.

With a 2021 change in Government, national education priorities have been refined to include implementation of the free education policy and overall increased investment in education. ECE and the expansion of opportunities for young people, including through skills development, have been identified as priority areas for increased focus and investment. To improve education quality, the Government's manifesto includes instituting a curriculum review, as well as hiring 30,000 new teachers and addressing the teacher deployment imbalance.[3] The Government will also focus on decentralization and service delivery within the sector, seeking to accelerate implementation of the National Decentralization Plan which may see provision of ECE, primary education and alternative modes of education delivery devolved to local authorities. The Government would retain central responsibility for secondary and higher education, the formulation of national policy and legislation, and oversight and coordination of the operations of statutory bodies and institutions.

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[3] A new workstream by UNICEF Innocenti, Teachers for All (T4A), further investigates reasons behind teacher shortages and imbalances, including in Zambia. See UNICEF Innocenti - Global Office of Research and Foresight, Zambia, MoE and UNICEF Zambia (2023) for a detailed report on Zambian teachers.

3. Analytical framework

Analytical framework

In the context described, the Zambian MoE is interested in leveraging innovative research to understand ways to improve education outcomes. To this end, the positive deviance research is a collaboration to identify existing, local practices and behaviours that can benefit the entire country. Across its four research stages, the positive deviance research uses mixed methods to answer a series of research questions which are further detailed in **Appendix F**. This report and description of the analytical framework focus on **Stage 1** of the research.

3.1. Methodology and research question

Stage 1 of the research seeks to answer the following research question:

> **What resources and contextual factors are most associated with school performance in Zambia?**

Secondary data analysis utilizing existing national-level administrative education data sets was conducted to answer this research question. A comprehensive ethical protocol, approved by the Health Media Lab,[4] was followed throughout the data analysis.

3.2. Analysis strategy

Multivariate regression analysis was used to understand the relationships between school performance, available resources and contextual characteristics in Zambia. The following regression model was estimated:

$$Y_{i,j,k} = \beta_0 + \beta_1 \text{Learner}_{i,j,k} + \beta_2 \text{Teacher}_{i,k} + \beta_3 \text{School}_{i,k} + \beta_4 \text{Other}_{i,k} + \beta_5 \text{District}_l + \beta_5 \text{Year}_k + \varepsilon$$

Where,

$Y_{i,j,k}$	represents school performance in school i, for students of gender j (male or female), in year k, as measured by average grade 7 exam scores (raw and standardized)
$Learner_{i,j,k}$	is a set of independent variables representing average learner characteristics in school i, for students of gender j (male or female), in year k
$Teacher_{i,k}$	is a set of variables is a set of variables representing average teacher characteristics for school i, in year k
$School_{i,k}$	is a set of variables representing school-level characteristics for school i, in year k
$Other_{i,k}$	is a set of variables is a set of variables representing other contextual information for school i, in year k
$District_l$	are unobserved time-invariant heterogeneities across each district l in which school i is located (district fixed effects)
$Year_k$	are unobserved time-invariant heterogeneities across each year k, six years ranging from 2015 to 2020 (year fixed effects)
ε	is the stochastic error term

[4] The Institutional Review Board application for the first two stages of the DMS research – 294EINN20 – was approved on 21 October 2021. It outlines the critical steps that were followed to analyse the secondary data sets, including steps to ensure the confidentiality and protection of personally identifiable information.

This analysis was conducted at the school level and prioritizes primary education.[5] Although schools with all grades (primary and secondary) are included in the analysis, only their characteristics for the primary grades are considered.

Learning outcomes, as measured by average grade 7 exam scores, were identified as the most important outcome to represent school performance in Zambia. This indicator was selected as the most appropriate indicator of learning outcomes because the grade 7 primary-school leaving examination is the first census-level standardized measure of children's learning in Zambia. Both the raw grade 7 examination scores (a scale ranging from 50 to 150) and the standardized exam scores were used in the analysis to facilitate a comprehensive understanding.

Average exam scores in grade 7 for mathematics, English and Zambian languages were used to represent school performance as the dependent variable.[6] These subjects were selected to investigate foundational reading and numeracy, the critical skills children must learn in primary school to engage with more advanced learning and skills development. Additionally, grade 7 scores (and not earlier grades) were used as the dependent variable for two reasons: firstly the primary school leaving examination is the first census-level standardized measure of children's learning in Zambia and similar data does not exist for earlier grades, and secondly the grade 7 exam is administered at the end of seven years of primary education and is used for both placement (selection into the eighth grade) and certification, marking an important milestone in the academic careers of Zambian children.

ECZ standardizes the subject-level results of the grade 7 examination to a score of 150.[7] This transforms the distribution of scores to have a minimum standardized score of 50 and a maximum of 150 for each subject. In this report, the transformed ECZ scores out of 150 are referred to as the raw scores, and analysis is also run by computing z-scores of each subject score (called standardized scores).

All independent or explanatory variables included in the analysis were calculated at the grade 7 level where relevant and available, or at school level, and refer to the characteristics of either learners (gender, age, etc.), teachers (age, qualification, etc.) or schools (size, governance, etc.). Independent variables were chosen based on their relevance to the research question, their variability,[8] and important data considerations.[9]

[5] The dependent variable represents grade 7 learner performance and is a grade-level metric. However, while this exam score is captured at grade 7, to some extent it captures learning throughout the primary cycle (assuming most children stay in the same school through primary schooling, which is the expected situation in Zambia). Additionally, most independent variables in the analysis represent characteristics of the primary school (and not just grade 7), hence allowing us to draw conclusions school characteristics and student learning in primary schools.

[6] All learner-level examination scores were aggregated for each examination centre by ECZ to derive an examination-centre level average score by subject.

[7] Standardization is done by firstly converting raw scores into z-scores (by aggregating for each case less the subject mean and dividing that by the standard deviation of the subject) and then multiplying these by 10 and adding 50 standard points. ECZ standardizes examination scores to ensure that the subject scores have the same theoretical length, as they are aggregated to obtain the overall composite score that is used for selection and certification purposes.

[8] Variables with low variation were not included in the models because they contribute little to the results and may introduce multicollinearities.

[9] Variables that were missing many observations (>10–15 per cent of sample) or that had a high number of obvious errors were discarded to avoid biasing the analysis. For example, a potential variable of interest was the distance of schools from District Education Offices (DEOs) to try and understand variation in support from the nearest DEO. However, the data on this variable had over 22 per cent of values missing and were highly inconsistent, so it was dropped from the model.

District and year fixed effects were included in the regression models to account for inherent differences between Zambian districts and across years. For instance, by adding year fixed effects, the analysis can account for the fact that 2020 was an atypical school year due to COVID-19, and yet extract meaningful correlations between school performance and selected independent variables.

Various other robustness checks were conducted to ensure results are consistent across different model specifications. **Appendix E** includes more information on the robustness checks conducted.

3.3. Data and sample

The secondary data analysis drew upon the six most recent years (2015–2020) of annual data from two sources: the country's EMIS database and the ECZ grade 7 national examination results.[10]

Zambia's EMIS is maintained at the national level within the Directorate of Planning and Information at the MoE and captures information across a broad set of categories, including school type and context, school infrastructure, teacher characteristics, instructional resources, and learner characteristics. The ECZ data set contains scores for grade 7 exams across subjects, averaged across examination centres, and disaggregated by student gender.

Across the six years of EMIS data, the number of schools for which MoE could collect data ranged from a low of 9,525 (in 2015) to a high of 11,068 (in 2018). These included public, private and community schools. In addition, the ECZ database was composed of exam scores for each examination centre and ranged from a low of 5,179 examination centres (in 2018) to a high of 6,253 examination centres (in 2019).

The difference between the number of schools in the EMIS and exam data sets is because not every primary school in Zambia has examination centre status.[11] Children who attend schools that are not examination centres must take their exam at a nearby school that is one. At the national level, ECZ disaggregates exam results by the examination centre and not by the school. As such, the exam scores of children whose schools are not examination centres are included in the average score of the centre where they sat their exams. In 2020, 58 per cent of schools included in the EMIS database were examination centres.

Merging the EMIS data with the ECZ data was complex. Each data set uses a different unique code to identify schools, and there is no key linking these codes. A process known as 'fuzzy merging' was used to link the two data sets by matching schools based on string variables such as school names and districts, accounting for minor errors in spelling. While this process allowed many schools from the ECZ data set to be merged with the EMIS data set, it was not possible to link all schools between the two data sets.

[10] Zambia conducts various learning assessments (such as NAS and SEACMEQ), but these are sample-based and not conducted annually and were hence not used for this analysis.
[11] Schools are granted examination centre status after it is assessed that they meet certain basic levels of readiness on the following factors: school enrolment and class pattern, provisions in terms of storage and security of examination question papers, desks, the state of the classrooms for teaching, availability of specialized rooms and equipment, school establishment, staffing levels and qualifications, and subjects taught.

Ultimately, across the six years included in this analysis, 87 to 95 per cent of schools in the ECZ database were successfully linked to the EMIS database. However, despite connecting close to 90 per cent of schools in a given year, many schools were not consistently followed across all six years in the regression analysis. This was due to missing information on independent variables included in the regression analysis.

In total, the regression sample included 5,724 unique schools, with some schools followed across all six years and some over fewer years. The final regression sample had between 49,609 to 50,000 observations depending on the subject because there were multiple observations per school. For example, a school that was followed over six years would have 12 observations in the analysis sample – two observations per year, disaggregated by student gender. See **Appendix B** for more details on the merging process.

3.4. Limitations of the research

This research has several limitations that are important to consider when interpreting the results. Firstly, the findings of positive or negative associations between school, teacher and learner characteristics and school performance represent correlations, and do not necessarily signal the existence of a causal link between the input and outcome variables. For example, the data show that exam performance in Zambian languages is marginally higher when teachers are younger. However, this does not necessarily mean hiring or retaining younger teachers will improve exam performance. It could instead be the case that schools that have younger teachers have more consistent training sessions and other teacher support systems in place, all of which could be contributing to higher exam performance. Hence, results should not be interpreted as causal, and must be considered in tandem with other similar research and available analysis. Future stages of this research will also aim to bolster the findings of this first phase.

Secondly, the available data do not capture information on all factors that may influence learner performance. For example, other unobservable factors such as the family or socioeconomic characteristics of the learners, or the different behaviours and practices implemented in schools, may also influence exam performance but are not captured in the data. Hence the model used cannot fully explain the determinants of learner performance, but nevertheless provides valuable insights. In **Stage 3** of this research, additional primary data will be collected to complement the available data and obtain deeper insights into the determinants of learner performance.

Another limitation previously referenced is that national grade 7 examination results are only available at the examination centre level rather than the school level. This has two main implications. Firstly, it drops all non-examination centre schools from the analysis. This means the results are not representative of these schools, which are systematically different from examination centre schools. Secondly, the inclusion of non-examination centre learner scores in an examination centre school's results creates more noise in the dependent variable. While this does not bias the regression estimates, the noise in the dependent variable may limit the ability to detect certain relationships.

4. Discussion of findings

Discussion of findings

This section firstly presents descriptive statistics on exam performance in Zambia (the outcome variable in the multivariate regression analysis) and then discusses results from the six primary econometric models which used the raw and standardized national examination results for grade 7 learners in three subjects: mathematics, English and Zambian languages.

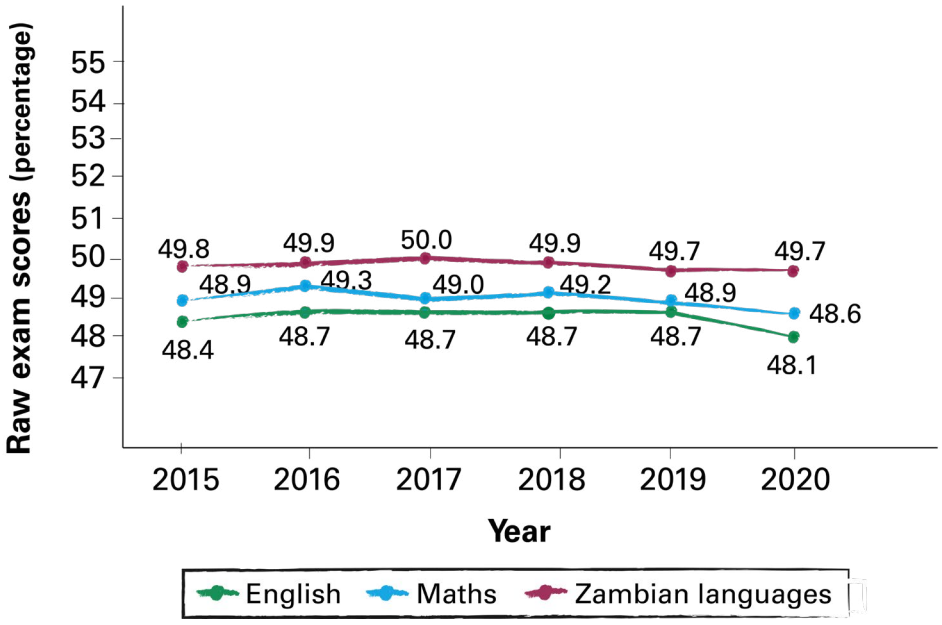
Results are grouped by learner, teacher and school-level characteristics. **Table 2** in **Appendix A** details the regression results.

A similar analysis was also conducted for other subjects (science and social studies), results from which are summarized in **Box 1**.

4.1. Descriptive statistics on exam performance

Exam performance is low across subjects, with limited variation over time. School-level average scores on grade 7 examinations did not vary widely between 2015 and 2020 in any of the three subjects analysed. Average mathematics, English and Zambian languages scores were all within the range of 48.5–50 per cent (98.4–100 points on the 50-to-150-point exam scale; see **Figure 2**). English scores were consistently the lowest each year, and scores in Zambian languages were consistently the highest. Overall, the differences between subjects were minimal.

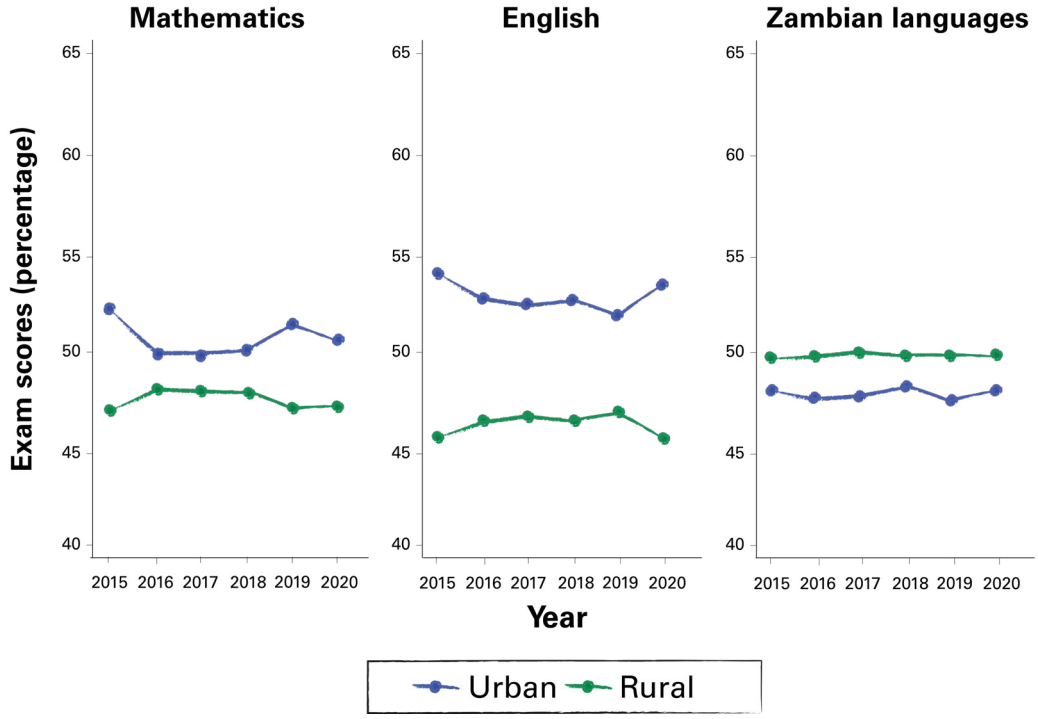
Figure 2: Average exam scores over time by subject



Source: ECZ data 2015–2020. The average exam scores are represented as percentages (converted from a scale of 50–150) and all point estimates are weighted by the total number of exam takers. Calculations made by authors, representing an average of averages (average computed from school-level average exam scores).

Urban schools outperform rural schools in mathematics and English. However, in Zambian languages, school performance is more similar. Most Zambian schools are in rural areas (83 per cent). As depicted in **Figure 3**, urban schools had higher scores in mathematics and English than rural schools, but they had slightly lower scores in Zambian languages. These trends have been consistent over the past six years. The lower performance of urban schools in Zambian languages may be due to higher usage of local languages in rural areas than in urban areas.

Figure 3: Average exam performance over time by urban/rural location



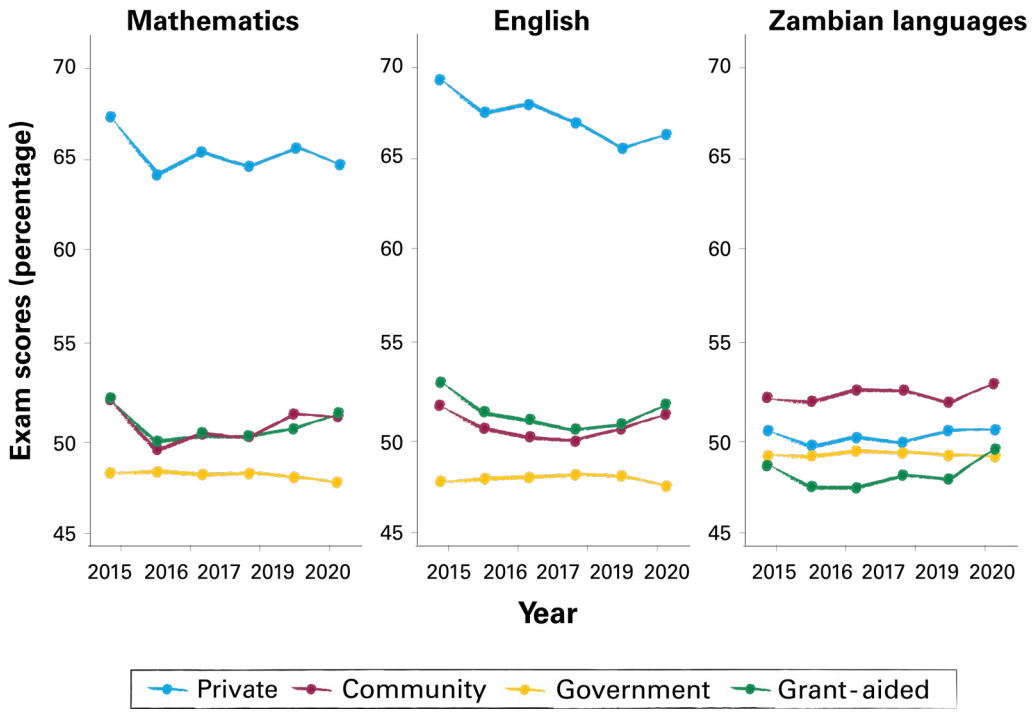
Source: ECZ and EMIS data 2015–2020. The average exam scores are represented as percentages (converted from a scale of 50–150) and all point estimates are weighted by the total number of exam takers. Calculations made by authors, representing an average of averages (average computed from school-level average exam scores).

Similar to the urban/rural trend, private schools outperform other types of schools in mathematics and English, but not in Zambian languages. In Zambia, there are four types of schools based on management: private schools, government-led schools, grant-aided schools and community schools.[12] Private schools had nearly 20 percentage point-higher scores in mathematics and English than government schools (see **Figure 4**). However, in Zambian languages the difference between private and government schools was much smaller – only 1.5 percentage points. Community schools consistently

[12] **Government schools** are fully funded by the Government of Zambia. **Community schools** are organized, owned and operated by a parents' committee and may receive support from civil society organizations or the Government. **Grant-aided schools** are run by organizations other than the Government (often faith-based organizations), but with government teachers and assistance. **Private schools** are run by private agencies or individuals and financed primarily through tuition; they may be profit or non-profit (Falconer-Stout et al., 2017). In 2020, 66 per cent of Zambian schools were government-led, 22 per cent were community schools, 8 per cent were private schools and only 4 per cent were grant-aided schools. However, the sample used to depict exam scores in **Figure 4** contains 89 per cent government schools, 5 per cent private schools, and 3 per cent each of community and grant-aided schools. This is because most community schools do not have examination centre status.

outperformed government schools across all three subjects, performing roughly 2 percentage points better in mathematics and English. Grant-aided schools performed similarly to community schools in mathematics and English, but dropped below government schools to be the lowest-performing school type in Zambian languages.

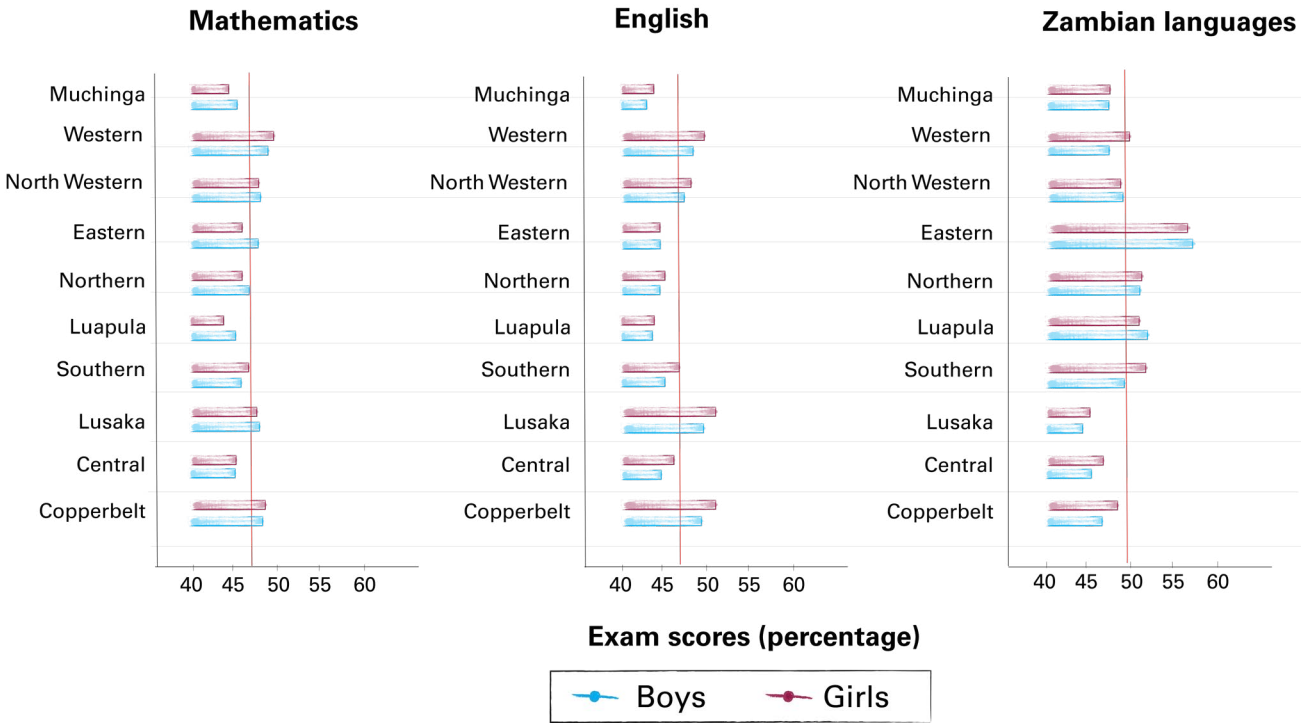
Figure 4: Average exam performance over time by school type



Source: ECZ and EMIS data 2015–2020. The average exam scores are represented as percentages (converted from a scale of 50–150) and all point estimates are weighted by the total number of exam takers. Calculations made by authors, representing an average of averages (average computed from school-level average exam scores).

Exam performance varies by region. More developed provinces typically scored higher in mathematics and English but lower in Zambian languages. **Figure 5** depicts 2020 exam results across the 10 provinces in the country. The vertical grey line in each panel represents the national average for that subject – 48.6 per cent in mathematics, 48.1 per cent in English, and 49.7 per cent in Zambian languages. Western, North-western, Lusaka and Copperbelt provinces consistently perform above the national average in English and mathematics. However, the trends are different in Zambian languages performance. Northern, Eastern, Luapula and Southern provinces outperform other provinces in Zambian languages, with Lusaka being the lowest performer.

Figure 5: Exam performance by learner gender and province in 2020



Source: ECZ data 2015–2020. The average exam scores are represented as percentages (converted from a scale of 50–150) and all point estimates are weighted by the total number of exam takers. Calculations made by authors, representing an average of averages (average computed from school-level average exam scores).

Detailed summary statistics on all the variables used in the multivariate analysis are included in **Appendix C**.

4.2. Learner characteristics

Global research shows that learner characteristics (e.g., their socioeconomic backgrounds, preschool experience, etc.) are associated with educational outcomes (World Bank 2018). This analysis examined the relationships between exam performance and characteristics such as learner gender, the proportion of repeaters per grade, financial support received by learners and learner age. Other learner-level characteristics, such as income level or parents' educational background, are important variables that likely influence learning, but information on these is unavailable in the EMIS or exam data sets. While these could not be directly captured in the analysis, they are partially captured within the district-level fixed effects included in the analysis model.

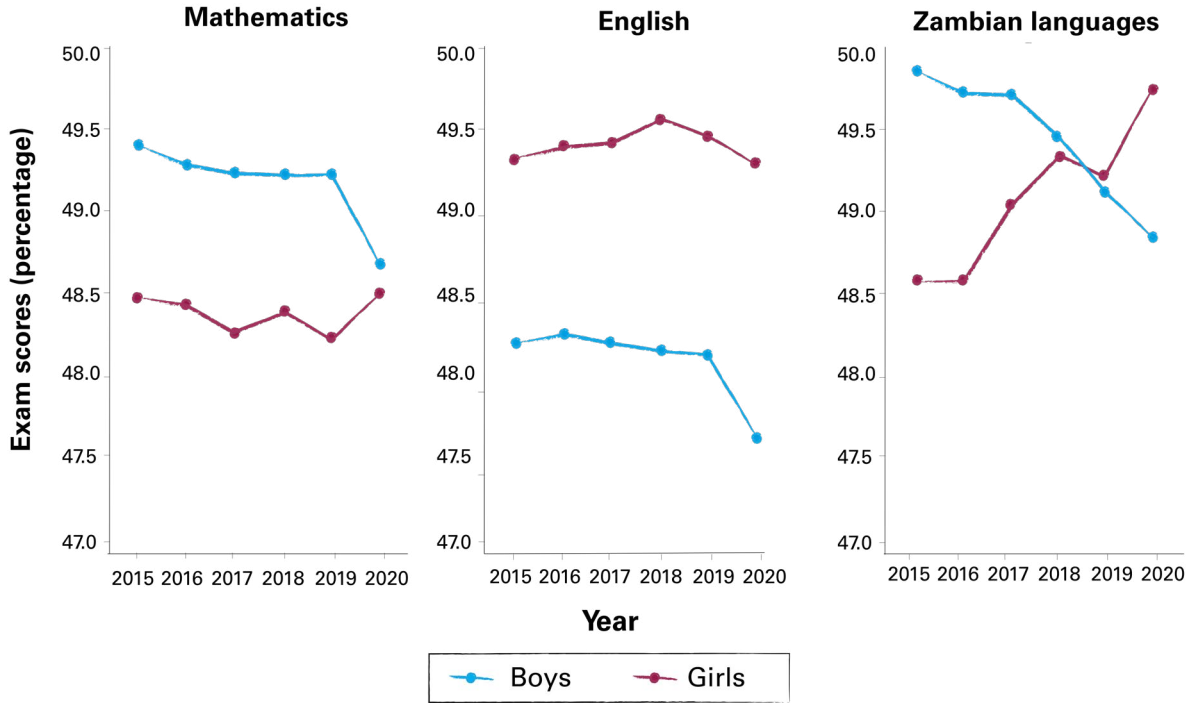
In Zambia, learner performance varies slightly based on gender and by subject. Girls' performance is marginally lower than boys in mathematics and, for most years, in Zambian languages.[13]

[13] T-tests to test the equality of means show a statistically significant difference (at the 5 per cent level of significance) in girls' and boys' performances across subjects. In mathematics, boys' performance is significantly higher than that of girls across all years. In Zambian languages, boys' performance is significantly higher than girls' performance in the years 2015–2018, while in 2020 girls' performance was statistically significantly higher. In English, girls' performance was statistically significantly higher than that of boys across most years.

However, girls outperform boys in English. On average across the six years, boys scored 1 raw point (0.1 standard deviations [SD][14]) higher than girls in mathematics and 0.6 raw points (0.06 SD) higher in Zambian languages, while girls score 0.7 raw points (0.07 SD) higher than boys in English.

As depicted in Figure 6, the gender differences have been relatively consistent across the years in English, have recently narrowed in mathematics, and have converged in Zambian languages. Notably, when schools were closed for three months due to COVID-19 in 2020, boys' performance fell across all three subjects, while girls' performance improved in mathematics and Zambian languages and fell only in English.

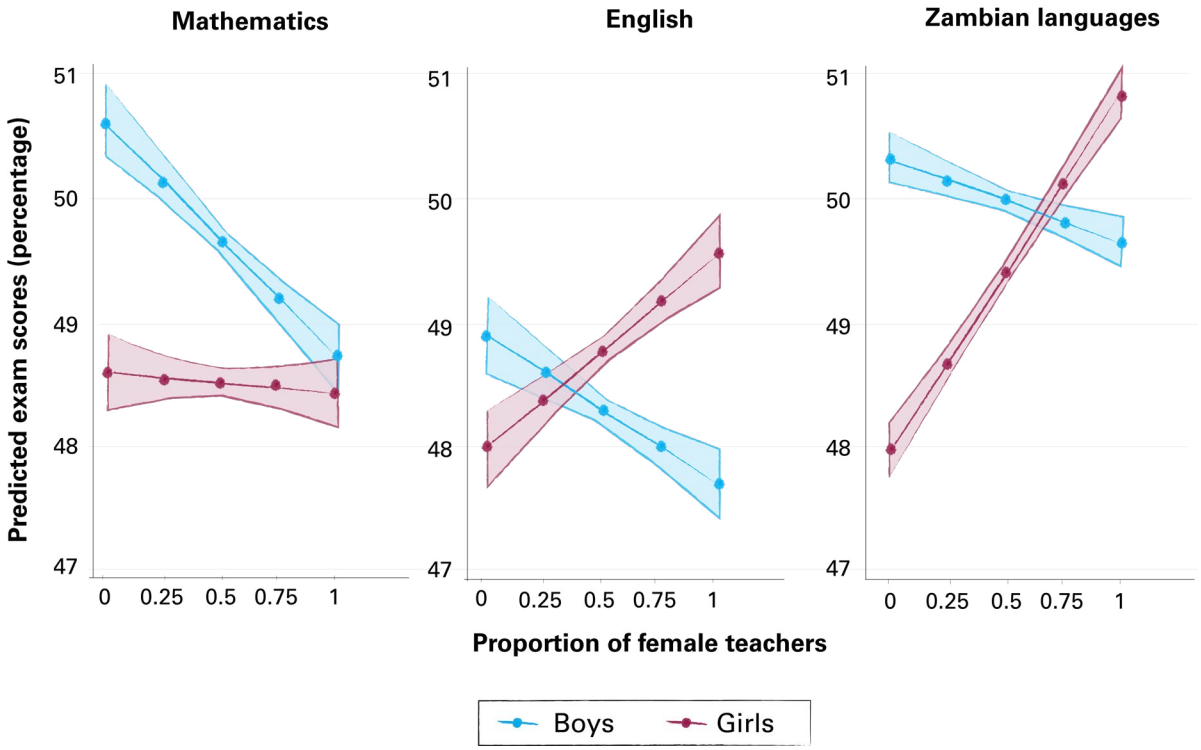
Figure 6: Average exam performance by gender



Source: ECZ data 2015–2020. The average exam scores are represented as percentages (converted from a scale of 50–150) and all point estimates are weighted by the total number of exam takers. Calculations made by authors, representing an average of averages (average computed from school-level average exam scores).

[14] The association between two variables (in this instance exam performance and student gender) is often standardized to facilitate comparability across different studies and samples. Comparison is possible because standardized values are unitless. For instance, it may be possible to compare results from this study to a similar study in a different country, if they both report results in SDs, and have samples with similar distributions. Each variable in the regression analysis (such as exam scores, student characteristics, teacher characteristics and school characteristics, etc.) is standardized by subtracting the variable's mean from the observed value and then dividing by the variable's SD (spread of data). Regression analysis is then run on these standardized values.

Figure 7: Exam performance by gender and proportion of female teachers



Reading this graph: The width of line represents the 95 per cent confidence interval for estimates, meaning we can be 95 per cent confident that the true population mean is contained within this interval. The x-axis represents increasing proportion of female teachers in the school (ranging from 0 female teachers to 100 per cent female teachers). The y-axis represents the predicted exam scores. The three panels represent trends by subject. In each panel, moving from left to right, the graph indicates predicted exam performance as the proportion of female teachers in the school increases.

Source: ECZ and EMIS data 2015–2020. The average exam scores are represented as percentages (converted from a scale of 50–150). Calculations made by authors, representing an average of averages (average computed from school-level average exam scores).

Girls may benefit from having female teachers. The econometric analysis revealed that girls' performance in English and Zambian languages improves as the proportion of female teachers at a school increases. For instance, in English, girls score 0.9 raw points (0.08 SD) lower than boys when all teachers are male. However, as the proportion of female teachers increases, this difference narrows, and in schools with all female teachers, girls score 1.8 raw points (0.17 SD) higher than boys. This improvement in girls' performance is even stronger in Zambian languages. In mathematics, girls' performance is relatively unaffected by teacher gender.

Conversely, boys perform better when schools have more male than female teachers. This association is true across all subjects but is strongest for mathematics. For example, in mathematics, boys score over two raw points (0.2 SD) higher than girls when all teachers at a school are male. However, this difference effectively disappears with all female teachers, because boys' performance falls as the proportion of female teachers increases. **Figure 7** visually depicts these trends for both boys and girls.

The association between teacher gender and learner exam performance only exists in rural schools. In urban schools, learner performance across subjects is unassociated with teacher gender. However, in rural schools, girls' performance is higher with more female teachers, and that of boys is higher with more male teachers (see models 7–12 in **Appendix D**).

These trends are unlikely to be because of different professional qualifications, which are included in the regression models and are very similar across the male and female workforce (see **Table 1**). Instead, these results signal there may be differences in how female and male teachers in rural Zambia interact with their learners, possibly driven by prevailing cultural or regional norms. Teacher composition by gender may also be a contributing factor. In rural Zambian schools, only 38 per cent of teachers are female, compared to 71 per cent of female teachers in urban schools. The fewer female teachers in rural schools may interact with girls differently (both inside and outside the classroom). Further investigation is needed to understand what drives these results, which will be a focus in **Stage 3** of the positive deviance research.

A higher proportion of repeaters in a school is associated with marginally lower exam performance; however, low levels of learner repetition in Zambia leave limited scope for policy action. In 2020, an average Zambian school had 5.3 per cent repeaters (out of total enrolled learners) in primary school. While rural schools had higher repetition than urban schools (6.3 per cent versus 2.9 per cent), and boys had higher repetition than girls (0.9 percentage points higher), on average, repetition was relatively low. Reducing repetition rates from the currently prevalent 5.3 per cent to zero would improve exam performance only marginally by 0.05–0.16 raw points (0.006–0.02 SD) across subjects.

There could be various reasons for this trend. Repeaters may have previously struggled with the educational content and may not be as self-confident or motivated as non-repeaters. Often, they are learners who have already dropped out once and are returning to school, or those who require special attention. Additionally, having a higher proportion of repeaters in a classroom may make classrooms more heterogenous, making it harder for teachers to cater to all learning levels. Overall, policies and trainings that support teachers in catering to repeaters can be beneficial.

The proportion of students in a school that receive bursary support[15] was also analysed to understand the influence of additional financial support on exam performance. **The association between students receiving bursary support and exam performance was not statistically significant in this analysis.**[16] While not (statistically significantly) associated with grade 7 exam results, bursary support may address the issue of dropouts from school and may support retention, as evidence from various contexts signals (Sabates et al. 2010; Hoque et al. 2022).

Learner age was negatively associated with exam performance, meaning that the older children are in grade 7, the lower they are likely to score on exams. The average age of grade 7 learners in Zambia is 14 years, which is higher than the ideal learner age at this level (11–13 years). A decrease in the learner's average age by one year is associated with an improvement in both English (0.6 raw points) and mathematics (0.4 raw points) performance.[17]

[15] This refers to any financial support received by pupils from the Zambian MoE, other line ministries or non-governmental organizations.
[16] It is possible that this analysis was unable to detect a relationship between bursary support and exam performance due to little variation in the proportion of students who receive support in a school, which was reported as only 1.5 per cent on average. Further investigation is required to uncover if and how bursary support may influence school performance.
[17] There is a positive association between Zambian languages exam performance and the learner's age; however, the magnitude of this association is minimal.

4.3. Teacher characteristics[18]

Teachers are central to the education process. Zambian teachers have diverse profiles. The average teacher in the sample is 42 years old, although teachers' age ranges from 20 to 80. On average, 43 per cent of teachers are female. However, this varies based on where a school is located: 71 per cent of teachers in urban schools are female compared to just 38 per cent in rural areas. In addition, a large proportion of the teacher workforce comprises of permanent teachers – 90 per cent.[19]

This analysis examined various characteristics of Zambian teachers to understand which teachers are associated with higher learner performance.

Firstly, professional qualifications of teachers, often considered a proxy for a teacher's pedagogical skills, were examined.[20] Teacher professional qualifications were captured by two variables: the proportion of teachers at a school with a teaching diploma, and the proportion of teachers with a bachelor's degree or higher.

Table 1: Teacher professional qualifications in 2020

		Gender		Location		School type			
Teacher qualifications	National	Female	Male	Rural	Urban	Govt.	Private	Grant-aided	Comm.
Professional certificate (or lower)[21]	38%	25%	28%	51%	46%	38%	38%	32%	36%
Professional diploma	50%	50%	52%	43%	46%	50%	56%	54%	57%
Professional degree (bachelors, masters, or higher)	11%	25%	20%	6%	8%	12%	6%	14%	7%

[18] The recently published data brief on Zambian teachers, under UNICEF Innocenti's T4A workstream, also explores primary school teachers and their characteristics (see UNICEF Innocenti, Zambia, MoE and UNICEF Zambia 2023). The small deviations in the summary statistics mentioned in the T4A data brief and this paper are due to the slightly different samples and level of analysis used in the papers. For instance, the T4A brief focuses on public schools only, and excludes schools that employ multigrade teaching; however, this analysis includes all school types.
[19] Permanent teachers hold full-time contracts and accrue a regular salary, pension and other benefits. They have relatively high job-security within the system. In addition, teachers can be on temporary contracts (without any pension or benefits, and with lower job security), volunteers or working on a probation basis.
[20] Another variable of interest regarding qualifications is the academic qualifications of a teacher. Academic qualifications are degrees or certificates that are non-teaching related. In Zambia, there was almost no variation along this metric: nearly all teachers had a grade 12 certification as their highest academic qualification, meaning there was too little variation to effectively include this variable in the multivariate regression analysis.
[21] Only 1.4 per cent of teachers were reported as having no professional qualifications whatsoever.

The minimum qualifications required to be a primary teacher in Zambia are a grade 12 school certificate and a three-year diploma.[22] In 2020, 38 per cent of teachers held a certificate or lower, 50 per cent had a diploma, and only 11 per cent had a degree. Teacher qualifications are similar by gender and across rural/urban areas (see **Table 1**).

Schools with a higher proportion of teachers with a diploma, as compared to a certificate, perform marginally better in mathematics and English. However, the practical magnitude of this association is small. It is estimated that having all current Zambian teachers with a teaching diploma or higher (currently, only 61 per cent) could improve exam performance marginally by 0.3–0.4 raw points (0.03 – 0.04 SD) in mathematics and English. There is, however, no statistically significant association between teacher professional qualifications and performance in Zambian languages exams. This is a relatively slight association, consistent with global trends that show that observable teacher qualifications such as formal education and certification status are not consistently correlated to improved student outcomes (Lauwerier and Akkari 2015; Hanushek et al. 2019; Sharma, Shotland and Komaragiri 2021).

Schools with a higher proportion of temporary or contract teachers have marginally better exam performance. With all other things equal, a school with 50 per cent temporary or contract teachers is expected to perform 1.2 raw points (0.2 SD) better in mathematics, 0.8 raw points (0.08 SD) better in English and 0.5 raw points (0.06 SD) better in Zambian languages exams. In 2020, most teachers in Zambia were permanent teachers, with only 10 per cent being temporary or contract.

This association, while seemingly counter-intuitive, has also been observed in other countries.[23] The global education literature provides some clues for why this trend may persist. The accountability structures temporary teachers face may incentivize higher performance, as they often encounter the prospect of losing their jobs if they perform poorly. However, this trend does not justify keeping teachers under temporary status; rather, it suggests the importance of having appropriate accountability structures and incentives for *all* teachers. Alternatively, there may be something different about schools with a higher proportion of temporary teachers. For instance, leaders in these schools may be leveraging innovative solutions (e.g., hiring temporary teachers) to address staffing, class size or discipline-related issues, which may manifest in better exam performance.

Next, the analysis explored the relationship between learner performance and various school-level characteristics. These included factors related to school leadership and supervision, teaching and learning environment and resources, the availability of infrastructure and water, sanitation and hygiene facilities, and school location-related characteristics.

4.4. School characteristics

4.4.1. School leadership

Schools led by female head teachers have slightly higher exam performance. This trend is observed across subjects, with female-led schools performing 0.2–0.3 raw points (0.02–0.03 SD) better in exams across

[22] According to government regulations, a primary school teacher must have a grade 12 school certificate or a General Certificate of Education (GCE) with five credits or higher, including English, mathematics and a science subject. They are also expected to have a minimum three-year diploma from an accredited teacher training college. No degree is required for primary teaching, but it is needed for secondary grades. Teachers are also required to be registered and hold a Practicing Certificate regulated by the Teaching Council of Zambia. In reality, teachers may not meet these criteria, either because they are older employees (who entered the profession when the requirements were different) or because they are hired (particularly on temporary contracts) to address shortages or urgent needs.

[23] For instance, experimental evidence from India (Muralidharan and Sundaraman 2013) and Kenya (Duflo, Dupas and Kremer 2012) shows that contract teachers can improve learning outcomes and are certainly no worse than regular teachers. In the DMS research, the same trend is seen in Nepal.

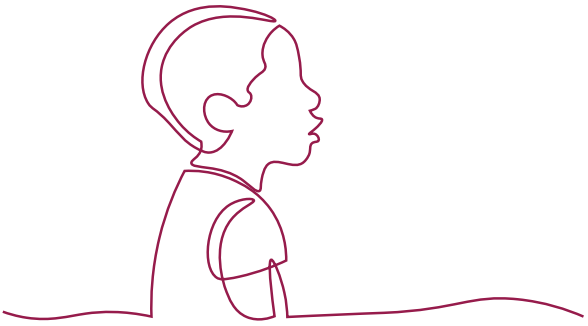
subjects. While marginal in magnitude, this association is in line with a growing body of global research and evidence from other DMS countries,[24] which finds that female-led schools perform better across various education outcomes (Bergmann et al. 2022). In Zambia, about 40 per cent of teachers are female, yet only 23 per cent of head teachers are female. While female representation in leadership roles is higher in Zambia than in other African countries, the data suggest women teachers face barriers preventing them from moving to leadership roles. Further research is required to understand what behaviours and practices female head teachers employ to improve school performance, and how to reduce the barriers to increasing their participation in leadership roles.[25]

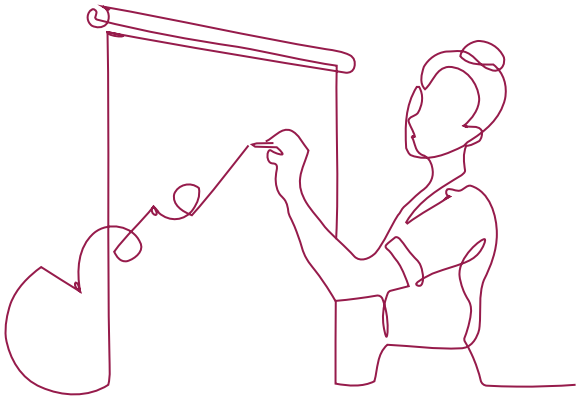
4.4.2. Teaching and learning resources and school infrastructure

To understand how instructional time is associated with exam performance across Zambian schools, pupil-teacher ratio (PTR) in primary schools, class size in grade 7 and contact hours in grade 7 were analysed.[26]

PTR at the school level is negatively associated with exam performance. PTR is an important tool for education resource allocation, used by ministries of education worldwide to ensure a sufficient number of teachers are allocated to schools. In Zambia, in 2020 the average PTR among the sample was 60 pupils per teacher, well above the national standard of 40.[27]

PTR varies widely *across* schools, locations (urban versus rural) and provinces. Almost two thirds of schools on average, have PTRs above the national ideal of 40 learners per teacher, and a quarter have higher than 75 learners per teacher. Rural schools have a higher average PTR than urban schools – 68 versus 41. PTR also varies across provinces, with Western, Central, Eastern, and Northern provinces facing the highest variation between rural and urban schools. A detailed exploration of primary school PTR and how it varies across Zambian schools is covered in the T4A data brief discussed in previous sections (UNICEF Innocenti, Zambia, MoE and UNICEF Zambia 2023).





[24] Specifically, in Côte d'Ivoire, female headteachers are positively associated with promotion rates in public primary schools. In Togo and Mali, female headteachers are positively associated with the promotion rate in primary schools for girls only. In Madagascar, female headteachers are positively associated with promotion rates for girls only and positively associated with exam success for all students.

[25] See the Women in Learning Leadership research programme at www.unicef-irc.org/research/women-in-learning-leadership.

[26] There are four possible types of classes in Zambian primary schools: regular classes which follow the national curriculum, interactive radio instruction classes, open learning classes (flexibly designed courses to meet individual needs) and special literacy classes. In this analysis, only the contact hours of regular classes faced by a grade 7 student on an average day were considered.

[27] This average PTR figure varies from the figure documented in the Zambia brief published under the T4A project (67:1), as it was calculated on a slightly different sample. This sample included all four school types (the T4A brief focuses on public schools only) and excluded schools which are not examination centres.

According to this analysis, reducing 20 pupils per teacher (such that the average PTR is at the national standard of 40) is expected to improve school exam performance by 0.2–0.6 raw points (0.02–0.06 SD) across subjects. While statistically significant, school-level PTR has a small association with exam performance, signalling that lowering the PTRs may not fully resolve the learning issue on its own, but still serves as a critical enabling condition to facilitate learning.[28]

Class sizes in grade 7 are also negatively associated with exam performance. Although related, the PTR is not equivalent to the class size, and hence the grade 7 class size was also included in this analysis.[29] Lowering grade 7 class size from the prevailing average of 50 to 40 students is associated with an increase in exam scores of 0.3–0.4 raw points (0.03–0.04 SD) across subjects.

Finally, contact hours are positively associated with exam performance, further highlighting the importance of instructional time for learners. Currently, the average grade 7 student has a daily contact time of around 5 hours for regular classes. Increasing contact time to 6 hours is associated with a mild improvement in exam performance of 0.1 raw points (0.01–0.02 SD) across subjects. Higher and quality instructional time does not necessarily require increasing the lesson contact hour time and can be achieved in other ways, including reducing teacher absenteeism or increasing the number of school days in the calendar.

Greater availability of teacher resource books is marginally associated with improved mathematics exam performance. On average, Zambian schools have 0.81 resource books per teacher; this ratio varies marginally across regions and location. For instance, Central has the fewest resource books (0.76 per teacher), and Northern has the most (0.86 per teacher). Urban schools have fewer resource books than rural schools (0.74 versus 0.84 books per teacher). The analysis revealed no association between teacher resource book availability and exam performance in English and Zambian languages. However, there was a small, positive association with mathematics performance (0.06 raw point improvement if there was one resource book per teacher).

While this needs to be explored more deeply, there could be various reasons why resource books are more important in mathematics. For example, mathematics books may be of higher quality and more catered to teacher needs, resource books may be pedagogically more important for mathematics, or perhaps there are more mathematics resource books available (and fewer books in other subjects), allowing more teachers to use them.

Sufficient seats for learners in a classroom are associated with improved learning. In 2020, the average seat to learner ratio[30] in Zambia was 0.3, indicating that only one seat was available for every three pupils in a primary school. Private schools had more seats compared to public schools (0.8 versus 0.3 seat to learner ratio), and as did rural schools (0.3) as compared to urban ones (0.4). The analysis reveals that increasing the seat to learner ratio to ensure one seat for every learner is associated with a 0.7 raw point (0.07 SD) improvement in mathematics performance. **In urban schools, this association is stronger** – ensuring one seat for every learner (as compared to the prevailing 0.4 seats per learner) is associated with an improvement of mathematics performance by 1.6 raw points (0.16 SD).

[28] This analysis could not explore the relationship between PTR and school retention, which could be of a larger magnitude as compared to exam performance. Hence, while considering policy, PTR influence on dropouts would be an important avenue to explore.
[29] The primary school-level PTR was examined to understand the teacher resources devoted to primary schools and how this influences exam performance. School PTR does not account for teacher work hours or instructional time and may mask significant grade-level variation. PTR is derived by dividing the total student enrolment by the total teacher workforce in a primary school, and does not account for instructional time for students compared to the length of a teacher's working day (OECD 2022). Hence similar PTR values between schools can result in different class sizes. In Zambia, the grade 7 class size and PTR variables are only mildly correlated to each other (pairwise correlation coefficient of 0.2).
[30] Seat to pupil ratio was calculated by dividing the total number of available seats in a school by the total pupils enrolled in that school. Total seats were calculated as: Number of single seater desks in school + 2* number of double seater desks in the school.

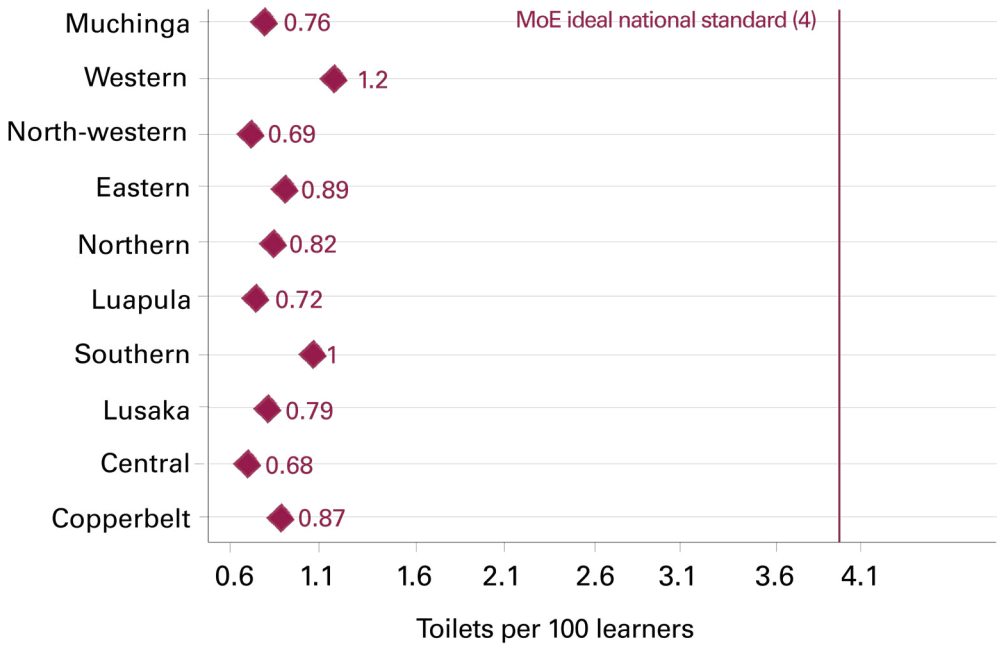
Sufficient learner textbooks and school libraries are both associated with better exam performance. Ministries of education and international organizations spend substantial resources on supplying books, yet the evidence on their effectiveness is mixed (Glewwe et al. 2009; Bolton 2013).

Similarly, school libraries support improved reading skills and academic achievement (Teravainen-Goff and Clark 2017; Wood et al. 2020). In both mathematics and English, around two to three learners share a textbook, while in Zambian languages around four learners share a textbook. Ensuring each learner has one textbook for the subject is associated with marginal improvements in exam performance – 0.4 raw points (0.04 SD) in English and 0.5 raw points (0.05 SD) in mathematics and Zambian languages.

In addition to textbooks, the presence of a school library was associated with a moderate 0.7 raw points (0.07 SD) improvement in mathematics and 0.9 raw points (0.09 SD) improvement in English exam performance. However, only 14 per cent of Zambian primary schools had a library in 2020, presenting an opportunity for exploring learning gains via increasing library success.

There are insufficient sanitation facilities (toilets) available in Zambian schools. In 2020, there were 0.85 toilets per 100 learners in a school. This toilet to learner ratio varied from three toilets per 100 learners in private schools to 0.8 in public schools, indicating wide infrastructural disparities across different school types. There were also variations by province (see **Figure 8**). The prevailing average of 0.85 toilets to 100 learners is significantly lower than the national ideal of four toilets to 100 learners.[31]

Figure 8: Toilet to learner ratio across provinces in 2020



Source: EMIS data 2015–2020. Calculations made by authors, representing an average of averages (average computed from school-level average toilet to learner ratio). All point estimates are weighted by the size of the primary school by enrolment.

[31] The national standard is 25 boys/toilet and 20 girls/toilet which translates into roughly 4 toilets per 100 students (or a toilet per 100 learners ratio of 4).

Presence of sufficient toilets is positively associated with exam performance. Ensuring access to hygienic toilets is beneficial for children's health and well-being and is expected to reduce absenteeism and promote learning (Snel and Shordt 2005; UNICEF China 2019). If the toilet to 100 learners ratio were improved from the prevailing average of 0.85 to 4, it is estimated that exam performance in English and mathematics could improve by 1.4 to 1.5 raw points (0.15 SD), and 0.5 raw points (0.06 SD) in Zambian languages. However, roughly 87,000 more toilets would need to be constructed across the nation to accomplish this, a massively expensive undertaking.

The presence of menstrual hygiene products in schools is also positively associated with school performance. Providing access to menstrual products is associated with a mild 0.3–0.4 raw points (0.03 SD) improvement in exam performance in mathematics and English. This is likely an inexpensive lever to improve exam performance. Currently, less than half of schools in the country (48.6 per cent) provide sanitary towels for girls. Fewer rural schools provide menstrual products – only 41.5 per cent, as compared to 65 per cent of urban schools. Interestingly, access to sanitary towels is more strongly related to school performance in urban areas than in rural areas. This difference could be due to differing cultural orientations and information surrounding the use of these products in urban settings compared to more rural areas.

The analysis also looked at the association of menstrual hygiene products with exam performance for girls only; to understand if girls' results were driving the trend. However, interestingly, this is not the case in most subjects, contrary to expectations.

4.4.3. Other school characteristics

Schools in urban areas perform better than those in rural areas. On average, an urban school performs 1–3 raw points (0.15–0.3 SD) better than a rural school, a sizeable and statistically significant association. This trend is somewhat expected given the many differences between urban and rural schools in terms of resources, geography, demographics, etc., that influence exam performance.[32]

Private schools significantly outperform all other types of schools in mathematics and English. However, the differences are less stark in Zambian languages performance. For example, on average, a private Zambian school is likely to perform 11–13 raw points (1–1.3 SD) better than other schools in mathematics. Similar trends persist in English performance. However, in Zambian languages, there are mostly no significant differences between private and other types of schools. In fact, grant-aided schools marginally outperform private schools. Similarly to the urban/rural differences, these trends likely reflect underlying differences in terms of resources, human capital capacity, and accountability structures prevalent in schools run by different agencies.

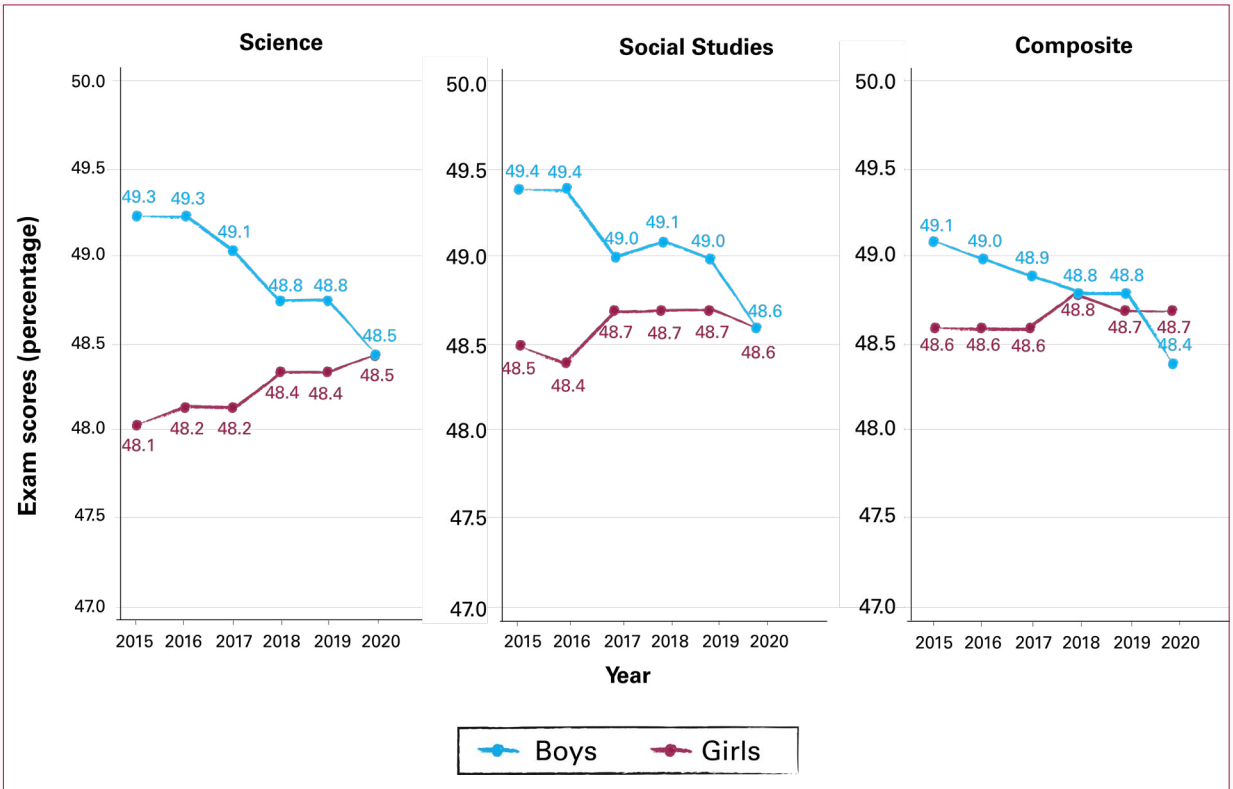
[32] This analysis controls for the observable differences in resources and staff quality. Still, there are likely other differences on which data are unavailable or unobservable. For example, urban schools may cater to students from higher socioeconomic backgrounds who are often better prepared for school.

Box 1

In addition to the foundational learning subjects, exam performance in science and social studies was also examined. **Figure 9** represents exam performance by gender in these subjects. Overall, **trends are similar to mathematics performance, with a narrowing of the gender gap, driven by small improvements in girls' performance and small drops in boys' performance over time.** For instance, in science, boys performed 0.8 percentage points lower in 2020 than in 2015, whereas girls' performance was 0.4 percentage points higher.

The econometric analysis showed similar associations and trends for science and social studies performance as mathematics and English (with minor differences in the magnitude of the associations and no differences in the direction of the relationship).

Figure 9: Exam performance in other subjects, 2020



Source: ECZ data 2015-2020. The average exam scores are represented as percentages (converted from a scale of 50-150) and all point estimates are weighed by the total number of exam takers. Calculations made by authors, representing an average of averages (average computed from school-level average exam scores).

5. Policy implications and areas for further exploration

Policy implications and areas for further exploration

This analysis from Stage 1 of the DMS positive deviance research illuminates trends and insights on the learner, teacher and school characteristics that are associated with exam performance in Zambian primary schools. These insights can serve as inputs in ongoing policy conversations or other research efforts, and can be a valuable tool for practitioners and researchers. The remainder of this section presents policy implications and areas for further exploration based on the results of the analysis.

Gender-responsive pedagogy

The findings suggest that **gender norms, expectations and biases may influence how teachers and students interact in Zambian schools, particularly in rural areas**. On average, girls perform better than boys in English, while boys consistently perform better than girls in mathematics. In addition, largely in rural areas, boys perform better in all subjects when there are more male teachers at their school, whereas girls perform better when there are more female teachers (especially for English and Zambian languages). These differences suggest the prevalence of gender-specific norms, which may influence how teachers and learners interact and behave in classrooms.

Stage 3 of the DMS research will investigate what school-level practices and behaviours may underlie these differences. Still, emerging policy implications include expanding efforts to dispel gender stereotypes, intensifying the encouragement of girls' interest in STEM subjects, and strengthening gender-responsive teaching methods and practices in schools and teacher training institutions. This may also include the need to review and revise teaching and learning materials, such as textbooks, where gender norms and biases may be depicted and reinforced. Many successful examples of gender-responsive teaching can be adapted to the Zambian context, including programmes piloted in the country. For example, when teachers in select Zambian schools were trained in gender-responsive pedagogy, they were reportedly able to create inclusive spaces that allowed learners to engage and interact more freely. Specifically, girls felt empowered to speak out when the teacher inequitably favoured boys in the classroom (Jaafar 2010 as cited in Dowd et al. 2018). Overall, these trends suggest a need for more deliberate mainstreaming of gender in all education sector policies.

Teacher allocation, training, and support

Early childhood education is a promising tool for improving promotion rates and other important outcomes.

According to the analysis, ECED experience is correlated to higher promotion rates in Nepal. Global evidence from other low- and The equitable allocation of a sufficient number of qualified teachers across all

regions is a key priority for the Government of Zambia, which has faced significant teacher shortages. At a national average of 60 students per teacher, the PTR is higher than the desired official standard of 40. **There is room to improve the equity of teacher distribution across schools and provinces.** The inequitable distribution of teachers influences both classroom learning conditions and teacher workloads, further compounding their already busy schedules. Understanding why these inequities persist and how to better allocate teachers can benefit learners and teachers.

In 2022, the Zambian Government recruited and deployed over 30,000 new teachers to address national teacher shortages and fill vacant teaching positions. The Government intends to recruit at least 4,500 more teachers. On the cusp of this expansive recruitment, some important considerations include:

- **Leveraging learnings from regions with appropriate PTRs.** PTRs in Zambia vary geographically (see section 4.3.2; UNICEF Innocenti, Zambia, MoE and UNICEF Zambia 2023), providing scope to investigate and learn from the policies and conditions in areas which have maintained appropriate PTRs.
- **Identifying ways of recruiting and retaining teachers in rural and remote areas.** Even within regions, there is variation in the PTRs between rural and urban locations, suggesting scope to allocate teachers more effectively within provinces. This is a complex issue to resolve, as teachers are often less enthusiastic about postings to rural or remote regions (as reflected in the country's high average rural PTR). However, some innovative incentive models exist, such as the salary increases model piloted in Zambia (Chelwa, Pellicer and Maboshe 2019), salary premiums in the Gambia (Pugatch and Schroeder 2014), and career progression and promotion pathways in Ghana and Kenya (Gad 2015; Kamere et al. 2019). Any of these models would need to be further piloted and contextualized to Zambia.

Given the relatively small associations seen between performance and PTR or class size, simply allocating teachers will likely not be enough to improve learning outcomes – other changes need to accompany this deployment. Detailed analysis and policy implications for this critical issue of teacher allocation in Zambia is further explored by UNICEF Innocenti's T4A initiative, which aims to expand the evidence base on optimizing teacher deployment in Africa (UNICEF Innocenti - Global Office of Research and Foresight, Zambia, MoE and UNICEF Zambia 2023).

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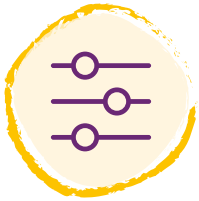
Language of instruction

There were often **differences in factors associated with performance in Zambian languages as compared to mathematics and English**. Zambian languages are the only subject for which rural schools perform better and where private schools do not perform sizeably better than government schools. Exam performance in Zambian languages has no association with teacher professional qualifications, and there is no consistent gender difference in exam results. This trend may be influenced by variations in how the existing language of instruction policy is implemented and perceived in Zambia. Anecdotally, MoE practitioners share that rural schools are more likely than urban schools to teach in the local language from grades 1 to 4 and code-switch in higher grades; this, combined with greater usage of the local language in daily life and play in rural communities, is likely to be reflected in higher Zambian languages scores in these locations, regardless of teacher competencies or school infrastructure.

Conversely, private schools may devote less time and resources to teaching Zambian languages due to perceptions that they are less important; learners in these schools may also be more likely to use English at home, which could further reduce their performance in Zambian languages. As such, future iterations on the language of instruction policy could benefit from a review of current trends and practices, ranging from how teachers are trained to how the policy is implemented and perceived at the school and classroom levels, as these differences may result in observable differences in school performance. Teachers' proficiency in Zambian languages also deserves further exploration, since teachers are currently deployed without consideration of their local language proficiency.

School libraries

Libraries could be a low-cost policy lever to improve learner performance. A library in the school is associated with higher exam performance in English and mathematics. Less than half of the primary schools in Zambia currently have libraries, offering a pathway to improve student learning by creating libraries and reading spaces. While it may not be financially feasible for schools to establish libraries from scratch, various creative, low-cost options include donation drives to build a book collection, creating 'library corners' in classrooms to provide some of the benefits of a library, or exploring the possibility of e-libraries. The national online learning platform, Learning Passport Zambia, was officially launched in November 2022 and provides opportunities for the MoE to upload e-books for learners to access reading materials from school computer labs or any device in their household.



Remedial learning

A higher proportion of repeaters in a classroom in Zambia was negatively associated with exam performance. More repeaters could make it more challenging to manage and run classes. These learners may require more attention and increase the heterogeneity in learning levels in a classroom. One way to address such

challenges could be more differentiated or remedial learning for learners based on their learning levels. This teaching method, popularly referred to as Teaching at the Right Level or TaRL, has been widely studied and shown to be effective across countries and contexts, including Zambia.

The MoE is already piloting this approach, known as the Catch-Up Programme, in 12 districts in the Luapula province (Oba 2022). If found effective, learnings from this pilot could help address similar challenges across all schools in the country. Other alternative remedial learning modalities that could be expanded include remedial lessons provided by the MoE's Directorate of Open and Distance Education through Open Learning Centres. These lessons take place after school in government schools and multimedia centres, and utilize interactive audio instruction through radios to help learners catch up with their studies.

Sanitation facilities

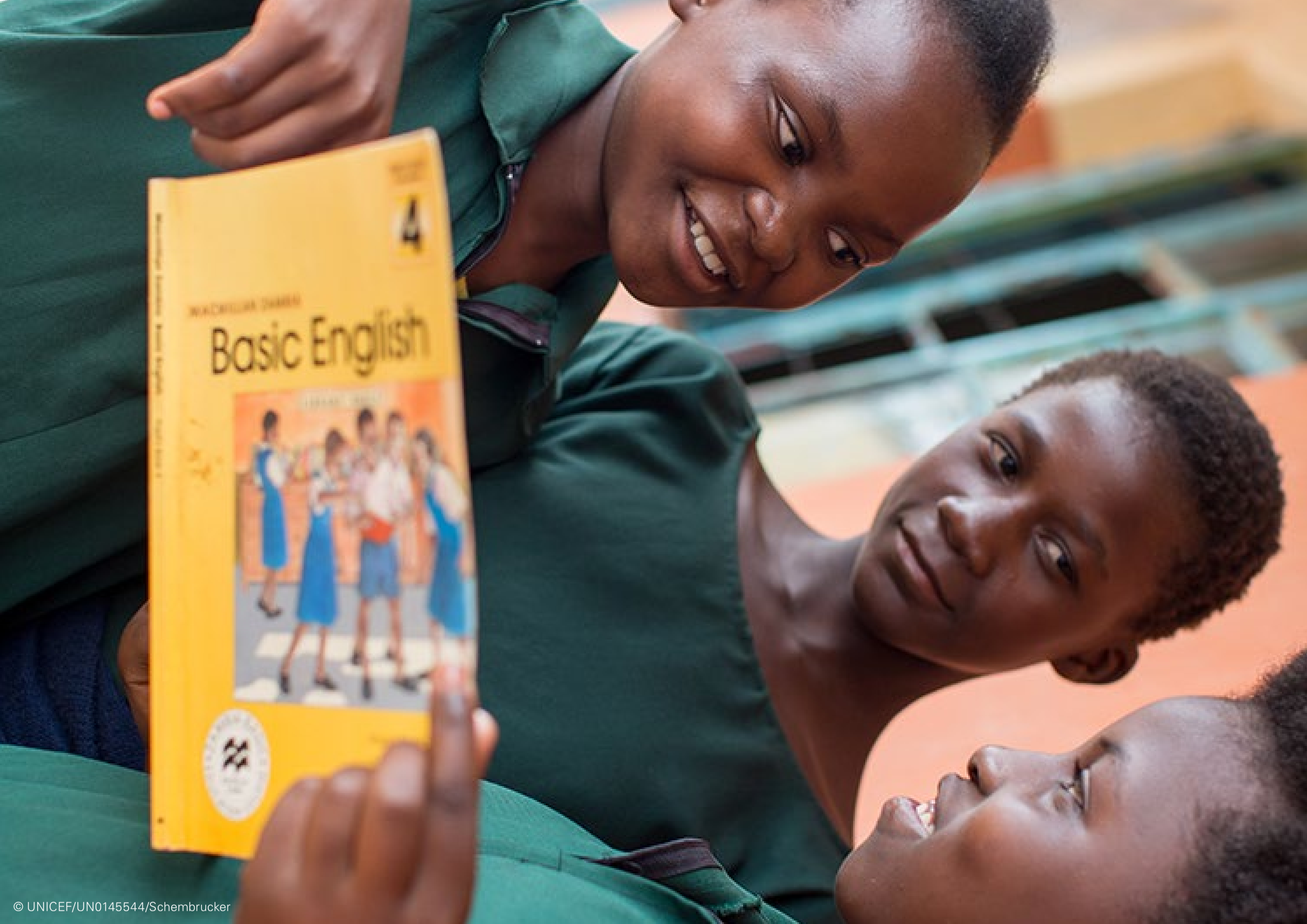
Sufficient access to clean toilets and menstrual hygiene products is associated with better exam performance, highlighting the importance of appropriate sanitation in schools. In Zambia, access to both facilities is insufficient and unequal, with better access in urban than in rural locations.

Access to menstrual hygiene products is more strongly associated with exam scores in urban areas. This could be because they are more likely to be used appropriately in urban regions, given prevailing cultural norms. Further research is needed to understand the dynamics of use in urban versus rural schools and to improve take-up. Additionally, providing access to sufficient menstrual hygiene products, a safe space to change during menstruation, and well-curated information on the benefits of using these, offer a relatively low-cost pathway to improving student learning.

Likewise, building and maintaining toilets offers another pathway to improved learning, albeit a more expensive one. However, while toilets are costly to construct, current capital investments can bear fruit over time and provide student learning and access gains.

School location and type

There were differences in exam performance or factors influencing performance based on a school's location or running agency. For instance, in 2020, rural schools were three raw points behind urban schools, and private schools scored 11–13 raw points higher than other schools in mathematics. **These inequities are a critical focus area for Zambia since most learners attend rural public schools, where performance is lower.** Policies targeting equity in outcomes across these different schools are essential for the future policy agenda. Government funding of public schools is one area where this challenge can be addressed. The current school grant allocation formula weighs school enrolment, a characteristic that advantages urban schools, at 50 per cent; meanwhile, distance, which may advantage rural schools, is only weighed at 20 per cent, and the remaining 30 per cent is a foundational amount received by all schools. The MoE aims to develop an updated school grant formula to address existing inequities better. This analysis can provide relevant insights to support this process.



6. Conclusion

Conclusion

Aligned with the national priority of improving learning outcomes, **Stage 1** of the DMS research drew upon six recent years of national education data to shed light on how school context and resource factors affect exam performance in Zambia.

Across the three main subjects of study (mathematics, English, and Zambian languages), many factors were consistently positively associated with exam performance. These included the context factors of having an urban location or private ownership, and factors related to school resources. Learner contact hours, sufficient seats for learners, sufficient learner textbooks and having a school library were associated with improved learning in all subjects, as were the presence of toilets and school provision of menstrual hygiene products. The presence of a female headteacher and the proportion of temporary or contract teachers, meanwhile, also had a smaller positive association with performance in all subjects. A few additional factors were positively associated with exam performance only in some subjects or for some students, but not all.

Other factors had negative associations with exam performance. For example, learner age, the percentage of repeaters in a grade, class sizes in grade 7 and the primary school PTR were negatively associated with exam performance.

The research findings identified insights that have implications for education policy in Zambia, including the Government's ongoing efforts to address teacher shortages and improve teacher allocation and training/support. They also highlighted the importance of fostering further discussion around the role of gender-responsive pedagogy, the language of instruction, libraries, effective options for remedial learning, and continuing to advance efforts to improve equity in education outcomes. Finally, these also offer areas for further research and exploration.

The quantitative and qualitative data collection planned for future stages of the DMS research will enable investigation into the root causes of some of the relationships identified in **Stage 1**; for example, why teacher gender is differentially associated with learner performance in rural areas. It will also enable the Ministry to delve beyond the limitations of nationally available education data to understand the more detailed school-level behaviours and practices that may affect student learning in Zambia. Together with the findings discussed in this report, the DMS research aims to develop a more nuanced understanding of how to improve student learning to inform policy in Zambia.

7. Appendices

Appendix A: Primary regression output table

Table 2: Multivariate regression analysis output tables

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Raw maths score**	**Raw English score**	**Raw Zambian languages score**	**Standardized maths score**	**Standardized English score**	**Standardized Zambian languages score**
Learner-level characteristics						
Learner gender (1 = female, 0 = male)	-2.109***	-0.967***	-2.548***	-0.212***	-0.091***	-0.336***
Proportion of repeaters in the grade	-2.374***	-3.012***	-0.905***	-0.239***	-0.284***	-0.119***
Average learner age in grade	-0.408***	-0.587***	0.065**	-0.041***	-0.055***	0.009**
Teacher characteristics						
Average age of teachers	-0.002	0.013	-0.010*	-0.000	0.001	-0.001*
Reference category: proportion of temporary or contract teachers						
Proportion of permanent teachers	-2.314***	-1.674***	-0.908***	-0.233***	-0.158***	-0.120***
Proportion of female teachers	-2.046***	-1.469***	-0.812***	-0.206***	-0.138***	-0.107***
Interaction: girl learner and female teacher	1.727***	2.732***	3.527***	0.174***	0.257***	0.465***
Reference category: proportion of teachers with a certificate or less						
Prop of teachers with a diploma	0.699***	0.864***	0.150	0.070***	0.081***	0.020
Prop of teachers with a degree	-0.518	0.733*	0.421	-0.052	0.069*	0.055
Teacher resource books-teacher ratio	0.317***	0.083	0.027	0.032***	0.008	0.003
PTR (in primary school)	-0.011**	-0.031***	-0.023***	-0.001**	-0.003***	-0.003***
Quadratic term: PTR squared	0.000	0.000***	0.000***	0.000	0.000***	0.000***

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Raw maths score**	**Raw English score**	**Raw Zambian languages score**	**Standardized maths score**	**Standardized English score**	**Standardized Zambian languages score**
School-level characteristics						
Gender of school head teacher (1 = female, 0 = male)	0.339***	0.221**	0.197***	0.034***	0.021**	0.026***
Daily contact hours	0.111***	0.087**	0.109***	0.011***	0.008**	0.014***
Classrooms per 100 learners	-0.037	0.035	-0.013	-0.004	0.003	-0.002
Class size in grade 7	-0.036***	-0.028***	-0.026***	-0.004***	-0.003***	-0.003***
# of seats per learner in the school	1.003***	0.661***	0.502***	0.101***	0.062***	0.066***
Toilets per 100 learners	0.446***	0.485***	0.131***	0.045***	0.046***	0.017***
Proportion of learners receiving bursary support	0.364	0.402	0.372	0.037	0.038	0.049
Does the school have electricity access (any source)?	-0.317***	-0.236**	0.134*	-0.032***	-0.022**	0.018*
Does the school have water access (any source)?	0.166	-0.031	0.383***	0.017	-0.003	0.050***
Does the school provide sanitary towels for girls?	0.262**	0.336***	-0.174**	0.026**	0.032***	-0.023**
Interaction: girl learner and access to sanitary towel	0.248	0.199	0.510***	0.025	0.019	0.067***
Does the school have a library?	0.684***	0.904***	-0.074	0.069***	0.085***	-0.010
Textbook-learner ratio for subject	0.911***	0.686***	0.508***	0.092***	0.065***	0.077***
Other controls						**0.077*** **
Is the school located in an urban neighbourhood?	1.765***	2.998***	1.012***	0.177***	0.282***	0.133***

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Raw maths score**	**Raw English score**	**Raw Zambian languages score**	**Standardized maths score**	**Standardized English score**	**Standardized Zambian languages score**
Reference category: private						
Running agency: Government	-12.887***	-13.504***	-0.423	-1.295***	-1.271***	-0.056
Running agency: grant	-10.747***	-11.499***	1.369***	-1.080***	-1.082***	0.180***
Running agency: community	-12.347***	-12.936***	-0.027	-1.241***	-1.218***	-0.004
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	120.554***	121.140***	101.755***	2.086***	2.106***	0.179**
Observations	50,000	49,985	49,609	50,000	49,985	49,609
R-squared	0.220	0.291	0.348	0.220	0.291	0.348

**** p<0.01, ** p<0.05, * p<0.1*

Appendix B: Descriptive statistics on variables used in primary analysis

This analysis required linking EMIS with ECZ data sets at the school/examination centre level for six years.

This was a complex process, because schools have different unique codes in the ECZ and EMIS databases, with no consistent key linking these two databases. For this reason, to harmonize school codes, fuzzy merging[34] was performed by using string variables such as school name and location.

Table 3 summarizes, by year, the number of schools for which data were successfully merged from the ECZ and EMIS databases across six years. Important caveats to this data set are that it (1) only includes schools that are examination centres (and hence present in the ECZ database), and (2) the average exam scores include scores from learners who attend the school and learners who attend a nearby non-examination centre school.

[34] Fuzzy merging is the process of matching two variables based on comparing strings, generally across multiple variables. For example, in this analysis, the comparison was conducted on school name, region name and district name.

Table 3: Merging the EMIS and ECZ databases

Year	Number of examination centres	Number of schools in EMIS data set	Number of schools merged
2015	5,281	9,525	4,909 (93%)
2016	5,468	9,642	5,125 (94%)
2017	5,584	9,852	5,272 (94.4%)
2018	5,179	11,068	4,899 (95%)
2019	5,897	10,611	5,269 (89%)
2020	6,253	10,807	5,447 (87%)

Appendix C: Descriptive statistics on variables used in primary analysis

Table 4 presents *weighted* descriptive statistics[35] for key variables at the national level and for various subpopulations (e.g., rural, urban, public and private). All estimates have been weighted by the primary school size (number of students enrolled) to represent the environment faced by an average student.

Table 4: Descriptive statistics by subgroup (2020)

Variables	National	Rural	Urban	Private	Public
Average maths score (50–150 scale)	98.6	97.7	100.8	117.6	98
Average English score (50–150 scale)	98.1	95.9	103.2	119.5	97.4
Average Zambian languages score (50–150 scale)	99.7	100.1	98.8	100.7	99.6
Learner age	13.9	14.1	13.4	12.4	14

[35] All summary statistics included in this table are weighted by the size of the primary school based on enrolment, and hence may differ from the unweighted statistics presented in certain sections of the report. For instance, in the teacher characteristics section, unweighted statistics are reported to provide a clearer picture of teacher resources and their characteristics in Zambia. Weighted statistics are presented to provide a sense of resources and environment faced by an average Zambian student.

Variables	National	Rural	Urban	Private	Public
Repeaters (%)	5.3	6.3	2.9	0.9	5.4
Teacher age	41.9	41.4	43.2	38.9	42
Permanent teachers (%)	93.8	95.8	89.3	3.4	96.5
Female teachers (%)	53	42.5	77.5	55.5	52.6
Teachers with a professional certificate or lower (%)	35.9	37	33.3	35.3	36
Teachers with a professional diploma (%)	51	50.7	51.8	57.6	50.8
Teachers with a professional degree (%)	13.1	12.3	14.9	7.1	13.2
Resource-teacher ratio	0.8	0.8	0.7	0.8	0.8
Pupil-teacher ratio	59.6	67.6	40.9	21.4	61.1
Electricity access (%)	62	48.3	93.9	99	60.2
Water access (%)	93	91.3	97	97.6	92.8
Classrooms per 100 learners	1.4	1.4	1.3	4.7	1.2
School head gender (% female)	0.3	0.2	0.5	0.4	0.3
Contact hours in grade 7	5	5.1	4.7	5.8	4.9
Class size in grade 7	49.7	45	60.4	31.3	50.4
Desk-learner ratio	0.3	0.3	0.4	0.8	0.3
Toilet-learner ratio	0.9	0.9	0.8	2.9	0.8
Schools with long-term multigrade provision (%)	0.02	0.02	0.01	0.03	0.02
Schools receiving bursary support (%)	0.01	0.01	0.01	0.04	0.01
Menstrual hygiene towels available (%)	0.5	0.4	0.7	0.7	0.5
Library (%)	0.1	0.1	0.2	0.6	0.1
Part of the population (%)	100	83.5	16.5	5.5	91.6

Appendix D: Subgroup analysis

As an additional robustness check and to understand which subgroup of schools may be driving certain associations seen in the data model, the analysis was also run on various subgroups – **rural, urban, public, private**. The results for the rural and urban schools' subgroups are depicted in Table 5. Similar analysis was also conducted for public and private subgroups and these results are available on request from the authors. For all models included in the table below, the model included in section 4.2 was estimated.

Table 5: Multivariate regression output by subgroup

	Mathematics			English			Zambian languages		
	(4)	(7)	(8)	(5)	(9)	(10)	(6)	(11)	(12)
Variables	National (std)	Urban (std)	Rural (std)	National (std)	Urban (std)	Rural (std)	National (std)	Urban (std)	Rural (std)
Learner gender (1= female, 0 = male)	-0.212***	-0.249***	-0.216***	-0.091***	-0.110	-0.072***	-0.336***	-0.131	-0.358***
Proportion of repeaters in the grade	-0.239***	-0.021	-0.272***	-0.284***	-0.232**	-0.240***	-0.119***	0.128	-0.133***
Average learner age in grade	-0.041***	-0.072***	-0.031***	-0.055***	-0.092***	-0.040***	0.009**	-0.001	0.010**
Average age of school teachers	-0.000	0.005**	-0.002***	0.001	0.005***	-0.001	-0.001*	-0.003*	-0.002*
Reference category: proportion of Temporary or Contract teachers									
Proportion of permanent teachers	-0.233***	-0.634***	-0.116**	-0.158***	-0.598***	-0.102**	-0.120***	0.052	-0.166***
Proportion of female teachers	-0.206***	0.237**	-0.206***	-0.138***	0.437***	-0.111***	-0.107***	0.043	-0.129***
Interaction: Girl learner and female teacher	0.174***	0.206*	0.198***	0.257***	0.298***	0.206***	0.465***	0.207**	0.515***

	Mathematics			English			Zambian languages		
	(4)	(7)	(8)	(5)	(9)	(10)	(6)	(11)	(12)
Variables	National (std)	Urban (std)	Rural (std)	National (std)	Urban (std)	Rural (std)	National (std)	Urban (std)	Rural (std)
Reference category: Proportion of teachers w. certificate or less									
Proportion of teachers w. a diploma	0.070***	0.107**	0.055**	0.081***	0.169***	0.038*	0.020	0.124***	0.001
Proportion of teachers w. a degree	-0.052	0.409***	-0.225***	0.069*	0.525***	-0.119***	0.055	-0.026	0.070
Teacher resource books: Teacher ratio	0.032***	0.035*	0.027*	0.008	-0.004	0.008	0.003	0.012	0.002
Pupil – Teacher Ratio	-0.001**	-0.008***	0.000	-0.003***	-0.012***	-0.001**	-0.003***	-0.003***	-0.003***
Quadratic term: Pupil – Teacher Ratio squared	0.000	0.000***	-0.000	0.000***	0.000***	0.000*	0.000***	0.000**	0.000***
0.034***	0.043***	0.023*	0.021**	0.041***	0.006	0.026***	0.026*	0.028**	0.028**
0.011***	0.013**	0.011***	0.008**	0.012**	0.010**	0.014***	0.005	0.016***	0.017***
-0.004	-0.044***	0.010*	0.003	-0.034***	0.012**	-0.002	-0.019***	0.008	0.008
-0.004***	-0.002***	-0.003***	-0.003***	-0.000	-0.002***	-0.003***	-0.002***	-0.004***	-0.006***
0.101***	0.196***	0.053**	0.062***	0.192***	0.004	0.066***	0.193***	0.019	0.023
0.045***	0.056***	0.018***	0.046***	0.063***	0.013**	0.017***	-0.008	0.029***	0.029***
0.037	-0.360***	0.109	0.038	-0.346***	0.116**	0.049	0.114	0.013	0.012
Does the school have electricity access (any source)?	-0.032***	-0.074**	-0.021**	-0.022**	-0.026	-0.014	0.018*	-0.062**	0.024**
Does the school have water access (any source)?	0.017	0.049	0.006	-0.003	-0.013	-0.010	0.050***	0.043	0.041***
Does school provide sanitary towels for girls?	0.026**	0.044**	0.010	0.032***	0.037*	0.022	-0.023**	-0.021	-0.027**

	Mathematics			English			Zambian languages		
	(4)	(7)	(8)	(5)	(9)	(10)	(6)	(11)	(12)
Variables	National (std)	Urban (std)	Rural (std)	National (std)	Urban (std)	Rural (std)	National (std)	Urban (std)	Rural (std)
Interaction: girl learner and access to sanitary towel	0.025	0.019	0.029	0.019	0.017	0.017	0.067***	0.045	0.077***
Does school have a library?	0.069***	0.135***	0.012	0.085***	0.128***	0.035**	-0.010	0.018	-0.031**
Textbook-Learner ratio for subject	0.092***	0.110***	0.084***	0.065***	0.098***	0.042**	0.077***	0.094***	0.072***
Is the school located in an urban neighbourhood?	0.177***			0.282***			0.133***		
Running agency: Government	-1.295***	-1.079***	-1.153***	-1.271***	-0.930***	-1.282***	-0.056	-0.303***	-0.179**
Running agency: Grant	-1.080***	-0.684***	-0.998***	-1.082***	-0.523***	-1.173***	0.180***	0.060	0.017
Running agency: Community	-1.241***	-1.016***	-1.139***	-1.218***	-0.942***	-1.201***	-0.004	-0.157***	-0.119
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.086***	2.470***	1.710***	2.106***	2.573***	1.829***	0.179**	0.199	0.472***
Observations	50,000	8,005	41,995	49,985	8,005	41,980	49,609	7,736	41,873
R-squared	0.220	0.538	0.118	0.291	0.578	0.146	0.348	0.482	0.320

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix E: Robustness checks

To check if the results obtained are robust to different specification choices for the estimated models, regressions based on alternative specifications were also estimated. The following specifications were estimated:

1	Firstly, sampling weights were used to account for the relative importance of schools and give more weight to larger schools (size being defined according to the number of learners). This was intended to address the fact that smaller schools have averages calculated on the basis of a limited number of pupils, which can lead to significant fluctuations from one year to the next and influence the results.
2	Another specification ran the regressions by excluding data from the year 2018, which had some inconsistencies in comparison to the other years of EMIS data.
3	Subgroup analysis: models were also estimated for various subgroups (see **Appendix D**) to understand if a certain subgroup was particularly important for certain associations, and to ensure that these results were consistent.
4	Fixed effects: models without fixed effects and with region fixed effects were also estimated.

While there are variations in some results, by and large these alternative models provide very similar results to the primary models estimated in the main section of this report.

Appendix F: Research questions and stages of the research

The DMS research employs mixed methods and a staged approach to answer four main research questions. It draws extensively on the positive deviance research approach as well as insights from behavioural sciences, implementation research and scaling science. The methodology employed includes both secondary data analysis and quantitative and qualitative data collection.

The four main research questions are:

Question 1	What are the human and material resources and contextual factors that are most associated with school performance in Zambia?
Question 2	Which schools are outperforming their peers in the same context and with the same level of operating resources?
Question 3	What are the practices and behaviours of stakeholders at district, school, classroom and community levels that are making a difference in positive deviant schools, in comparison to the practices and behaviours in the other less-performing schools?
Question 4	What policy, system and community levers can incentivize the scaling of the positive deviant practices and behaviours in low-performing schools, addressing the 'know-do' gap?

At country level, the research design is implemented through the following four stages.

Stage 1	**Quantitative research**	This first stage employed statistical analysis using existing education data sets to identify the human and material resources and contextual factors driving school performance in Zambia, with findings shared in this report.
Stage 2	**School typology**	This stage, which was carried out in 2022, will categorize schools according to their contexts and will identify positive deviant schools in each contextual and resource environment.
Stage 3	**Identifying behaviours and practices**	The third stage will investigate why positive deviant schools perform better using mixed-methods primary data. Behaviours and practices in the high-performing 'positive deviant' schools and average-performing 'control schools' will be compared using data-collection instruments such as interviews, surveys, and classroom and school observations. Other data-collection instruments will include questionnaires and interviews with key stakeholders at all levels – country, province, district, school and community. The data collected will help identify positive deviant practices and behaviours in different contexts. This stage will be implemented in late 2022 and early 2023.
Stage 4	**Scaling science and implementation research**	This stage will use participatory action research to identify concrete levers and incentives at the system, school and community levels to scale up positive deviant practices and behaviours to all Zambian schools. This stage involves various stakeholders to identify practical, scalable and feasible policy levers to incentivize low-performing schools to adopt the behaviours and practices of the positive deviant schools and, in turn, become high-performing schools themselves. It will be carried out in mid-2023.

The country-level stages of the research are also informed by a global DMS methodological review that was conducted in the research inception stage. National, regional and global dissemination of the research findings will be an additional ongoing process throughout the research.

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