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Geography, School Size and Infrastructure Inequality:

Institutional Constraints in South African Schooling

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OPTIMA

Geography, School Size and Infrastructure Inequality: Institutional Constraints in South African Schooling

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Abstract

Significant and persistent inequalities in school infrastructure remain a defining feature of South Africa's education landscape. Using three rounds of the School Monitoring Survey (2011, 2017, and 2022), this paper documents spatial patterns in access to basic services, functional facilities, and classroom conditions. A case study of Limpopo highlights how historical settlement patterns and institutional processes shape these inequalities. The paper also analyses National Treasury expenditure data to trace long-run trends in infrastructure spending, illustrating uneven provincial investment over time.

Although primarily descriptive, the paper employs econometrics to estimate the association between school size and infrastructure quality. Complementary spatial analysis and graphical evidence deepen the understanding of how infrastructural backlogs constrain academic offerings and learner performance in small schools. Moreover, infrastructure-constrained schools face heightened transaction costs. The paper theoretically explores how these elements affect teachers, their professional aspirations, utilisation, and motivation. The findings provide an empirical foundation for infrastructure policy, rationalisation debates, and future work that employs more rigorous causal methods.[2]

[2] A more rigorous econometric approach for estimating the causal impact of infrastructure interventions on learner performance, using a Difference-in-Differences framework, is explored in a separate forthcoming paper.

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1. Introduction

The United Nations, through the Sustainable Development Goals (SDG) numbers three, four, and six, hereafter referred to as 'the SDGs', advocates for the advancement of good health and well-being, quality education, and *clean water and sanitation*, respectively. Therefore, advocating for the betterment of school infrastructure in South Africa not only passes as a national prerogative, but as a fundamental human right recognised globally through the SDGs, and domestically through Paper 2[3] of the Constitution of the Republic of South Africa, hereafter referred to as 'the Constitution,' and goals 17, 24, and 25[4] of the Department of Basic Education's (DBE) Action Plan to 2024[5], which aligns with the broader National Development Plan (NDP) of 2030. To supplement the SDGs and the DBE's Action Plan, the Bill of Rights protects the following rights that bear relevance to the aims and objectives of this thesis: (1) education, '*Everyone has the right to a basic education…which the state, through reasonable measures, must make progressively available and accessible';* (2) environment, '*Everyone has the right to an environment that is not harmful to their health or well-being*'; (3) human dignity, '*Everyone has inherent dignity and the right to have their dignity respected and protected*'. It is therefore possible to consolidate the aforementioned SDGs, rights, and goals of the action plan into one unified message that reads as follows: "*All learners and educators in South Africa have the right to teach and learn in an educational environment that promotes good health, well-being, and is fitted with sanitation facilities that protect and uphold their human dignity.*"

Regrettably, South Africa has continually relied on outdated systems and ideologies to address the longstanding problem of school infrastructure backlogs, when overcoming these backlogs and achieving universal, dignified school infrastructure requires a renewed political and bureaucratic approach that is adaptive to on-the-ground realities. One such reality is migration, and this paper will closely examine its historical and

[3] Chapter 2 of South Africa's Constitution entitled: The Bill of Rights.
[4] Goals 17, 24, and 25 are targeted towards the achievement of the following aims, respectively: "improve teacher job satisfaction," "improve school infrastructure," and "promote health and well-being."
[5] The Action Plan to 2024 serves as the DBE's sector plan and serves as the department's strategic thrust towards "the realisation of schooling 2030", through access, redress, equity, inclusivity, quality, and efficiency.

contemporary role in creating efficiency differences in service delivery between rural and urban areas and in shaping urban preferences[6].

2. Research Questions and Data

Given Apartheid's legacy and undeniable contribution to post-apartheid school infrastructure backlogs, it is worth pondering the malleability of existing political and bureaucratic systems to accommodate change. To aid our understanding of how political, bureaucratic, social, and economic interactions give rise to urban preferences and efficiency differences, this paper will investigate the following research questions: (1) What has happened to key school infrastructure spending in South Africa over time (2) What has happened to key school infrastructure variables in South Africa over time, and what systems (i.e., political and bureaucratic) are relied upon to address poor infrastructure backlogs? (3) Is there a relationship between school size and school infrastructure quality? (4) How does the relationship between school size and infrastructure translate to academic performance in school-leaving exams at the end of grade 12?

2.1 Data Sources

Subsequent sections of this paper will rely on three data sources to bolster its arguments. Firstly, three rounds of the School Monitoring Survey (SMS) will be used: the 2011, 2017, and 2022 iterations. The SMS[7] is a 2000-school, nationally representative survey of public schools and serves as a critical enabling tool for policymakers to assess the progress of the education sector in South Africa against the DBE's Action Plans and the Department of Planning, Monitoring and Evaluation's (DPME) five-year Medium-Term Strategic Frameworks (MTSF). The survey commenced in 2011, followed by two subsequent rounds in 2017, which tracked progress against Action 2019 and MTSF 2014-2019, while the 2022 round tracked progress against Action Plan 2024 and MTSF 2019-

[6] The *'Urban Preference'* among teachers has most recently been documented by van der Berg et al., (2015) in the Sub-Saharan Africa context. Hofmeyr, Pampallis, Qvist and Swelindawo (2024) further confirm the persistence of this preference, while a forthcoming paper by Swelindawo (2026) examines the dynamics of the urban preference and the corresponding 'rural compromise' in greater depth.

[7] The 2000 schools are separated in two groups of 1000 schools; 1000 schools offering Grade 6 (identified to be primary schools) and 1000 schools offering Grade 12 (identified to be secondary schools).

2024. The SMS is a rich dataset that comprehensively captures school infrastructure and sanitation.

Secondly, National Senior Certificate (NSC) data for multiple years (2008-2022) is employed to conduct learner-level performance analysis in Mathematics and English First Additional Language (EFAL). The NSC data is used in unison with the third data source, which contains a list of closed schools in South Africa between 2017 and 2023. The dataset includes 3990 schools across eight provinces (excluding Gauteng). It contains information on the school's district, name, the *Education Management Information System* (EMIS) number[8], province, and the number of teachers and learners.

The data sources are therefore employed to conduct several, yet integrated analyses ranging from spatial to pure econometric analyses.

3. Exclusion, Urbanisation and the 'Urban Preference'

Segregationist and Apartheid policies have left an ingrained mark on the geographic landscape of South Africa. The seeds were sown in the period between 1913 and 1936, when British administrators, later followed by successive Apartheid governments, sought to separate the native black population from the white population through the establishment of 'reserves' in mostly rural and tribal areas. The pace of segregation intensified when the National Party (NP), an Afrikaner Nationalist party, came into power in 1948. The Department of Native Affairs, under the stewardship of Minister E.G. Jansen, was paramount in overseeing the intensification. Despite Minister Jansen's bold declarations to rigorously contain African urbanisation, some sections of the NP saw him as too "timid" and inadequate a leader to champion the intensification of Apartheid. As such, Jansen was relieved of his duties as minister in favour of the more hardline nationalist, Hendrik Verwoerd, in 1950 (Dubow, 2014:60). Verwoerd's tenure saw the intensification of native administration and subjugation, as evidenced by the promulgation of the Group Areas Act (GAA) in the same year of his appointment. The GAA was a key vehicle in reinforcing racist Apartheid ideology and was promulgated to control many aspects of land ownership in South Africa through a racial lens (Maharaj,

[8] Every school in South Africa has a unique identifier number known as the Education Management Information System (EMIS) number.

1997:135). This brought about the establishment of the Bantustans[9] and included, but not limited to, the separation of residential areas, amenities, and educational services by race and ethnicity (Lipton, 1972:1; Turok, 2012:8).

From the literature, it is evident that Bantustans were never destined for high-quality infrastructure development; thereby, resigning those who lived in them to a life of grave underdevelopment. In addition to infrastructure underdevelopment, the introduction of the Bantu Education Act in 1953, which gave power to the creation of a sub-standard education system aimed at black education in the homelands, further solidified the foundations of Apartheid as part of the Bantu Education system included a deliberate attempt to instil racial inferiority and '*prepare natives for a life of subservience in a predominantly white society'* (Christie and Collins, 1982:59).

The large-scale financial neglect of Bantustans meant that adequate standards of infrastructure development could not be achieved, resulting in most schools relying on archaic systems, e.g., mud-built structures, bucket toilets, and pit latrines, and functioning without electricity or clean water. Some of these issues continue to characterize the lived experience of many schools in South Africa (Khumalo & Mji, 2014:1521), 31 years since the end of Apartheid.

[9] The Bantustans, also known as Homelands, were separated primarily by ethnicity. The Xhosa people were divided into two separate Bantustans, the Ciskei and the *Transkei*. *KwaZulu*, which directly translates to "the home of Zulu", was reserved for the Zulu people. *Bophuthatswana* was reserved for the Setswana people. *Lebowa* was home to the Pedi and Northern Ndebele speaking people. The *Venda* homeland was home to the Venda people, while Gazankulu and QwaQwa were reserved for the Tsonga & Shangaan people, respectively, and for the Basotho people (Lipton, 1972:4-5).

3.1 The Role of Migration and Urbanisation

The end of Apartheid in 1994 saw the reunification of all Bantustans with the formerly white republics, e.g., the Orange Free State, Transvaal, and the Cape of Good Hope, into one republic comprising nine (9) provinces (Alexander, 2018). The new dispensation came with the lifting of restrictions on movement, allowing all South Africans to move freely between the nine provinces. Numerous authors, Posel and Casale (2003:4), Kok *et al.* (2003), Posel (2004), Crush (2011), Turok *et al*. (2014:675), and Moses (2020) find that internal migration, which measures migration within the borders of a country, increased significantly in the post-Apartheid period. Posel and Casale (2003:4) report that during 1993 and 1999, migration in South Africa was dominated by Black Africans, particularly females, thanks to greater female labour force participation (Posel, 2004:277). For simplicity, authors generally refer to the most common migration patterns seen in South Africa as *'rural-to-urban'* migration (Turok *et al.*, 2014:676), notwithstanding the circular[10] nature of this migration. The accurate reality, however, according to Cross *et al*. (1998:646), is that most migrants leave rural areas to settle in the rural peripheries of urban metropolitan areas, i.e. townships, which are often plagued by overcrowding, unemployment and poor social conditions in general, resulting in what Ravallion *et al*. (2007) refers to as the '*urbanisation of poverty*'. As such, the conditions of schooling in the peripheries of urban areas often mimic those in rural areas, albeit to a lesser extent, e.g., poor infrastructure, sanitation, and educational outcomes.

Freedom of movement and migration in the post-Apartheid period may constitute only part of the explanation for the existence of the *'urban preference'*. Rural-urban migration may have increased after Apartheid, but it coincided with increases in global urbanization (Wang et al., 2012:300). The post-Apartheid trends in global urbanization suggest that rapid urbanisation was an international phenomenon, driven mainly by political and technological change, more so in developing countries (Cohen, 2006:68; Turok, 2012:1). Given this, then, rapid urbanisation inadvertently exacerbated rural deprivation (Turok

[10] Born from exclusionary policies that were aimed at restricting black urbanisation during Apartheid, circular migration still represents the main migratory pattern seen in South Africa today. Migrants often oscillate between their rural and urban homes (Cross *et al.*, 1998; Posel, 2004). Therefore, out-migrating from rural areas into centres of urban development to seek employment and earn an income, before returning to their homes in the rural areas. This is also true for cross-border migrants from outside South Africa, such as Mozambicans (de Vletter, 2000) and Zimbabweans (Zinyama, 2000).

et al., 2014:676), as rural areas experienced an exodus of 'productive'[11] rural inhabitants, to seek employment in urban areas. In a developmental context, Amartya Sen's *Development as Freedom* (2000) argues that, to increase individuals' freedoms and capabilities, development should not start from the outside but from within. From a community development perspective, then, one should expect the inhabitants of a village to be at the forefront of championing the growth and development of their villages, as opposed to 'benevolent' outside forces. However, when the most productive individuals in a village out-migrate, they leave behind the least productive members, e.g., the elderly, economically inactive, children, *etc.*, who are also the least likely to lead any developmental process; therefore, limiting the developmental potential of that village. The outflow of productive individuals broadly characterizes the past and current reality of South Africa's rural areas (Turok, 2012:11), which may explain the inertia seen in rural development.

The lack of prior and contemporary development in rural areas often results in them being overlooked for infrastructure and economic development. Whatever the reasons, one potential explanation lies in the high transaction costs of developing rural areas from the ground up. As such, the impact of past legacies and urban pulling forces ensures that rural and black education.[12] In general, if one may call it that, it continues to suffer grave losses in educational performance, which heavily impedes attempts to restore the dignity of those trapped in rural areas – learners and teachers alike.

4. Infrastructure Delivery and Fiscal Context

Limpopo, alongside the Eastern Cape and KwaZulu-Natal, is one of South Africa's leading provinces in terms of geographic rurality and school infrastructure backlogs (NEIMS, 2009-2020). Historically, these three provinces also had the largest contingent of homeland land cover (Butler *et al.,* 1978); thus, it is unsurprising that they have also experienced severe backlogs in basic infrastructure development. These provinces,

[11] 'Productive' in this context is describes those individuals, men and women, who, firstly, have the means and drive to relocate from rural areas in hopes of finding employment opportunities elsewhere and secondly, those who are willing and able to exchange their labour for a monetary reward.

[12] Although most formerly "White only" schools are racially integrated today, many schools in South Africa remain racially homogenous, especially among the Black population. Shepard, 2011; Taylor, 2011 and Spaull, 2013, show that former homeland schools, African language schools and Black learners are overrepresented in underperformance statistics when it comes to literacy and numeracy test scores.

particularly the Eastern Cape, also boast the largest contingent of small[13] schools. The Limpopo Department of Education (LDoE) presents itself as an appropriate candidate for case study research on school infrastructure[14], due to its large contingent of rural villages in the province, which, when juxtaposed against more urban settings, provides a clear contrast of realities from which efficiency differences and transaction costs can be studied.

4.1 Defining School Infrastructure

According to the respondents, the definition of school infrastructure comprises four crucial aspects. The first aspect is *basic security,* which concerns the provision of basic needs and services commonly expected in a school, such as water, sanitation, and general safety. The second aspect is *minimum functionality,* focusing on meeting the minimum operational needs of a school, including classrooms, kitchens, administration blocks, and printing and storage rooms. These needs are deemed essential, as their absence negates any attempt to conduct teaching and learning. The third aspect is *optimum functionality;* this is the highest level of infrastructure provisioning that provincial infrastructure planners aim to achieve. It includes providing other types of infrastructure that promote holistic education, e.g., sports fields and recreational amenities. Expectedly, *optimum functionality* is challenging to attain across the quintile and geographic landscape, owing to decades of segregationist and exclusionary education policies that prioritised the needs of white urban schools, at the expense of rural and predominantly black schools. As a result, inequalities in optimum functionality, as with many other aspects of South Africa's education system, can be drawn along racial, socioeconomic, and geographic lines; addressing this problem continues to pose significant challenges to infrastructure planners. [15]

[13] According to the DBE's Guidelines for Rationalisation and Re-alignment of Public Schools, a school is classified as "micro" when enrolment is less than 135 learners for primary schools, whilst the threshold increases to 200 and fewer learners for secondary and combined schools.

[14] Interviews were conducted over the course of a week in August and September of 2021; the respondents consisted of senior management officials in the finance, strategic planning, and infrastructure departments, which allowed for the gathering of rich information about the inner workings of the entire infrastructure delivery process, i.e., planning, budgeting, and implementation.

[15] The fourth aspect is known as *enhancement*. It does not form part of the overall goals of infrastructure planners, as the need for school enhancements is determined solely by the national Minister of Basic Education. It is a rare occurrence and involves the 'additional' supply of infrastructure to a school that already satisfies all three aforementioned aspects, i.e., building of a state-of-the-art library or computer laboratory.

4.2 Budgeting for School Infrastructure

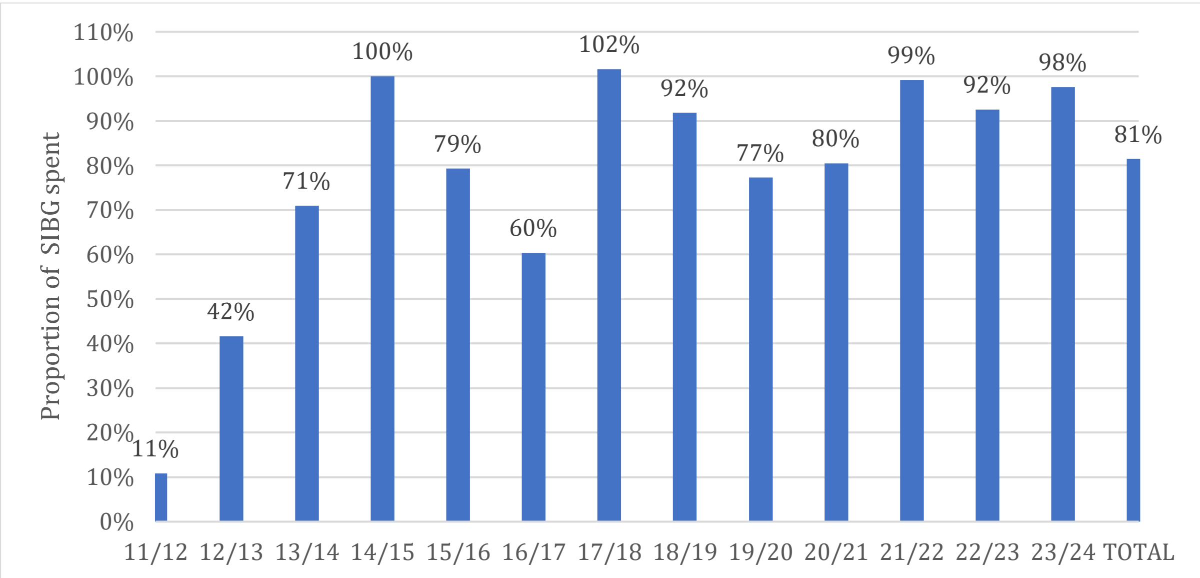
Budgeting for infrastructure is a unique process; according to respondents, the main distinguishing factor between infrastructure and other goods and services is the type of funding provided. The total infrastructure budget for Limpopo for the 2021/22 financial year was R1.3 billion. The grant is conditional, regulated by the Education Infrastructure Grant (EIG) framework, and specifically earmarked for infrastructure projects within a financial year. The grant is all-encompassing and covers many aspects of infrastructure beyond brick-and-mortar operations, including maintenance and professional service fees (e.g., engineers and architects). The grant also includes the salaries of designated infrastructure officials in the department. Roughly, 30 to 40 percent of the annual infrastructure budget is spent on professional services and wages. This is significantly different from the budgeting process for other goods and services, which usually starts with the national treasury requesting budgets for provincial departments' goods and services; these may go through several drafts before being approved by the national treasury. Only once the treasury has approved the department's budget can it request the budgets of the districts falling under its jurisdiction. The provincial department, therefore, studies district-level budgets and allocates funds to districts based on their most pressing infrastructure needs, rather than on all budgeted items. Budgetary priority is also given to multi-year and existing projects over new ones.

Another dynamic that distinguishes infrastructure budgeting from that of other goods and services is the fact that infrastructure budgets are drawn up and approved for the lifespan of the projects, i.e., from start to finish. Conversely, for other goods and services, funds can be withdrawn and redirected to different areas in the event of unforeseen emergencies.

4.2.1 Trends in School Infrastructure Spending

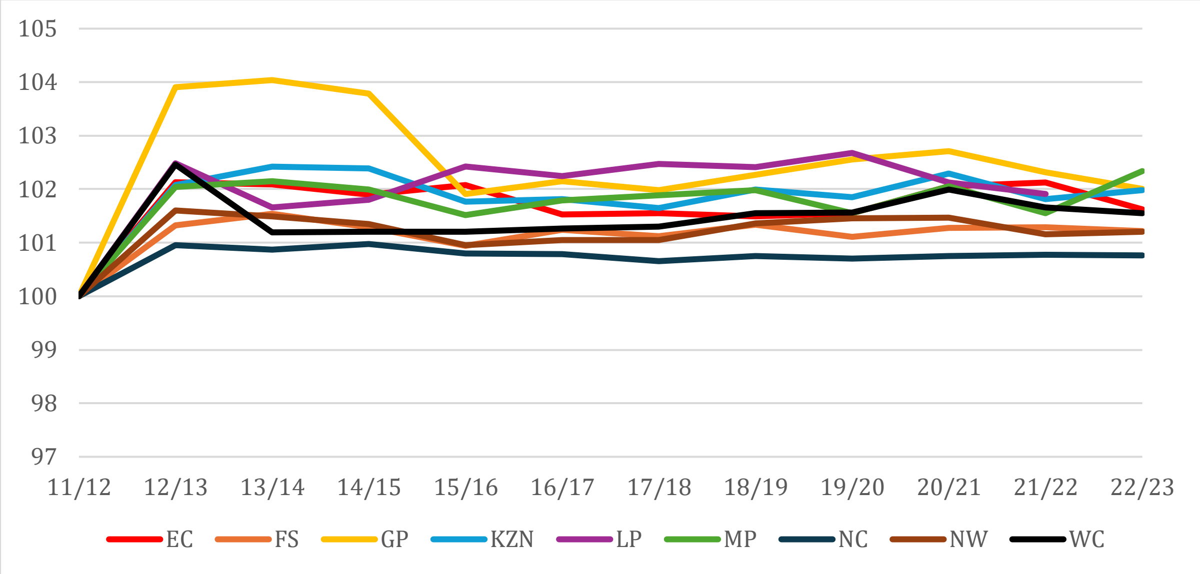
The EIG is supported by the School Infrastructure Backlogs Grant (SIBG) in dealing with the county's school infrastructure needs. The SIBG primarily deals with infrastructure backlogs and funds the Accelerated School Infrastructure Delivery Initiative (ASIDI), which seeks to implement basic infrastructure Norms and Standards in schools. Over time, billions of Rands have been allocated towards the EIG and SIBG. Figure 1 below shows the SIBG's spending patterns over the period 2011/12 to 2023/24. Overall, 81% of all funds allocated towards the SIBG have been spent on eradicating infrastructure backlogs. In the 2011/12 financial year, only 11% of the SIBG was paid, but a clear pattern of improvement in spending patterns was observed until the 2014/15 financial year, where 100% of the SIBG was spent. The following financial years, 2015/16 and 2016/17, saw a reduction in spending, before spending improved once more in 2017/18. Since 2017/18, SIBG expenditures fluctuated between 77% and 99%, with a notable decline during the COVID-19 pandemic. Since the Covid-19 pandemic, spending has increased and remained consistent at 90%-100%, a positive sign for the country's schools, which are in urgent need of infrastructure and maintenance upgrades.

Figure 1: Percentage of School Infrastructure Backlogs Grant spent over time



Note: Author’s own calculations. Data provided by the National Treasury.

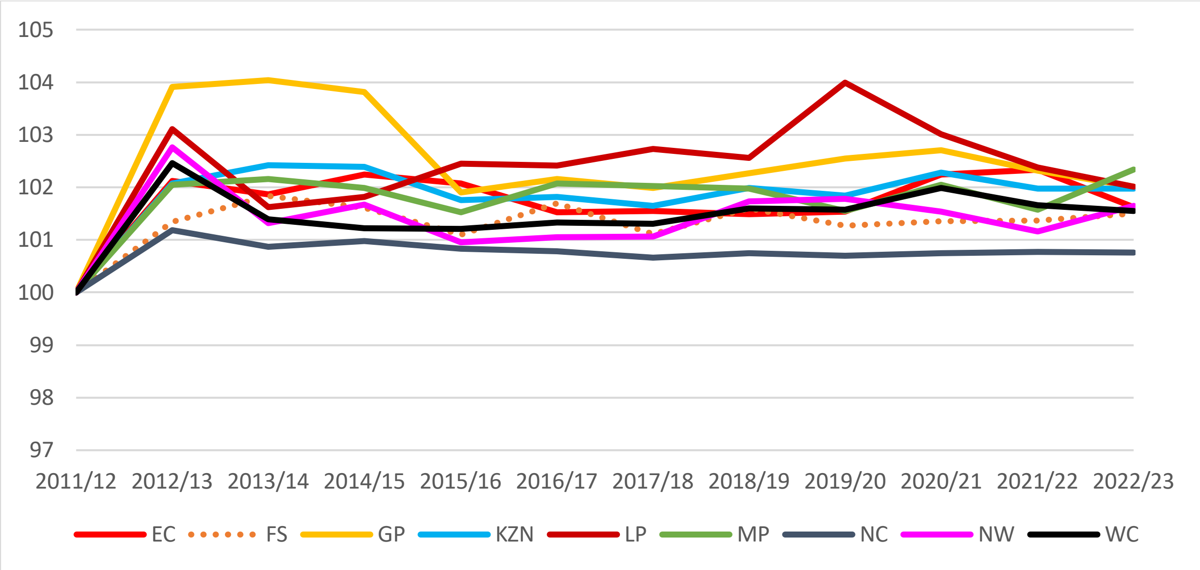
Figure 2: Inflation and Population adjusted EIG made available by provinces between 2011/12 and 2022/23



Note: Author's own calculations. Data provided by the National Treasury. Figures are adjusted for inflation and population growth using total learner enrolment numbers as published in the School Realities Reports from various years. The 2022/23 figure for Limpopo is excluded due to an unexpected jump that distorts the overall graph.

Figure 2 above depicts the growth in the EIG made available to provinces for the 2011/12 and 2022/23 financial years, adjusted for inflation and population growth using learner enrolment numbers. Despite the outsized growth in the EIG for Gauteng relative to other provinces, since the 2015/16 financial year, it has declined to within the range of the other eight provinces. Overall, all provinces have seen growth in their EIG allocations, averaging about 3% for the period under study. Figure 2 shows only intertemporal growth in EIG, not its expenditure, which is a more important indicator of PED's commitment to providing quality school infrastructure.

Figure 3: Inflation and Population-adjusted EIG expenditure by province between 2011/12 and 2022/23



Note: Author's own calculations. Data provided by the National Treasury. Figures are adjusted for inflation and population growth using total learner enrolment numbers as published in the School Realities Reports from various years. Linear interpolation was employed to impute a value for Limpopo in the 2020/21 financial year.

Analogous to Figure 2, Figure 3 shows an increase in EIG expenditure across all provinces from 2011/12 levels. While Gauteng saw an outsized rise in spending between 2011/12 and 2014/15, expenditure normalised to a pattern of growth similar to that of the other provinces over the period under study. Since the 2013/14 financial year, Limpopo has steadily increased EIG expenditure, an encouraging development given the province's struggles to eradicate infrastructure backlogs. As a result of this sustained growth, Limpopo was also the only province to see expenditure growth exceed 3%. However, this increase was observed only between the 2018/19 and 2019/20 financial years, after which expenditure declined to within the 3% growth band for the remaining financial years.

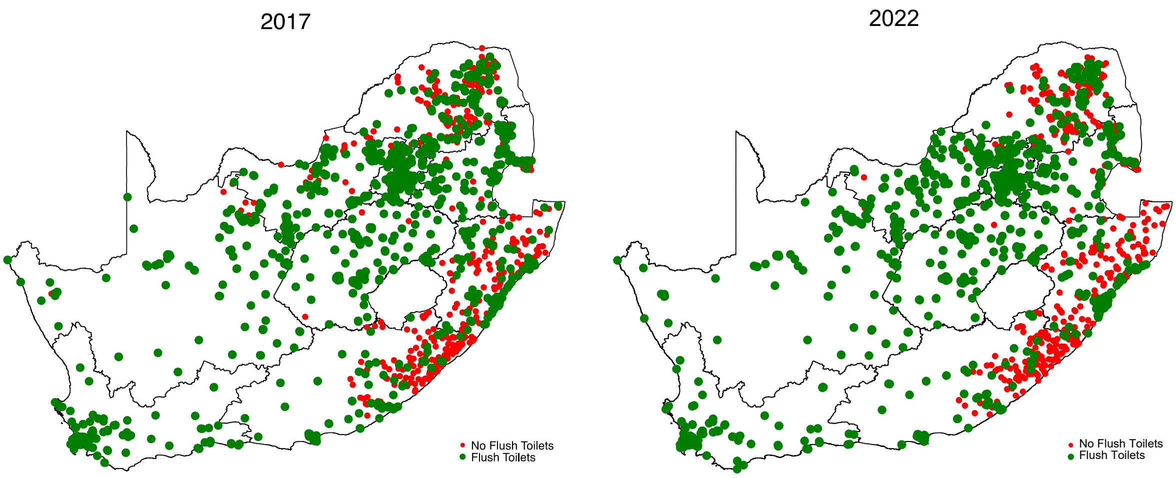
Overall, the growth in EIG funds allocated and spent is encouraging, albeit within a 0-3% band. It is particularly encouraging given South Africa's sluggish economic growth over the same period. However, the reality on the ground often does not match the spending patterns shown in Figures 2 and 3, as many schools across the country still struggle with basic infrastructure needs, as illustrated in Section 5 below.

5. Spatial Trends in School Infrastructure Variables

The subsequent series of maps generated in the statistical programme, Stata, examines trends on critical infrastructure variables, which include sanitation facilities (specifically flush toilets), water supply, electrification, internet accessibility, and learner-to-classroom ratios (a measure for overcrowding), for the years 2017 and 2022[16]. Central to this analysis is the understanding that the School Monitoring Survey (SMS), which serves as the primary data source, did not survey identical schools across the 2017 and 2022 rounds. Therefore, the approach avoids attempts to demonstrate direct one-to-one comparisons within the same schools for the variables above. The primary objective, however, is to paint a comprehensive overview of overarching trends reflecting improvements or deteriorations across the two periods under study. The use of maps is insightful for tracking the evolution of school infrastructure trends across South Africa. The importance of these insights is twofold: (1) they highlight the strides taken by the authorities in championing educational and socio-economic development across some of South Africa's previously disenfranchised regions. However, and perhaps more importantly, given South Africa's segregationist past, (2) they have the power to expose longstanding neglect of these areas by post-Apartheid governments, thus serving as a yardstick against which their promises can be measured.

5.1 Access to Toilets

Figure 4: Access to Flush Toilets in South African Schools for 2017 and 2022.



Source: School Monitoring Survey, 2017 and 2022

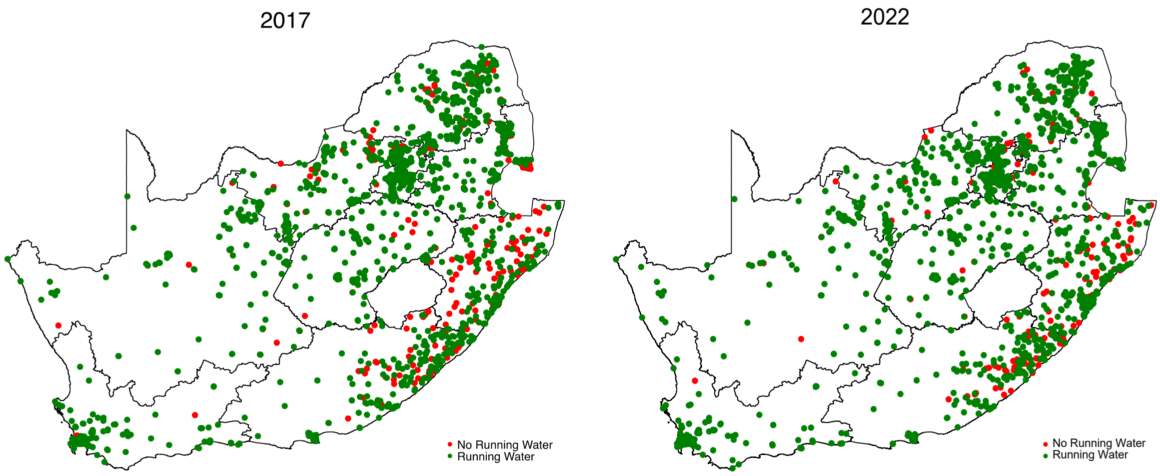
[16] See Appendix A for the tabular illustration of the maps which includes 2011 SMS outcomes.

In Figure 4 above, it is evident that between 2017 and 2022, South Africa made notable advancements in providing access to flush toilets in primary and secondary schools in the North West province, whilst the persistent challenge of non-flush toilets continues to plague parts of the Eastern Cape, Limpopo, and KwaZulu-Natal. The trend seen in the latter provinces is multifaceted and profoundly influenced by the lingering legacy of Apartheid, most notably in the former homeland areas. However, Figure 4 cannot be taken at face value without the following considerations: Firstly, the present analysis deems flush toilets as the standard that all schools should be elevated towards. The variable of interest, therefore, reflects this consideration and captures only the binary outcome of whether a flush toilet was present at the school on the day of the visit. Secondly, it is essential to note that flush toilets depend on water supply; therefore, the trend seen in Figure 4 may well reflect municipal infrastructure rather than a failure by provincial education departments (PEDs) to supply flush toilets to schools. Finally, although considered as the highest standard of toilets in this analysis, flush toilets are the only form of toilet type that is approved for use in South African schools; as a result, the red dots cannot simply be interpreted as a reflection of non-compliance with *Regulation 920 of 2013*, but rather the state of municipal infrastructure in those regions. In these regions, the eradication of pit latrines and other non-flush alternatives has remained a prolonged struggle since the advent of democracy.

Where advancements are observed, however, such as in the case of the North West province, they serve as a testament to the positive strides achievable when concerted efforts and targeted investments are directed toward addressing embedded challenges, even within the country's formally disenfranchised regions. Notably, South Africa's urban centres have consistently enjoyed greater access to flush toilets between the two periods under study, an indicative sign of urban prioritisation and infrastructure development in these areas, relative to their rural counterparts, as predicted by the urban bias thesis.

5.2 Access to Water

Figure 5: Access to Running Water in South African Schools for 2017 and 2022



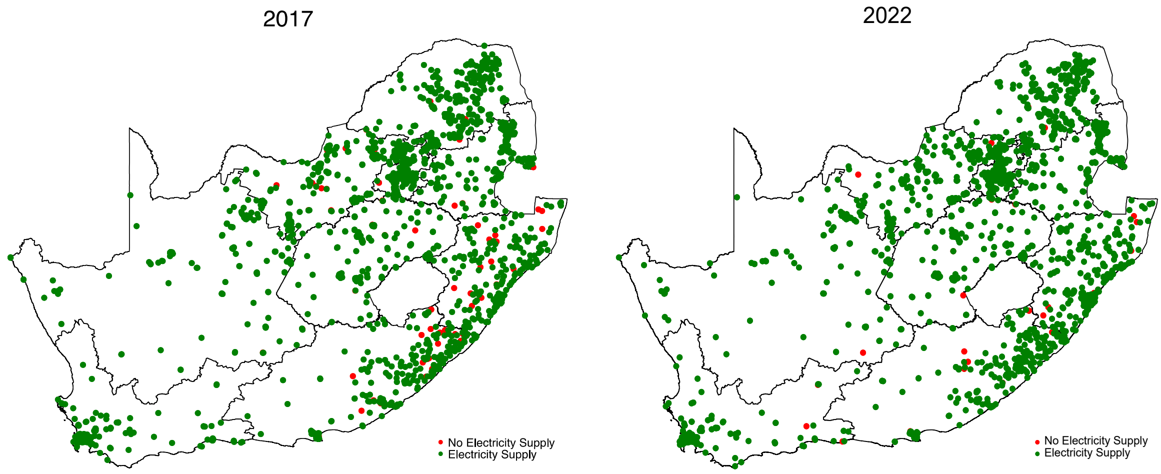
Source: School Monitoring Survey, 2017 and 2022

Figure 5 above provides an overview of trends in the availability of running water in primary and secondary schools across South Africa. The variable of interest in this analysis centres on whether schools had access to running water on the day of the visit, irrespective of the water source, which may include water tanks, boreholes, rainwater harvesting, or municipal connections.

Analogous to the observed trend in flush toilet access shown in Figure 4 above, albeit to a lesser extent, the overall trend in water supply from 2017 to 2022 once more captures the multifaceted and enduring legacy of Apartheid, with particular emphasis on the Eastern Cape and KwaZulu-Natal. These regions continue to grapple with the arduous challenge of providing running water to rural and remote schools, highlighting the persistent disparities in educational infrastructure between South Africa's urban hubs and its poorest, most remote rural areas.

5.3 Access to Electricity

Figure 6: Electrification in South African Schools for 2017 and 2022

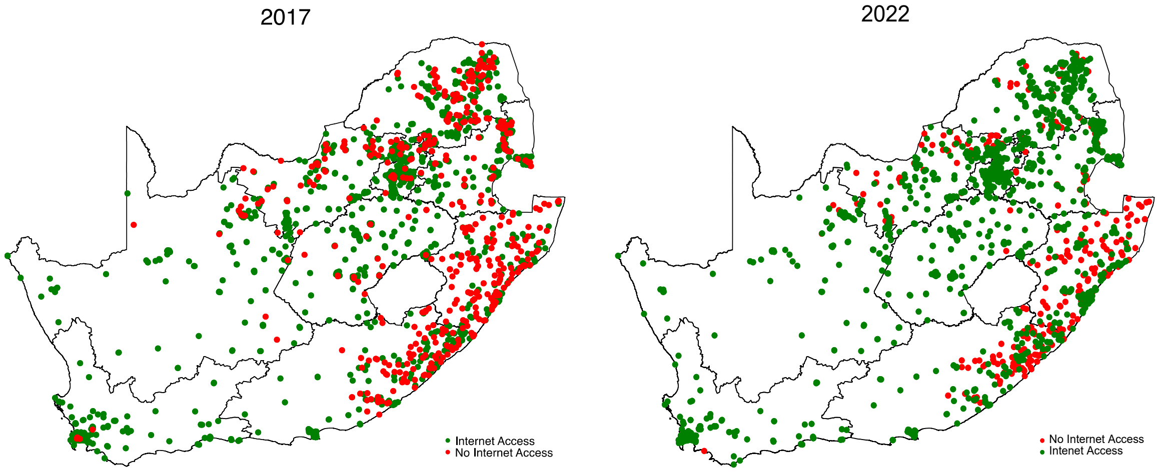


Source: School Monitoring Survey, 2017 and 2022

Universal electrification in schools is one of the leading Norms and Standards for minimum school infrastructure, and the trend in electrification in South African primary and secondary schools between 2017 and 2022 represents progress towards achieving this norm. Akin to trends in water access, the variable of interest in this analysis is a binary indicator of whether a school had electricity on the day of the visit, regardless of the source (e.g., municipal connection, generators, solar, or wind-generated electricity). While challenges with school electrification were more widespread in 2017 – particularly in parts of the Eastern Cape and KwaZulu-Natal - there has been noticeable improvement since then, although gaps remain in certain regions. These persistent shortfalls highlight that, despite progress, universal access to reliable electricity has yet to be fully achieved across all schools.

5.4 Access to Connectivity

Figure 7: Internet Access in South African Schools for 2017 and 2022.



Source: School Monitoring Survey, 2017 and 2022

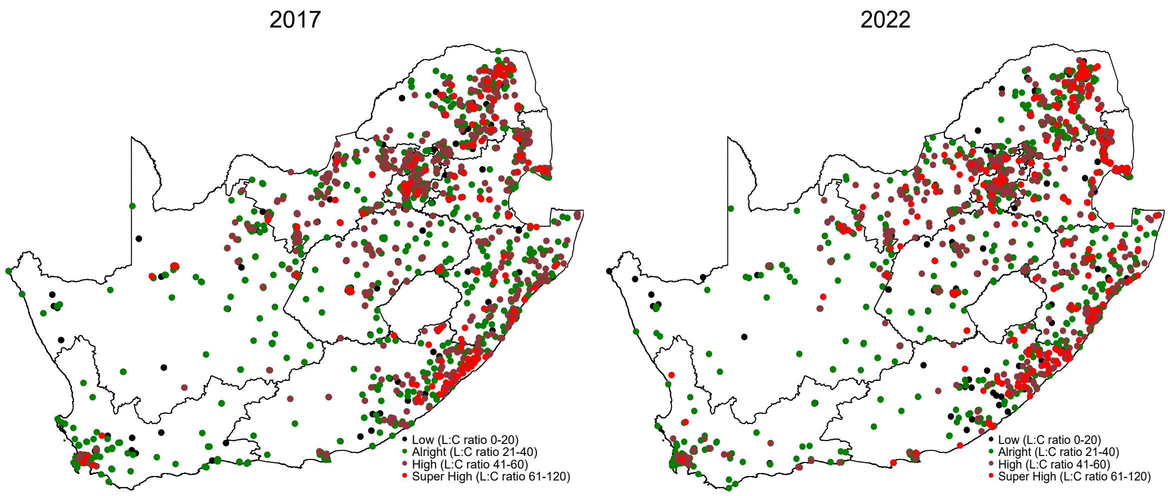
The trend depicted in Figure 7 regarding internet access in South African primary and secondary schools tells a compelling story of progress and efforts to overcome the digital divide. The variable of interest, mapped in Figure 7, is a binary indicator of whether a school had internet access on the day of the visit, regardless of the intended users (e.g., educators, learners, administrative staff).

Over the two periods under study, a noticeable pattern of progress can be observed, predominantly in the country's central regions. This progress is primarily noted in parts of the North West, Mpumalanga, Gauteng, and Limpopo. Limpopo can be singled out as a notable example of progress, having achieved significant improvements in internet connectivity.

Unfortunately, the lingering legacy of Apartheid and post-Apartheid lethargy in school infrastructure service delivery continues to plague the rural parts of the Eastern Cape and KwaZulu-Natal. Resolving this issue is of paramount importance, given the ever-increasing importance of internet connectivity for teachers and learners in an ever-expanding hybrid educational landscape.

5.5 Classroom Availability Overcrowding

Figure 8: Learner-to-Classroom Ratios in South African Schools for 2017 and 2022



Source: School Monitoring Survey, 2017 and 2022

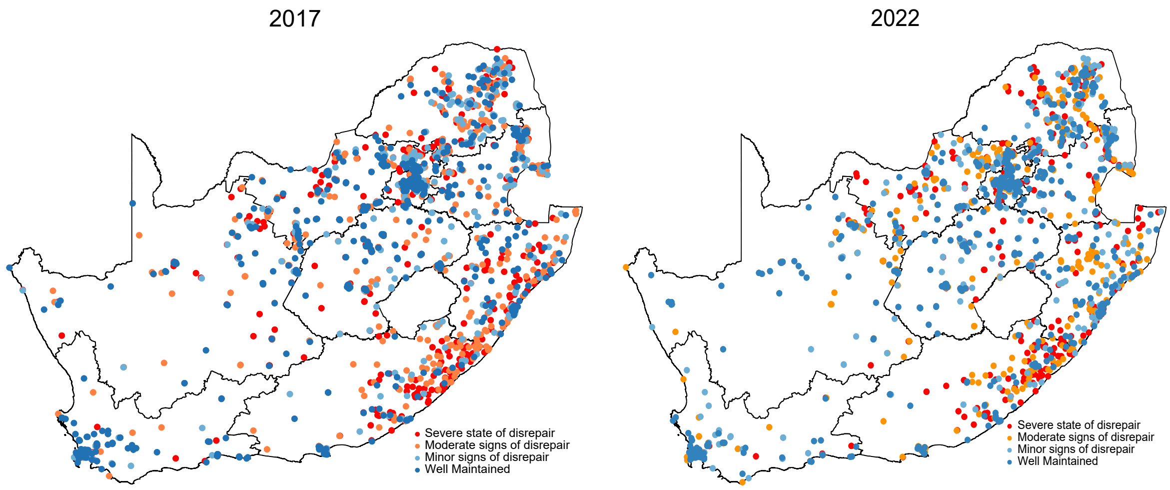
Figure 8 above shows the spatial trends in learner-to-classroom (l-t-c) ratios, a measure of overcrowding, across South Africa. The L:C ratio is calculated by dividing the number of learners in a school by the total number of ordinary classrooms. The L:C ratios are grouped into four distinct categories: i) *Low*, for L:C ratios between 0 and 20; ii) *Alright*, for L:C ratios between 21 and 40; iii) *High*, for those in the 41 to 60 range; and iv) *Super High,* for L:C ratios between 61 and 120.

Over the 5 years, trends in overcrowding exhibit notable consistency, with slight deteriorations in Gauteng and the North West. In urban centres, overcrowding is frequently caused by migration, where schools are often tasked with the considerable difficulty of accommodating the influx of new learners. Migratory patterns in South Africa still largely resemble those of the Apartheid era, as economic agents migrate to urban areas to pursue better educational and employment opportunities. This, unfortunately, places significant strain on existing school infrastructure. The inability of schools to swiftly build new classrooms to accommodate the influx of new learners results in excessively high learner-to-classroom ratios.

Conversely, in rural areas, the problem of overcrowding often stems from lethargic infrastructure development, which impedes the expansion and enhancement of school facilities. Furthermore, teacher subject specialisation and teacher shortages may be additional contributing factors to excessive overcrowding in rural areas. Regardless of the reasons for overcrowding, addressing it in schools requires a deliberate, tailored approach that adequately considers regional-level school infrastructure conditions.

5.6 Levels of infrastructural Disrepair

Figure 9: Severity of School Infrastructural Disrepair in South Africa for 2017 and 2022



Source: School Monitoring Survey, 2017 and 2022

Figure 9, which examines the trends in the severity of school infrastructure disrepair in South African primary and secondary schools, highlights distinct patterns of urban-rural disparities in school infrastructure maintenance. Between 2017 and 2022, a notable concentration of well-maintained schools in South Africa's urban centres can be seen, whilst severe and moderate levels of school infrastructure disrepair in the Eastern Cape and KwaZulu-Natal seem to persist over the period under study, especially along the border of these two provinces.

This geographic clustering of severe and moderate disrepair in schools alludes to familiar regional and systemic issues, which reiterate South Africa's persistent challenge in aligning its rural schools with the stated Norms and Standards. These challenges persist despite the establishment of infrastructure backlog programmes, such as the Accelerated School Infrastructure Delivery Initiative (ASIDI), underscoring the need for targeted interventions to remedy historical imbalances and ensure a fair and equitable distribution of school infrastructure.

The spatial analysis presented in sections 5.1 through 5.6 highlights a clear pattern of varied infrastructure conditions across South African public schools. However, the spatial analysis fails to highlight the different experiences of teachers within this varied infrastructure landscape. The overarching aim of this paper has been to investigate teacher motivation within the context of these varied infrastructure conditions, given the intricate relationship between working conditions and job satisfaction.

6. School Size, Infrastructure, and Teacher Motivation

Debates about school infrastructure are often structured along rural-urban lines, as if to assume that all urban schools have good infrastructure, while rural ones inherently lack it. Figure 9 above shows that this is not always the case, as well-maintained schools remain prevalent even in some rural areas. A further limitation of studying infrastructure disparities along purely rural-urban lines is that it assumes uniformity in teachers' experiences in rural schools (regardless of school size or prevailing working conditions). As the analysis that follows will demonstrate, poor infrastructure plagues large schools as it does small ones. Subsequent sections of this paper will thus focus on the relationship between school size and the infrastructure; this decision is motivated by the need to examine teacher utilization more closely. As subsequent sections will demonstrate, infrastructure deficiencies are pronounced in specific geographic locations and small schools.

Regardless of school size, severe infrastructure deficiencies often leave teachers navigating a host of challenges that extend beyond teaching and learning (Kruger et al., 2024). The compounded effect of these deficiencies can significantly impact motivation and morale, underscoring the relationship between school size, its prevailing infrastructure conditions, and teacher motivation. While overcrowded classes may overwhelm teachers in larger schools (eliciting fatigue and demotivation due to overutilization), teachers in small schools may experience a mixture of two feelings: professional underutilization, due to teaching subjects that may not align with their interests and specializations, and overutilization induced by staffing shortages. Teacher utilization in schools is essential because it affects teachers' self-perception in the workplace and their ability to achieve professional goals (e.g., educating learners and advancing their careers). Furthermore, human resources, employee wellness, and support are crucial considerations in the government's decision to close small and non-viable schools.[17] Notwithstanding other considerations, this paper will systematically highlight the potential role of infrastructure quality in this decision and its relationship to teacher satisfaction and motivation.

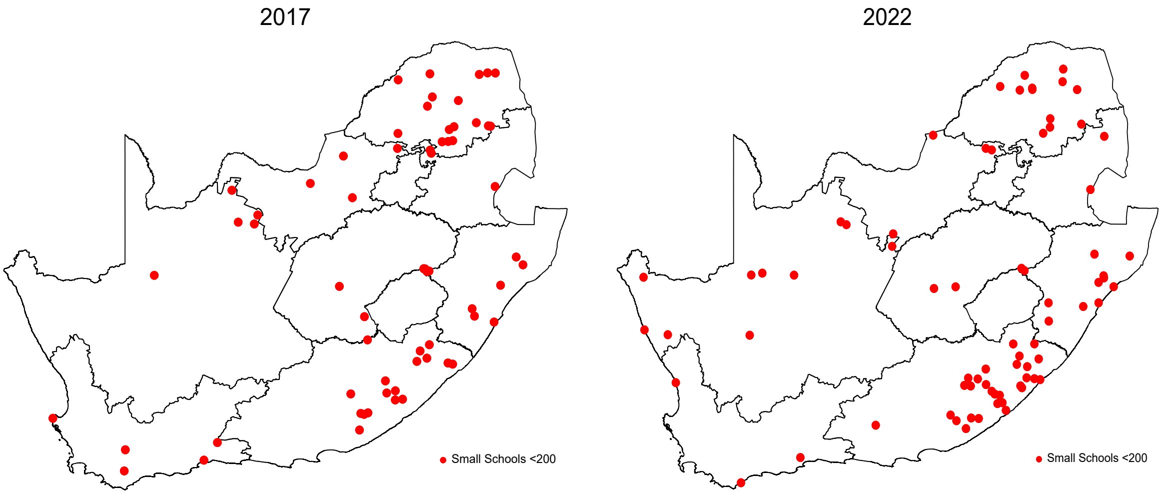
7. School Size, Infrastructure, and the Rise of Transaction Costs

The proliferation of small, rural schools across South Africa's most remote villages naturally begs the question: '*Why do PEDs not merge small schools in proximity to one another*?' In the Limpopo interviews, it was revealed that, *ceteris paribus*, merging smaller schools should be a significant consideration for infrastructure planners, given the large number of rural schools in the province. However, this consideration is relegated to near nonexistence due to the social dynamics that complicate the process. According to the respondents, communities understandably prefer schools built closer to their communities; a finding consistent with Theunynck's (2009:7-8) assertion that *distance to school* is positively associated with school participation. As a result, attempts to merge schools usually end before any concrete steps are taken to engage communities, due to the hostile reception such considerations receive. For example, when plans to merge two small schools from separate, but nearby, communities emerge, the question often posed by the communities is: '*Where will the school be built?*' This is a calculated question that aims to ascertain which community will 'lose out' if the school is built closer to their community. In the end, however, we find that both communities lose out due to threats by the furthest community to disrupt attempts to build the school, so that no school is ever built.

The distribution of small schools in SMSs (see Figure 10 below), compounded by community-based obstacles, ensures that small, non-viable schools remain part of the South African education landscape and continue to pose a persistent challenge to the DBE and its PEDs. Small schools do not, in and of themselves, constitute an educational problem. However, their existence (especially the poor and rural ones) represents an opportunity cost for education planners, as it still requires financial and human resources to remain viable.

[17] The following are the eight considerations (processes) the DBE must consider before closing a school: Institutional, Technical, Legislative, Human Resources, Infrastructure Provisioning, Administration, Employee Wellness and Support, followed by a second round of Legislative processes.

Figure 10: Small Schools (<200 learners) found in SMSs for 2017 and 2022



Source: School Monitoring Survey, 2017 and 2022

Figure 10 above shows the geographic distribution of small schools, as defined by the DBE's guidelines on the rationalization and realignment of small schools, i.e., enrolment of less than 200 learners.[18], across South Africa for 2017 and 2022. The trend depicted in Figure 10 underscores two crucial points: firstly, small schools remain concentrated in South Africa's known-to-be rural provinces, e.g., the Eastern Cape, KwaZulu-Natal, and Limpopo. Secondly, their geographic placement maps well onto that of the former homelands (notwithstanding the presence of small schools in other non-former-homeland provinces, such as the Western Cape).

Table 1 below uses multivariate regression analysis to capture the conditional correlation between school size and two sets of standardized indices: infrastructure and school management. The indices are standardized to a mean of zero and standard deviation of one, whilst controlling for province and school quintile, both of which are categorical variables, thereby setting small schools, the Eastern Cape, and Quintile 1 (one) schools as the base categories of those respective variables. Furthermore, controls for management and access control are included in the regressions seen in panels 1 and 3.

[18] Although the DBE has distinct thresholds for what constitutes a micro school. However, during the informant interviews, officials revealed their negation of infrastructure upgrades in schools with fewer than 300 learners. Therefore, given that 135 and 200 both fall below the minimum threshold in Limpopo, this paper adopts a unified threshold of 200 for both primary and secondary schools, since it is closer to 300. This decision thus allows for non-separation between primary and secondary schools in the succeeding analyses and consistency with administrative principles applied in practice.

Table 1: OLS Multivariate regression results

	Primary		Secondary	
	(1)	(2)	(3)	(4)
	Infra Index	Man Index	Infra Index	Man Index
Medium Schools	**0.718*** **	0.394	0.364	0.341
	(0.101)	*(0.307)*	*(0.298)*	*(0.423)*
Large Schools	**1.167*** **	0.362	**0.876*** **	0.321
	(0.113)	*(0.313)*	***(0.302)***	*(0.431)*
Province	Yes	Yes	Yes	Yes
Quintile	Yes	Yes	Yes	Yes
Management Index	Yes	No	Yes	No
Access Control	Yes	Yes	Yes	Yes
Infra Index	No	Yes	No	Yes
Constant	-1.915***	-0.439	-1.299***	-0.658
	(0.091)	*(0.306)*	*(0.302)*	*(0.419)*
Observations	841	841	832	832
R-squared	0.419	0.088	0.415	0.079

Notes: Z-scores reported. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

In the present analysis, the classification of small schools remains consistent with the methodology used to generate Figure 10, i.e., enrolment of fewer than 200 learners. The medium-sized category was generated by calculating the median of the school-size variable and setting it as the upper bound; medium-sized schools therefore range from 201 to 912 learners. Schools with enrolment figures of 912 or more are classified as large. From model 1 in Table 1 above, it is evident that infrastructure conditions are statistically worse in small schools than in their medium- and large-sized counterparts. In secondary schools, this is true only for large schools, whereas there are no significant differences in management practices across primary and secondary schools. Given the results in Table 1, the question becomes, *are the infrastructure results based purely on school size or geographic location?* The succeeding analysis, presented in Tables 2 and 3, aims to answer this question by scrutinizing the infrastructure index more closely. The counterhypothesis is that small schools have worse infrastructure because they are in areas with poor municipal infrastructure, e.g., water supply. Table 2 presents ten regression models for primary and secondary schools, respectively. In models 1-10, the infrastructure index is regressed on province, quintile, municipality, school management, and access control. The municipality variable is included to control for heterogeneity in municipal quality.

Table 2: OLS Multivariate regression results

	Primary Schools					Secondary Schools				
	1	2	3	4	5	6	7	8	9	10
	Infra	Infra	Infra	Infra	Infra	Infra	Infra	Infra	Infra	Infra
Medium	1.107***	0.800***	0.955***	0.934***	0.812***	0.747**	0.276	0.493	0.5	0.484
	(-0.122)	*(-0.149)*	*(-0.217)*	*(-0.241)*	*(-0.253)*	*(-0.291*	*(-0.275)*	*(-0.317)*	*(-0.348)*	*(-0.336)*
Large	1.903***	1.221***	1.313***	1.298***	1.138***	1.511***	0.778***	0.996***	0.996***	0.971***
	(-0.118)	*(-0.154)*	*(-0.222)*	*(-0.246)*	*(-0.259)*	*(-0.289)*	*(-0.281)*	*(-0.325)*	*(-0.355)*	*(-0.342)*
Province	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes	No	No	No	No	Yes
Constant	1.702***	2.480***	2.617***	1.951***	1.874***	1.137***	1.407***	4.008***	-0.496	0.134
	(-0.109)	*(-0.19)*	*(-0.217)*	*(-0.288)*	*(-0.29)*	*(-0.284)*	*(-0.299)*	*(-1.019)*	*(-0.456)*	*(-0.469)*
Observations	852	852	852	841	841	841	841	841	832	832
R-squared	0.196	0.465	0.601	0.608	0.615	0.154	0.48	0.645	0.65	0.651

Notes: Z-scores reported. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Model 1 estimates the unconditional association between school size and infrastructure quality. The coefficients are large and highly statistically significant, especially for large schools, reaching nearly two standard deviations relative to small schools. However, when controlling for province and quintile (Model 2), the effect sizes drop but remain highly statistically significant. Notably, the introduction of these controls produces a substantial increase in the R-squared, suggesting that provincial differences and socioeconomic contexts explain a meaningful share of the variation in infrastructure. Model 3 tests whether the local municipality in which a school is situated influences infrastructure outcomes. The results strongly support this hypothesis. The coefficients increase again, and so does the R-squared, underscoring the significant role of local municipal conditions in shaping school infrastructure. Models 4 and 5 control incorporate controls for school management and access control. These variables produce a slight reduction in the coefficients, but the estimates remain highly statistically significant.

The pattern for secondary schools (Models 6-10) mirrors that of the primary schools in the unconditional specification. In Model 6, larger schools show substantially better infrastructure than small schools, although the statistical significance of the medium-sized category is somewhat weaker compared to the primary school case. As covariates are sequentially added across Models 7-10, the results differ from the primary school case in that only large secondary schools retain statistically significant advantages in infrastructure relative to small schools. The fully specified model (Model 10) has a high R-squared, similar to the primary school case, indicating that the included covariates, especially municipality, province, and quintile, explain a large proportion of the variation in infrastructure conditions at the secondary level.

Table 3: Multivariate regression results (Linear Probability Model)

	Primary Schools					Secondary Schools				
	1	2	3	4	5	6	7	8	9	10
	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets
Medium	0.333***	0.192***	0.234***	0.233**	0.220**	0.286***	0.103	0.188*	0.202*	0.203*
	(-0.070)	*(-0.063)*	*(-0.089)*	*(-0.091)*	*(-0.091)*	*(-0.086)*	*(-0.086)*	*(-0.113)*	*(-0.111)*	*(-0.114)*
Large	0.699***	0.317***	0.319***	0.320***	0.302***	0.616***	0.224**	0.304***	0.324***	0.324***
	(-0.068)	*(-0.067)*	*(-0.093)*	*(-0.094)*	*(-0.096)*	*(-0.085)*	*(-0.089)*	*(-0.115)*	*(-0.113)*	*(-0.116)*
Province	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes	No	No	No	No	Yes
Constant	0.165**	-0.121**	0.128	0.12	0.135	0.190**	-0.0997	0.328**	1.144***	1.144***
	(-0.065)	*(-0.053)*	*(-0.284)*	*(-0.284)*	*(-0.280)*	*(-0.082)*	*(-0.085)*	*(-0.151)*	*(-0.356)*	*(-0.356)*
Observations	989	981	981	967	967	972	960	960	950	950
R-squared	0.17	0.67	0.71	0.72	0.72	0.41	0.55	0.71	0.71	0.71

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 3, like Table 2, presents 10 Linear Probability Model (LPM) estimates, regressing a binary dependent variable indicating whether a school had flushing toilets[19] on the day of the visit on a set of covariates, introduced sequentially into the models. Analogous to Table 2, a similar pattern emerges when examining access to flushing toilets. In primary schools, the unconditional LPM produces large, statistically significant coefficients that shrink when province and quintile are added as covariates in Model 2. The introduction of these covariates coincides with a substantial increase in the model's explanatory power, from 0.17 to 0.67. Controlling for municipality raises both the coefficients and the R-squared, although not to the extent seen in Table 2. As additional covariates are introduced in Model 4, both the coefficients and the R-squared remain relatively stable

[19] The models presented in Table 3 focus exclusively on flushing toilets, for which the spatial analysis revealed particularly striking patterns. Regression tables for the remaining components of the standardized infrastructure index are provided in Appendix B. These results present a mixed picture: variables such as water access and electrification show no statistically significant association with school size in either primary or secondary schools, whereas indicators such as internet and computer labs show varying significance across phases.

before shrinking again in Model 5, but retaining their statistical significance. It could therefore be argued that, after controlling for province, quintile, and municipal resourcing, notwithstanding the fluctuations seen in Models 3-5, the association between school size and access to flushing toilets remains relatively consistent.

For secondary schools, the unconditional model yields large, statistically significant coefficients, though the baseline R-squared is much higher than in the primary school models. The addition of covariates brings about a decline in the coefficient, but statistical significance is retained across large schools. Significance for medium-sized schools drops out in Model 7, but a weaker form of statistical significance reappears and is maintained in Models 8 through 10. Across all secondary school specifications, the R-squared remains high and stable, yet again suggesting a persistent association between school size and access to flushing toilets.

Considering the results observed in Table 2, a question worth posing is: *'Are infrastructure conditions in small schools worse because of their size, or due to policies put in place?'* Given the qualitative responses from officials at the LDoE, this paper argues that poor infrastructure in small schools is driven, in part, by policies in place, as highlighted in earlier sections of Section 6, which point to officials' decisions not to upgrade infrastructure in schools with fewer than 300 learners. Although the rationale for such negations is financially sound, it also means that, as long as schools with fewer than 300 learners remain in operation, their prospects of securing infrastructure upgrades remain dire. The longer these schools remain in operation, the longer those teachers and learners will be subjected to inadequate conditions of teaching and learning.

The results presented in Tables 2 and 3 demonstrate that school size alone cannot explain variation in infrastructure quality. While larger schools consistently exhibit better infrastructure outcomes in unconditional models, the coefficients reduce in size once provincial and socioeconomic controls are added. Furthermore, the substantial increase in explanatory power between Models 2 and 3 underscores the crucial role of municipal contexts in shaping infrastructure outcomes. This pattern is consistent across all tables presented above and in Appendix B, thereby reinforcing the importance of spatial factors in understanding disparities in school infrastructure.

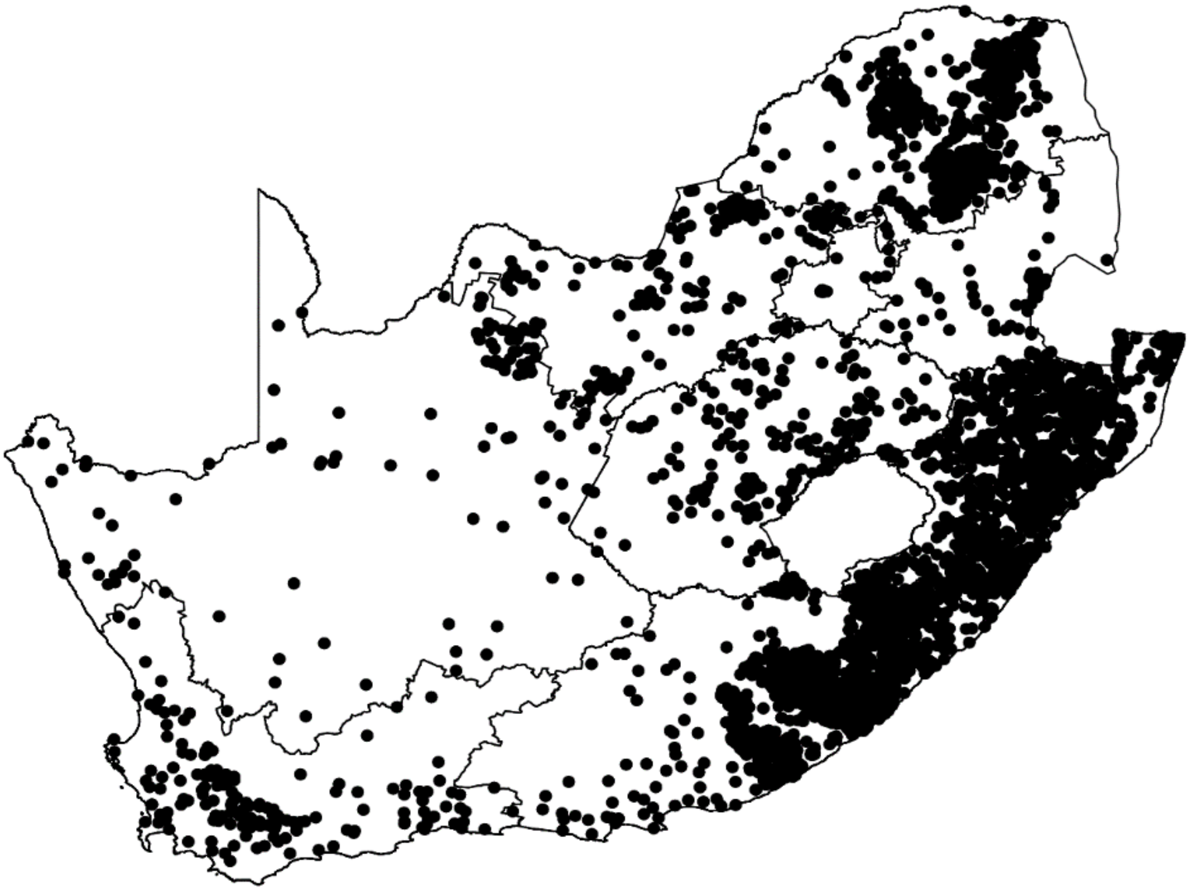
7.1 Small Schools, Geographic Location, and Non-viability

The preceding discussion highlighted the role of geography in mitigating the small-school disadvantage for selected school infrastructure variables, especially in secondary schools. It is worth reiterating that small schools on their own do not constitute an education problem. However, the challenge with small schools arises when they are poor and situated in deep rural and remote areas. Small, no-fee-paying, and remote schools pose significant financial trade-offs and incur substantial transaction costs to the state. It is to this end that the DBE has policies, such as the aforementioned "*Guidelines for Rationalisation and Re-alignment of Public Schools,*" in place to close small and non-viable schools. Figure 10 above presented the spatial distribution of small schools in South Africa using the 2017 and 2022 School Monitoring Surveys, respectively.

The succeeding analysis will attempt to answer two crucial questions: Firstly, '*do small schools that have been closed map onto the same homeland pattern?*' Secondly, '*do the historical infrastructure conditions of these closed small schools confirm the notion that small schools typically have ailing infrastructure, thus potentially justifying their closure?*' To answer these questions, this paper employed the DBE's list of closed and small schools (*hereafter referred to as 'closed schools'*), which are (1) already closed or (2) small and earmarked for closure. To gather historical information on the schools' infrastructure conditions, the DBE's list of closed schools was matched with the 2011, 2017, and 2022 SMSs to ascertain whether some of the already closed schools could be traced back into the surveys, which contain information on infrastructure conditions, school management, school funding, etc. The DBE's list offers a unique opportunity to study the historical infrastructure conditions at these schools, among other things. Ultimately, 411 schools were successfully merged into the three respective rounds of SMSs: 47 in the 2022 SMS, 76 in the 2017 SMS, and 288 in the 2011 SMS. Figure 11 below shows the spatial distribution of DBE's closed schools across South Africa for 2017 and 2022 only, due to the lack of geocoordinates[20] in the 2011 SMS.

[20] An alternative approach would have been to use the 2011 Masterlist of Schools Data to extract the geocoordinates; however, the DBE's Masterlist data only dates back to 2014.

Figure 11: Geographic distribution of the DBE's closed small schools in South Africa.

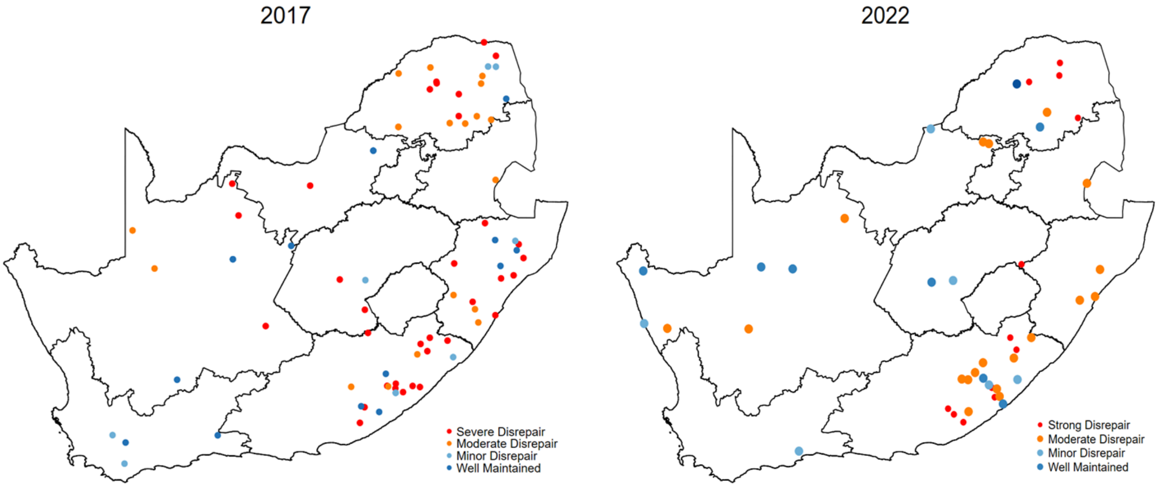


Source: DBE's closed small schools (2017-2023).

Undeniably, save for Gauteng, small schools exist across the country; however, the patterns of concentration point towards South Africa's poorest and most rural provinces, i.e., the Eastern Cape, KZN, and Limpopo. Of the 411 closed schools identified in the respective SMSs, 282 were in the Eastern Cape (135), KZN (83), and Limpopo (64). These three provinces, therefore, account for 69% of the total sample of identified closed schools, which renders plausibility to the hypothesis that large concentrations of these closed schools would map closely to South Africa's most rural provinces, and by extension, onto the spatial distribution of the former homelands.

To answer the second question, this paper investigated the infrastructure conditions in these schools to either confirm or reject the notion that small schools generally have poor infrastructure conditions. Figure 12 below shows the spatial distribution of the identified closed schools in 2017 and 2022, along with the infrastructure conditions prevailing in them, as recorded in the respective SMSs.

Figure 12: Severity of School Infrastructural Disrepair in South African closed schools in 2017 and 2022



Data Sources: DBE's closed small schools and the School Monitoring Surveys of 2017 and 2022.

Like Figure 9, Figure 12 above shows the severity of infrastructure disrepair in the DBE's list of closed schools. It is clear from Figure 14 that the DBE's list of closed schools did not have the best infrastructure conditions. This is true for both 2017 and 2022, as evidenced by the greater concentration of red and orange dots, which represent schools with severe and moderate infrastructure disrepair. Among other reasons (such as low subject variety, educational performance, and inefficient school management), inadequate infrastructure may be a leading factor in the DBE's decision to render these schools non-viable and in the decision to close them. The spatial analysis confirms to some extent (given that the data is restricted to only the small schools successfully matched to the SMSs) that small schools, on average, often fail to meet the minimum threshold for infrastructure adequacy as per the Norms and Standards. This raises questions about the well-being and motivation of teachers stationed at similarly sized schools.

7.2 Historical Academic Performance in Small Schools

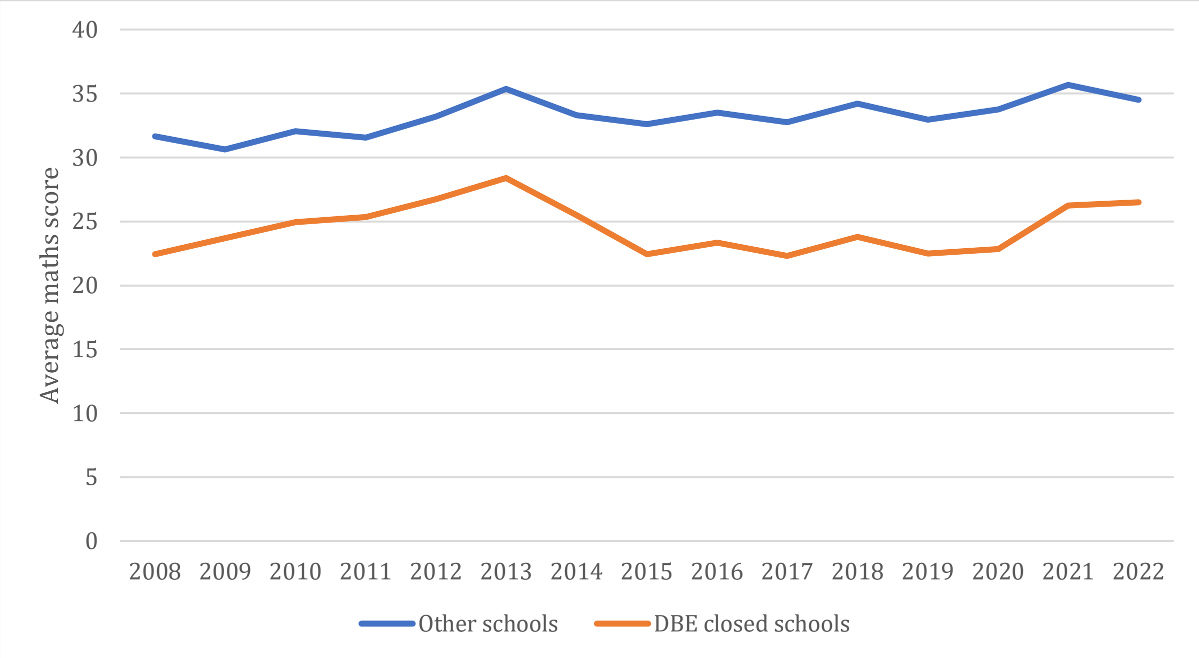
The following analysis investigates educational performance in closed small schools or earmarked for closure as at 2022. A common assumption about the closure of small schools is that they were academically underperforming, thereby necessitating their closure. However, this paper argues that, despite educational performance, school closures may have been driven (among other things) by school infrastructure inadequacies and the inefficient use of teachers in such environments. The preceding analysis focuses on only two subjects, Mathematics and English First Additional Language (EFAL), across numerous years of National Senior Certificate (NSC) data, starting in 2008.

Importantly, the mathematics score used in the analysis below is a composite score, which puts all learners who took Mathematics or Mathematical Literacy on the same scale. The motivation to equate the two subject scores stems from the fact that small schools can often offer only one of the two mathematics subjects due to teacher or enrolment constraints. The composite mathematics score was derived from a subject-pairs analysis of the relationships among Physical Sciences, Mathematics, and Mathematical Literacy. As a robustness check, the method used both lowess and local polynomial regressions to confirm consistency in the results. The main objective was to analyse the relationship between physical science scores (ranging between 0 and 100) and the corresponding mathematics and mathematical literacy scores. Across the range of physical science scores, the mathematical literacy curves consistently surpassed the mathematics curves. This indicates that, for a given level of physics aptitude, a learner would be expected to score higher on a mathematical literacy test than on a mathematics test. This is an unsurprising result, as mathematical literacy is traditionally viewed to be easier than mathematics.

Given these results, a new composite mathematics score was derived by incrementally adjusting the original mathematics score based on the gap observed between the mathematics and mathematical literacy curves. This approach sought to equate the two scores and achieve parity in mathematics and mathematical literacy, enabling the comparative study of historical educational performance in closed schools and their non-closed counterparts without distinguishing between small schools that offered only mathematics and those that offered only mathematical literacy.

7.2.1 Mathematics

Figure 13: Learner performance in mathematics (composite score) in closed schools versus non-closed schools from 2008 to 2022



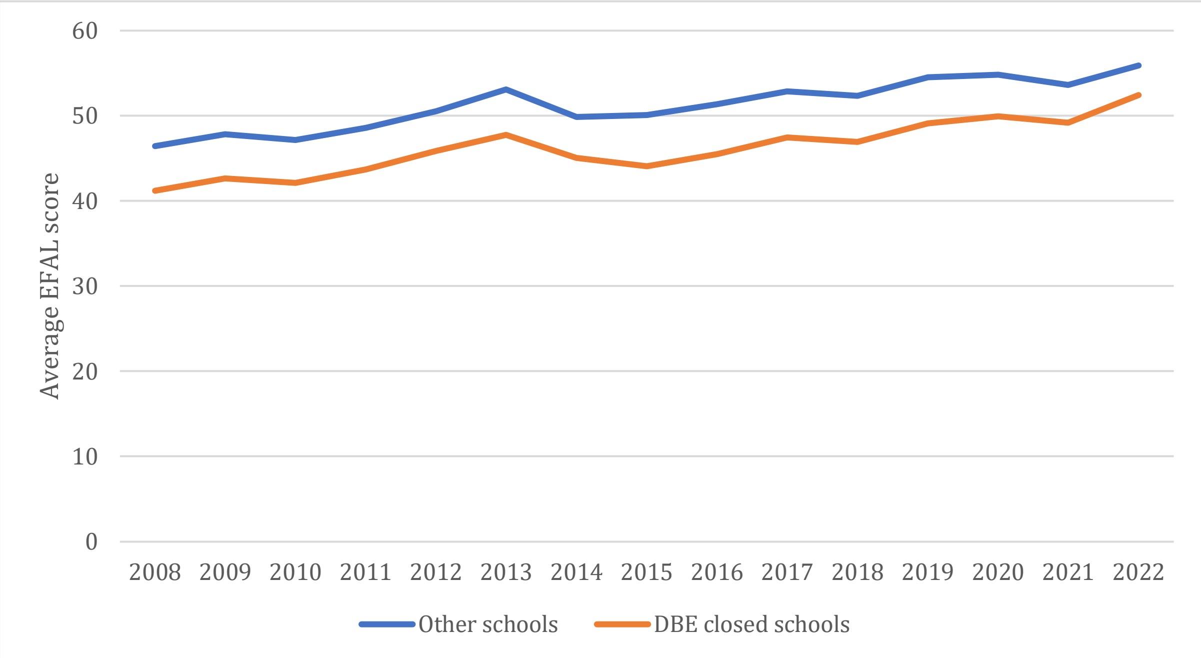
Source: Author's own calculations using National Senior Certificate (NSC) data for 2008-2022

Figure 13 above plots mathematics performance for two sets of learner categories – those who were in small schools and subsequently closed (or earmarked for closure), and learners from all other schools still open at the start of 2023. From Figure 13, a clear pattern emerges: closed schools consistently performed worse in mathematics than their non-closed counterparts, with a significant widening between 2013 and 2020, followed by post-2020 convergence. Despite the outright and sustained poorer performance, the performance of closed schools appears to have followed the general trend in the education sector over the period under study; when there was sector-wide improvement, closed schools also improved, and vice versa. Closed schools showed better resilience between 2021 and 2022 than their non-closed counterparts, showing sustained improvements at a decreasing rate. This finding supports the hypothesis that small schools do not necessarily present an education problem and that learners and teachers can still thrive in such environments. However, there exists a particular type of '*smallness*' that is surrounded by an acute set of conditions that ultimately necessitate closure. Those conditions are then characterized by poor infrastructure. Although more learners from non-closed schools tend to perform better in mathematics, some learners from closed schools also perform well. This indicates that some learners and teachers can rise above their circumstances and produce competitive educational performance. The trend observed in Figure 15 was also evident in several other indicators, such as the age distribution of learners, the number of distinctions, the average aggregate score, and English First Additional Language (EFAL). The results for EFAL are shown in Figure 16 below.

7.2.2 English First Additional Language

To offer a balanced view of educational performance in closed schools versus their non-closed counterparts, learner performance in EFAL is considered due to the sheer number of learners who sit the EFAL exam each year.

Figure 14: Learner performance in EFAL in closed schools versus non-closed schools - 2020-2022



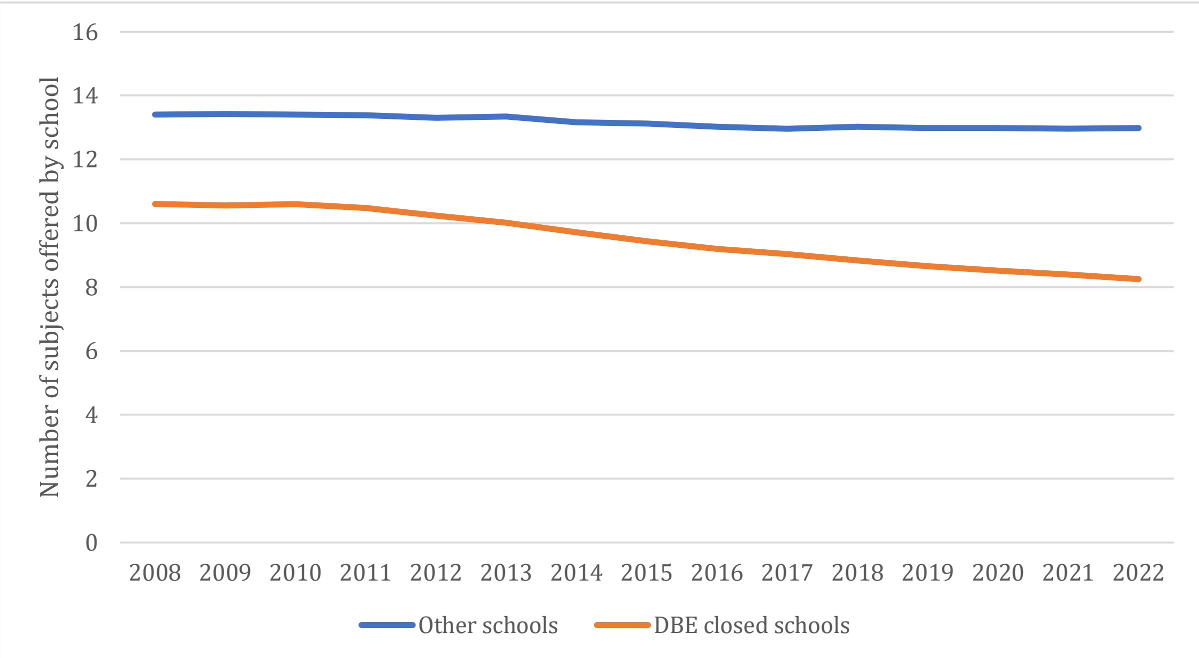
Source: Author's own calculations using National Senior Certificate (NSC) data from 2020-2022

Analogous to the trend observed in Figure 13, Figure 14 depicts an outright and sustained underperformance record in EFAL for closed schools relative to their non-closed counterparts. Notwithstanding the differences in difficulty between mathematics and EFAL, this result suggests that EFAL performance in closed schools was not as poor as one might have initially hypothesized. This could indicate improving levels of academic resilience in small schools. This resilience, considering existing vulnerabilities, could be attributed to targeted learner and teacher support in closed schools.

7.2.3 Subject offering, teacher utilization, and learner performance

The trends observed in Figures 13 and 14 bolster the arguments of this paper, in that small schools were not necessarily deteriorating over time; therefore, poor performance, by itself, cannot be argued to be a catalyst for their closure. However, the historic resilience of closed schools may distort the current reality of teaching and learning in small schools, leading to misguided policy directives, such as keeping them open without the requisite infrastructure standards. Over time, a worrying trend emerged in closed schools regarding subject offerings. Between 2008 and 2022, the average number of subjects offered by closed schools decreased from approximately 11 to approximately 8. In contrast, the average number of subjects provided by non-closed schools remained reasonably stable over the same period.

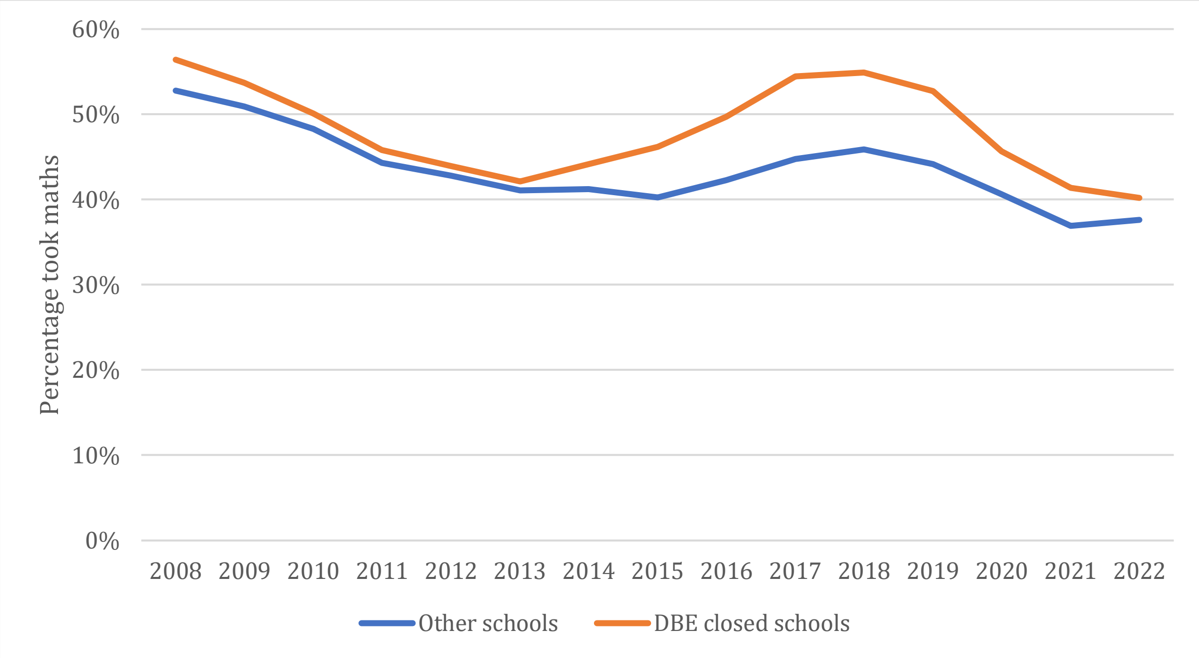
Figure 15: Average number of subjects offered by closed versus non-closed schools, 2008 to 2022



Source: Author's own calculations using National Senior Certificate (NSC) data from 2008-2022

The reduction in the number of subjects offered by small schools poses significant risks to teaching and learning. Firstly, it limits learners' academic capabilities and growth by restricting the interests and potential career avenues available to them. Secondly, and perhaps more importantly, it exacerbates mismatches in subjects' choices, the ramifications of which are best illustrated by the choice learners face between mathematics and mathematical literacy.

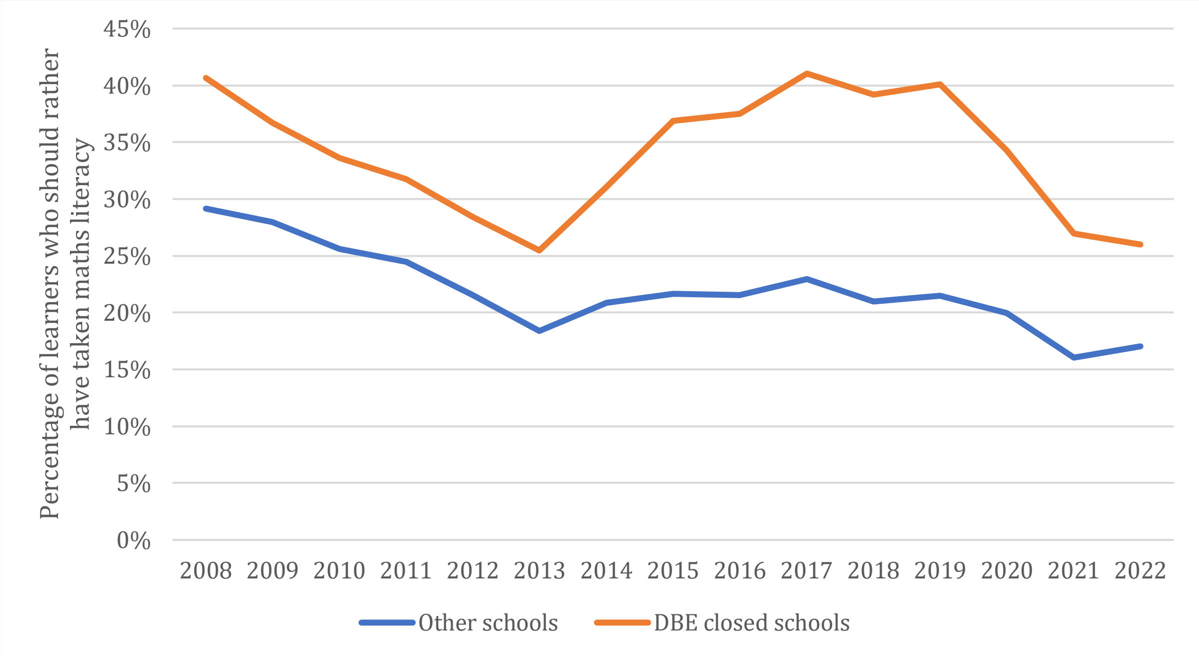
Figure 16: Percentage of learners who took mathematics in closed schools versus non-closed schools, 2008-2022



Source: Author's own calculations using National Senior Certificate (NSC) data from 2008-2022

Figure 16 shows the percentage of learners who took mathematics (over all candidates who sat the NSC examinations in those respective years) in secondary school. Figure 16 shows that since 2008, the percentage of learners who took mathematics in closed schools has been consistently higher than that of learners in non-closed schools. Two possible explanations account for this finding. This paper argues, among other reasons, that teacher shortages in closed schools may be a leading cause for this finding. This is because small schools are often not at liberty to offer both mathematics and mathematical literacy for several reasons, such as insufficient enrolment numbers and staff shortages. Therefore, whichever one of the subjects a school elects to offer at the FET level, perhaps based on the expertise of the mathematics teacher at the school, all the learners in the school will be compelled to take it. This approach forces learners to opt into a subject that is either too easy or too difficult, depending on the aptitudes of learners in the school. On the other hand, non-closed schools, which are larger and can offer both mathematics and mathematical literacy, can shift learners between the two based on their performance. Thus, ensuring a harmonious match between learners' capabilities and the subjects they take is an option not readily available to learners in small schools. For illustrative purposes, we consider the case in which learners take mathematics, even though it may be above their academic capabilities. It is essential to distinguish between the two ways in which the above may occur. Firstly, learners may overestimate their abilities and opt to take mathematics rather than mathematical literacy of their own volition. Secondly, as in small schools, learners may be compelled to take mathematics because it is the only subject offered.

Figure 17: Percentage of learners who should have instead taken mathematical literacy in closed and non-closed schools, 2008-2022



Source: Author's own calculations using National Senior Certificate (NSC) data from 2008-2022

Figure 17 shows the percentage of learners who took mathematics and performed poorly (e.g., achieved less than 30%) in closed schools and their non-closed counterparts between 2008 and 2022. Evidently, many learners in closed schools performed poorly in mathematics in 2008. This was followed by a concerted effort to reduce the number of learners who took mathematics between 2008 and 2013. Offering mathematical literacy as an alternative to mathematics may be a possible explanation for this dramatic decline in learner-subject mismatch. However, since 2013, the mathematics learner-subject mismatch worsened further, and a circular[21] by the DBE in 2013 to triple the number of learners taking mathematics and achieving passes could be a likely catalyst for this sudden worsening. As a result, the percentage of learners failing mathematics between 2013 and 2019 worsened to 2008 levels, before a reduction between 2019 and 2021.

[21]https://www.education.gov.za/Portals/0/Documents/Publications/Circular%20s%2013%20of%202014.pdf?ver=2015-03-26-103918-493

8. Discussion

The preceding analyses aimed to show that a strong relationship exists between school size and infrastructure quality. This finding highlights the need to explore teacher motivation and educational performance from a different perspective, rather than the traditional urban-rural perspective. A purely urban-rural approach overlooks nuances shaped by school size and may falsely attribute disparities in learner performance solely to geography. As such, the analysis has shown that school size is crucial in shaping the infrastructure and educational dynamics on the ground. Even large, overcrowded, and non-fee-paying urban schools benefit from their proximity to facilities and resources, which places them in a better position to attract teachers. Conversely, small, non-fee-paying, and rural schools struggle to attract and retain high-quality teachers due to their geographic isolation, resource constraints, and size. School size has emerged as a leading new angle for exploring the relationship between school infrastructure and teacher motivation, given the school closure policies to which small schools are often subjected.

The Mathematics and EFAL analyses showed that learner performance in closed schools showed resilience and gradual improvement over time, despite consistently performing worse than their non-closed school counterparts. Given these improvements, the central question then becomes: '*What led to the closure of these schools*?' This paper argues that infrastructure plays a significant role in this decision, due to its material effects on teachers and their well-being, as well as on learners and their academic performance. This is because small schools have limited access to amenities, such as adequate classroom space and sanitation facilities, that support effective teaching and learning. Left unchecked, these deficiencies impede teacher recruitment, motivation, and retention by failing to ensure an optimal environment in which teachers can perform their duties.

Teacher motivation is inherently tied to the teaching environment, and the worse the school infrastructure, the greater the challenges teachers will face in delivering quality education. This is particularly true in some of South Africa's small rural schools, as found by Kruger *et al*. (2024:15-18). Space constraints lead to overcrowding, which impedes effective classroom management and personalized instruction aimed at identifying learning difficulties in learners. Furthermore, sub-standard sanitation facilities deteriorate the teaching environment and may lead to a decline in teacher motivation and job satisfaction.

Teachers in small rural schools often face the added problem of geographic isolation. This isolation may manifest as distance from other schools or limited opportunities for professional development. Additionally, geographic isolation adversely affects the effective delivery of support systems, such as subject advisor or district official visits. Kruger *et al*. (2024:18-19;35) find that although older teachers are more resilient to these conditions for various reasons[22] Younger teachers are less prone to remaining in such teaching environments in the long term. This has dire consequences for teacher recruitment and retention as schools become trapped in a vicious cycle of poor performance and high turnover, fuelled by the scarcity of high-quality teachers.

The strong association between school size and infrastructure presents a convincing case for infrastructure investments in medium-sized and large schools. It is not a given that all medium-sized and large schools are equally well endowed, as SES disparities persist even within these categories. However, relative to small schools, these categories of schools (which leverage economies of scale in funding opportunities) are better placed to provide adequate classrooms and maintenance of sanitation facilities. Infrastructure challenges and resource constraints in small schools are nearly insurmountable without substantial investments. The logistical and budgetary constraints small schools face compound the infeasibility of turning these schools around. Therefore, closing them down to consolidate their inhabitants into larger schools presents a reasonable solution to the issues of learner underperformance and teacher utilization.

The adequate and sustained utilization of teachers has numerous advantages for education in South Africa more generally. The more teachers are exposed to working environments that challenge them as educators, e.g., lesson preparation, classroom management, and extracurricular activities, the more experience they can build over

[22] Many older teachers tolerate harsh teaching conditions more than their younger counterparts, because they are nearing retirement and teaching is the only profession many of them have ever known (There is also the need to protect their pensions). Others recognise their inability to pivot towards other careers due to a lack of transferable skills, given that many of them were trained during the era of Apartheid. Furthermore, many black older teachers believe that they have a responsibility towards Black learners in rural areas: “if not me, then who?”

time. This experience, which may be easier to accumulate in larger schools, has a positive effect on teachers' retention.

9. Conclusion

South Africa's persisting school infrastructure troubles are deeply rooted within the constructs of the Apartheid system. Overcoming and reversing the legacies of apartheid in this regard, therefore, entails a renewed approach to tackling the existing backlogs. However, the current political, economic, and social systems constrain the extent to which the governments (past and present) can address the backlogs with maximum efficiency. Politically, addressing the issue requires the buy-in of other parties to pass bills in parliament. Fiscally, they are constrained by a strict financial regulatory framework; therefore, investing in the eradication of poor infrastructure rather than other sectors of the economy incurs a significant opportunity cost. The eradication of school infrastructure backlogs further presents a substantial trade-off against eradicating other social ills, e.g., mass unemployment. This paper, based on interviews with government bureaucrats, focused on and sought to uncover the economic and political constraints that give rise to transaction costs in the provision of school infrastructure.

The interviews demonstrated two things: first, the issue of infrastructure backlogs is not a contemporary one; and second, government officials are aware of the problem and its true extent. Additionally, despite the respondents' ability to diagnose and offer a clear prognosis, visible action to address the situation in the absence of political pressure appears to be lacking. Officials attempt to exonerate themselves from blame by highlighting the environments that constrain them, e.g., legislative, financial, and implementation constraints. However, this does not absolve them of responsibility for the problem or for their lethargic approach to solving it. The present institutional environment justifiably endeavours to constrain bureaucratic powers, aiming to simultaneously curb corruption and guide officials during periods of uncertainty caused by unforeseen events. However, to truly make a significant contribution towards eradicating school infrastructure backlogs, South Africa needs to create a flexible institutional environment and move away from its current pragmatic approach towards a more proactive one.

The spatial and econometric analysis (although not causal) aimed to achieve two goals: (1) to demonstrate how key education infrastructure variables changed over time across the South African landscape; and (2) to provide a new and nuanced approach to the study of school infrastructure through the lens of school size. As such, the analysis uncovered a critical association between infrastructure quality and school size. Small schools (particularly poorer ones) are significantly disadvantaged because they are unable to attract more learners, teachers, and funding. Furthermore, a lack of growth in these areas presents a stumbling block for these schools to acquire infrastructure upgrades, which perpetually constrains their growth and negatively affects teacher motivation and learner performance.

Eradicating school infrastructure backlogs requires a nuanced approach that recognizes the relationship between school size and infrastructure quality and how it may affect educational performance across South Africa's geographic and socio-economic landscapes. This paper supports the DBE's policies of closing small and non-viable schools (while minimizing disruptions during transition) and advocates for investments in schools with better infrastructure to ensure effective teaching and learning environments, support learner success, and enhance teachers' motivation.

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Appendix A

Beginning in 2022, the School Monitoring Survey introduced two separate learner-weight variables – one for primary schools and another for secondary schools. In contrast, in 2011 and 2017, a single *learner weight* variable was used for both phases. As a result, the tables in this appendix present statistics for 2011, 2017, and 2022 (primary schools) side by side, for ease of comparison and space efficiency. Statistics for 2022 secondary schools are presented separately in the subsequent table. This convention is followed consistently throughout the appendix.

Access to Toilets

Table 2: Provincial changes in access to flush toilets in South African Schools for 2011, 2017 and 2022 (Primary Schools)

	2011			2017			2022 - Primary Schools		
Province	No Flush Toilets	Flush Toilets	Total	No Flush Toilets	Flush Toilets	Total	No Flush Toilets	Flush Toilets	Total
EC	241 (74%)	83 (26%)	324	192 (61%)	122 (39%)	314	89 (64%)	51 (36%)	140
FS	9 (8%)	105 (92%)	114	14 (12%)	106 (88%)	120	0 (0%)	55 (100%)	55
GT	11 (4%)	298 (96%)	309	6 (2%)	297 (98%)	302	5 (3%)	175 (97%)	180
KZN	267 (56%)	212 (44%)	479	269 (57%)	199 (43%)	468	115 (53%)	101 (47%)	216
LP	221 (77%)	65 (23%)	286	190 (74%)	66 (26%)	256	84 (66%)	44 (34%)	128
MP	72 (43%)	94 (57%)	166	81 (46%)	93 (54%)	174	29 (35%)	55 (65%)	84
NC	10 (22%)	36 (78%)	46	4 (10%)	36 (90%)	40	0 (1%)	22 (99%)	23
NW	38 (30%)	88 (70%)	126	25 (20%)	102 (80%)	127	2 (4%)	66 (96%)	68
WC	1 (1%)	153 (99%)	154	5 (3%)	175 (97%)	180	1 (1%)	96 (99%)	97
SA	**869**	**1134**	**2004**	**785**	**1196**	**1981**	**326**	**665**	**991**

Notes: Data from the School Monitoring Surveys of 2011, 2017 and 2022. Author's own calculations. Learner weights applied. In 2011 and 2017, a single *learner weight* variable was applied across both primary and secondary schools. In 2022, however, separate *learner weight* variables were introduced for primary and secondary schools. The 2022 statistics presented in this table therefore refer to primary schools only, while those for secondary schools are presented separately in Table 2 below.

Table 2: Provincial changes in access to flush toilets in South African Schools - 2022 (Secondary Schools)

	2022 – Secondary Schools		
Province	No Flush Toilets	Flush Toilets	Total
EC	76 (58%)	55 (42%)	131
FS	0 (1%)	51 (99%)	51
GT	3 (2%)	163 (98%)	166
KZN	139 (56%)	111 (44%)	250
LP	91 (63%)	53 (37%)	144
MP	36 (38%)	59 (62%)	95
NC	0 (2%)	18 (98%)	18
NW	3 (5%)	57 (95%)	60
WC	1 (2%)	68 (98%)	70
SA	349	**635**	**984**

Notes: Data from the 2022 School Monitoring Survey. Author's own calculations. Learner weights applied.

Access to Water

Table 3: Provincial changes in access to running water in South African Schools for 2017 and 2022 (Primary Schools)

	2011			2017			2022 - Primary Schools		
Province	No Water	Running Water	Total	No Water	Running Water	Total	No Water	Running Water	Total
EC	83 (25%)	242 (75%)	324	69 (22%)	244 (78%)	174	30 (21%)	110 (79%)	140
FS	4 (4%)	110 (96%)	114	9 (8%)	111 (92%)	61	4 (7%)	51 (93%)	55
GT	1 (0%)	308 (100%)	309	8 (3%)	294 (97%)	153	24 (13%)	157 (87%)	180
KZN	71 (15%)	407 (85%)	479	150 (32%)	318 (68%)	213	62 (29%)	154 (71%)	216
LP	22 (8%)	264 (92%)	286	30 (12%)	226 (88%)	116	9 (7%)	119 (93%)	128
MP	17 (10%)	149 (90%)	166	34 (19%)	140 (81%)	88	8 (9%)	77 (91%)	84
NC	3 (7%)	43 (93%)	46	3 (6%)	37 (94%)	23	1 (4%)	22 (96%)	23
NW	18 (14%)	108 (86%)	126	21 (17%)	106 (83%)	72	5 (7%)	63 (93%)	68
WC	1 (0%)	154 (100%)	154	14 (8%)	165 (92%)	89	1 (1%)	96 (99%)	97
SA	**220**	**1784**	**2004**	**339**	**1642**		**142**	**849**	**991**

Notes: Data from the School Monitoring Surveys of 2011, 2017 and 2022. Author's own calculations. Learner weights applied. "No Water" in the headings is short for "No Running Water".

Table 4: Provincial changes in access to running water in South African Schools - 2022 (Secondary Schools)

	2022 – Secondary Schools		
Province	No Water	Running Water	Total
EC	32 (24%)	99 (76%)	131
FS	3 (6%)	48 (94%)	51
GT	15 (9%)	151 (91%)	166
KZN	48 (19%)	201 (81%)	250
LP	18 (13%)	126 (87%)	144
MP	8 (8%)	87 (92%)	95
NC	1 (5%)	17 (95%)	18
NW	4 (6%)	56 (94%)	60
WC	3 (4%)	67 (96%)	70
SA	**131**	**853**	**984**

Note: Notes: Data from the 2022 School Monitoring Survey. Author's own calculations. Learner weights applied. Minor discrepancies between component figures and reported totals may occur due to rounding.

Access to Electricity

Table 5: Provincial changes in electrification in South African Schools for 2011, 2017, and 2022 (Primary Schools)

	2011			2017			2022 - Primary Schools		
Province	No Electricity	Electricity	Total	No Electricity	Electricity	Total	No Electricity	Electricity	Total
EC	78 (24%)	246 (76%)	324	34 (11%)	279 (89%)	314	8 (5%)	132 (95%)	140
FS	1 (1%)	112 (99%)	114	5 (4%)	115 (96%)	120	2 (3%)	53 (97%)	55
GT	7 (2%)	302 (98%)	309	8 (3%)	295 (97%)	302	2 (1%)	179 (99%)	180
KZN	65 (14%)	413 (86%)	479	38 (8%)	430 (92%)	468	7 (3%)	209 (97%)	216
LP	9 (3%)	277 (97%)	286	8 (3%)	248 (97%)	256	0 (0%)	128 (100%)	128
MP	8 (5%)	158 (95%)	166	5 (3%)	169 (97%)	174	2 (2%)	83 (98%)	84
NC	0 (0%)	46 (100%)	46	1 (1%)	39 (99%)	40	0 (0%)	23 (100%)	23
NW	3 (2%)	123 (98%)	126	11 (8%)	116 (92%)	127	1 (2%)	67 (98%)	68
WC	0 (0%)	154 (100%)	154	3 (2%)	176 (98%)	180	3 (3%)	94 (97%)	97
SA	**172**	**1832**	**2004**	**113**	**1868**	**1981**	**23**	**968**	**991**

Notes: Data from the School Monitoring Surveys of 2011, 2017, and 2022. Author's own calculations. Learner weights applied.

Table 5: Provincial changes in electrification in South African Schools - 2022 (Secondary Schools)

	2022 - Secondary Schools		
Province	No Electricity	Electricity	Total
EC	4 (3%)	128 (97%)	131
FS	1 (3%)	50 (97%)	51
GT	0 (0%)	166 (100%)	166
KZN	13 (5%)	237 (95%)	250
LP	3 (2%)	141 (98%)	144
MP	1 (1%)	94 (99%)	95
NC	0 (3%)	18 (97%)	18
NW	2 (3%)	58 (97%)	60
WC	3 (5%)	66 (95%)	70
SA	**26**	**958**	**984**

Notes: Data from the 2022 School Monitoring Survey. Author's own calculations. Learner weights applied.

Access to Connectivity

Table 6: Internet Access in South African Schools for 2011, 2017 and 2022 (Primary Schools)

2011				2017			2022 - Primary Schools		
Province	No Internet	Internet	Total	No Internet	Internet	Total	No Internet	Internet	Total
EC	293 (90%)	31 (10%)	324	124 (40%)	188 (60%)	313	61 (44%)	77 (56%)	138
FS	88 (78%)	26 (22%)	114	10 (8%)	110 (92%)	120	1 (1%)	54 (99%)	55
GT	178 (58%)	131 (42%)	309	26 (9%)	274 (91%)	300	3 (2%)	175 (98%)	178
KZN	407 (85%)	71 (15%)	479	270 (58%)	195 (42%)	465	89 (42%)	124 (58%)	214
LP	277 (97%)	10 (3%)	286	87 (34%)	169 (66%)	256	16 (12%)	112 (88%)	128
MP	146 (88%)	20 (12%)	166	47 (27%)	127 (73%)	174	13 (15%)	71 (85%)	84
NC	36 (79%)	10 (21%)	46	3 (8%)	36 (92%)	40	0 (1%)	21 (99%)	22
NW	114 (90%)	12 (10%)	126	27 (21%)	100 (79%)	127	17 (26%)	50 (74%)	67
WC	64 (42%)	90 (58%)	154	4 (2%)	176 (98%)	180	1 (1%)	95 (99%)	96
SA	**1604**	**400**	**2004**	598	1375	1973	**201**	**780**	**981**

Notes: Data from the School Monitoring Surveys of 2011, 2017 and 2022. Author's own calculations. Learner weights applied.

Table 6: Internet Access in South African Schools - 2022 (Secondary Schools)

	2022 - Secondary Schools		
Province	No Internet	Internet	Total
EC	53 (41%)	75 (59%)	128
FS	1 (2%)	49 (98%)	50
GT	9 (5%)	154 (95%)	162
KZN	119 (50%)	119 (50%)	238
LP	25 (17%)	119 (83%)	143
MP	14 (15%)	80 (85%)	94
NC	1 (5%)	16 (95%)	16
NW	14 (24%)	45 (76%)	59
WC	2 (3%)	66 (97%)	68
SA	**237**	**723**	**960**

Notes: Data from the 2022 School Monitoring Survey. Author's own calculations. Learner weights applied.

State of Infrastructure

Table 7: Severity of School Infrastructural Disrepair in South Africa for 2017 and 2022 (Primary Schools)

	2011					2017				
Province	Severe	Moderate	Minor	Well	Total	Severe	Moderate	Minor	Well	Total
EC	65 (36%)	23 (18%)	80 (45%)	11 (6%)	179	114 (37%)	99 (33%)	35 (11%)	57 (19%)	306
FS	23 (29%)	6 (8%)	38 (49%)	11 (14%)	78	18 (16%)	31 (27%)	29 (25%)	35 (31%)	112
GT	46 (20%)	23 (10%)	124 (54%)	39 (17%)	232	58 (19%)	94 (31%)	57 (19%)	90 (30%)	299
KZN	61 (25%)	46 (19%)	115 (48%)	18 (8%)	241	122 (27%)	142 (32%)	62 (14%)	120 (27%)	446
LP	72 (42%)	26 (15%)	65 (38%)	7 (4%)	169	55 (22%)	78 (32%)	58 (24%)	54 (22%)	245
MP	20 (18%)	21 (19%)	52 (48%)	16 (15%)	109	32 (18%)	63 (37%)	36 (21%)	42 (24%)	173
NC	4 (18%)	2 (9%)	15 (65%)	2 (8%)	23	9 (24%)	13 (31%)	5 (12%)	13 (33%)	40
NW	34 (41%)	8 (10%)	39 (47%)	2 (2%)	83	29 (23%)	34 (28%)	18 (15%)	43 (35%)	125
WC	21 (18%)	22 (18%)	62 (52%)	15 (12%)	120	26 (15%)	35 (20%)	32 (18%)	86 (48%)	179
SA	**345**	**177**	**590**	**121**	**1233**	**463**	**589**	**332**	**541**	**1924**

	2022 - Primary Schools				
Province	Severe	Moderate	Minor	Well	Total
EC	52 (37%)	36 (26%)	15 (11%)	28 (20%)	140
FS	9 (16%)	12 (22%)	12 (22%)	21 (39%)	55
GT	36 (20%)	47 (26%)	23 (13%)	70 (39%)	180
KZN	44 (20%)	44 (20%)	42 (20%)	79 (36%)	216
LP	30 (23%)	31 (24%)	23 (18%)	43 (34%)	128
MP	21 (24%)	25 (30%)	11 (14%)	26 (31%)	84
NC	3 (13%)	8 (34%)	4 (19%)	7 (32%)	23
NW	18 (26%)	21 (31%)	11 (16%)	19 (28%)	68
WC	11 (11%)	15 (16%)	24 (25%)	47 (49%)	97
SA	**223**	**238**	**165**	**339**	**965**

Notes: 26 schools were not assigned to any of the categories shown in Table 7; they were assigned to the "Other" category and have been removed from the tables and the total of 991.

Table 8: Severity of School Infrastructural Disrepair in South Africa - 2022 (Secondary Schools)

	2022 - Secondary Schools				
Province	Severe	Moderate	Minor	Well	Total
EC	46 (35%)	41 (31%)	12 (9%)	26 (20%)	131
FS	14 (28%)	11 (21%)	9 (17%)	17 (34%)	51
GT	35 (21%)	37 (22%)	25 (15%)	67 (40%)	166
KZN	67 (27%)	86 (35%)	40 (16%)	52 (21%)	250
LP	36 (25%)	47 (33%)	19 (14%)	36 (25%)	144
MP	29 (31%)	25 (26%)	14 (15%)	22 (23%)	95
NC	4 (23%)	5 (30%)	3 (16%)	5 (28%)	18
NW	12 (20%)	19 (31%)	10 (17%)	18 (31%)	60
WC	6 (8%)	13 (19%)	15 (22%)	35 (50%)	70
SA	**250**	**285**	**147**	**279**	**962**

Notes: Data from the School Monitoring Surveys of 2011, 2017, and 2022. Author's own calculations. Learner weights applied. Twenty-two schools were not assigned to any of the categories shown in Table 8; they were assigned to a category called "Other" and have been removed from the tables and the total of 984.

Classroom Availability and Overcrowding

Table 9: Provincial changes in learner-to-classroom ratios in South African Schools for 2017 and 2022 (Primary Schools)

	2011					2017				
Province	Low	Alright	High	Super High	Total	Low	Alright	High	Super High	Total
EC	43 (14%)	133 (43%)	96 (31%)	40 (13%)	312	25 (8%)	129 (44%)	95 (32%)	45 (15%)	294
FS	13 (12%)	71 (62%)	28 (24%)	2 (24%)	113	13 (12%)	59 (56%)	33 (31%)	2 (2%)	107
GT	10 (3%)	195 (65%)	93 (31%)	2 (31%)	301	17 (6%)	158 (56%)	93 (33%)	15 (5%)	282
KZN	29 (6%)	203 (44%)	188 (40%)	47 (40%)	467	29 (6%)	223 (49%)	175 (38%)	27 (6%)	455
LP	24 (8%)	163 (58%)	78 (28%)	18(28%)	283	14 (6%)	92 (37%)	104 (42%)	39 (16%)	249
MP	9 (6%)	75 (46%)	57 35%)	22 (14%)	163	8 (5%)	69 (43%)	70 (43%)	13 (8%)	161
NC	4 (10)	33 (72%)	7 (16%)	1 (2%)	46	4 (11%)	27 (71%)	6 (15%)	1 (3%)	38
NW	11 (9%)	56 (45%)	50 (41%)	7 (5%)	123	5 (4%)	50 (41%)	61 (50%)	5 (4%)	122
WC	11 (7%)	110 (71%)	33 (22%)	0 (0%)	154	11 (6%)	138 (79%)	21 (12%)	3 (2%)	173
SA	**154**	**1037**	**631**	**139**	**1961**	**127**	**946**	**658**	**150**	**1881**

2022 - Primary Schools				
Low	Alright	High	Super High	Total
21 (16%)	56 (43%)	40 (30%)	15 (11%)	132
6 (12%)	28 (52%)	17 (31%)	3 (5%)	53
5 (3%)	88 (52%)	66 (39%)	9 (6%)	168
16 (8%)	108 (53%)	68 (33%)	13 (6%)	205
5 (4%)	54 (43%)	49 (39%)	18 (14%)	126
2 (3%)	34 (42%)	34 (41%)	11 (14%)	81
1 (6%)	16 (75%)	3 (15%)	1 (4%)	21
3 (4%)	26 (42%)	26 (42%)	7 (11%)	62
3 (3%)	70 (77%)	17 (19%)	1 (1%)	91
62	**480**	**318**	**78**	**938**

Notes: Data from the School Monitoring Surveys of 2011, 2017 and 2022. Author's own calculations. Learner weights applied. "Low (L:C <20)" 2 "Alright (L:C 21-40)" 3 "High (L:C 41-60)" 4 "Super High (L:C 61-118.5)"

Table 10: Provincial changes in learner-to-classroom ratios in South African Schools - 2022 (Secondary Schools)

	2022 - Secondary Schools				
Province	Low	Alright	High	Super High	Total
EC	8 (7%)	40 (33%)	40 (33%)	34 (28%)	123
FS	5 (11%)	30 (61%)	13 (26%)	1 (2%)	50
GT	9 (6%)	75 (49%)	61 (40%)	7 (5%)	151
KZN	8 (4%)	80 (34%)	99 (43%)	44 (19%)	231
LP	18 (13%)	56 (40%)	36 (26%)	30 (21%)	140
MP	10 (11%)	31 (34%)	33 (36%)	17 (19%)	92
NC	1 (9%)	10 (65%)	4 (22%)	1 (3%)	16
NW	4 (7%)	25 (43%)	23 (40%)	6 (10%)	57
WC	5 (8%)	50 (76%)	10 (16%)	1 (1%)	66
SA	**70**	**396**	**319**	**140**	**926**

Notes: Data from the School Monitoring Surveys of 2011, 2017 and 2022. Author's own calculations. Learner weights applied.

Appendix B

Table 1: OLS multivariate regression results - Infrastructure (Primary Schools)

	1	2	3	4	5
	Infra Index	Infra Index	Infra Index	Infra Index	Infra Index
Medium	1.107***	0.800***	0.955***	0.934***	0.812***
	(-0.122)	*(-0.149)*	*(-0.217)*	*(-0.241)*	*(-0.253)*
Large	1.903***	1.221***	1.313***	1.298***	1.138***
	(-0.118	*(-0.154)*	*(-0.222)*	*(-0.246)*	*(-0.259)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	1.702***	2.480***	-2.617***	-1.951***	1.874***
	(-0.109)	*(-0.190)*	*(-0.217)*	*(-0.288)*	*(-0.290)*
Observations	852	852	852	841	841
R-squared	0.20	0.47	0.60	0.61	0.62

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 2: OLS multivariate regression results - Infrastructure (Secondary Schools)

	1	2	3	4	5
	Infra Index	Infra Index	Infra Index	Infra Index	Infra Index
Medium	0.747**	0.276	0.493	0.5	0.484
	(-0.291)	*(-0.275)*	*(-0.317)*	*(-0.348)*	*(-0.336)*
Large	1.511***	0.778***	0.996***	0.996***	0.971***
	(-0.289)	*(-0.281)*	*(-0.325)*	*(-0.355)*	*(-0.342)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	1.137***	1.407***	-4.008***	-0.496	0.134
	(-0.284)	*(-0.299)*	*(-1.019)*	*(-0.456)*	*(-0.469)*
Observations	841	841	841	832	832
R-squared	0.17	0.51	0.65	0.65	0.69

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 3: LPM multivariate regression results - Toilets (Primary Schools)

	1	2	3	4	5
	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets
Medium	0.333***	0.192***	0.234***	0.233**	0.220**
	(-0.070)	*(-0.063)*	*(-0.089)*	*(-0.091)*	*(-0.091)*
Large	0.699***	0.317***	0.319***	0.320***	0.302***
	(-0.068)	*(-0.067)*	*(-0.093)*	*(-0.094)*	*(-0.096)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.165**	-0.121**	0.128	0.12	0.135
	(-0.065)	*(-0.053)*	*(-0.284)*	*(-0.284)*	*(-0.280)*
Observations	989	981	981	967	967
R-squared	0.17	0.67	0.71	0.72	0.72

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 4: LPM multivariate regression results - Toilets (Secondary Schools)

	1	2	3	4	5
	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets	Flush Toilets
Medium	0.286***	0.103	0.188*	0.202*	0.203*
	(-0.087)	*(-0.086)*	*(-0.113)*	*(-0.111)*	*(-0.114)*
Large	0.616***	0.224**	0.304***	0.324***	0.324***
	(-0.085)	*(-0.089)*	*(-0.115)*	*(-0.113)*	*(-0.116)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.190**	-0.0997	0.328**	-1.144***	-1.144***
	(-0.082)	*(-0.085)*	*(-0.151)*	*(-0.356)*	*-0.356)*
Observations	972	960	960	950	950
R-squared	0.14	0.55	0.71	0.71	0.71

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 5: LPM multivariate regression results - Water (Primary Schools)

	1	2	3	4	5
	Water	Water	Water	Water	Water
Medium	0.022	0.018	-0.041	-0.054	-0.041
	(-0.104)	*(-0.109)*	*(-0.137)*	*(-0.135)*	*(-0.136)*
Large	0.093	0.023	-0.050	-0.056	-0.038
	(-0.103)	*(-0.110)*	*(-0.138)*	*(-0.136)*	*(-0.138)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	Yes	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.800***	0.706***	1.027**	1.046**	1.031**
	(-0.102)	*(-0.125)*	*(-0.420)*	*(-0.418)*	*(-0.419)*
Observations	981	981	981	967	967
R-squared	0.01	0.14	0.34	0.35	0.35

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 6: LPM multivariate regression results - Water (Secondary Schools)

	1	2	3	4	5
	Water	Water	Water	Water	Water
Medium	0.018	0.003	0.032	0.047	0.055
	(-0.090)	*(-0.104)*	*(-0.118)*	*(-0.125)*	*(-0.124)*
Large	0.124	0.0912	0.133	0.145	0.156
	(-0.088)	*(-0.104)*	*(-0.121)*	*(-0.128)*	*(-0.126)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.797***	0.489***	0.561***	1.111***	1.106***
	(-0.087)	*(-0.132)*	*(-0.167)*	*(-0.201)*	*(-0.201)*
Observations	960	960	960	950	950
R-squared	0.03	0.13	0.39	0.39	0.39

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 7: LPM multivariate regression results - Electricity (Primary Schools)

	1	2	3	4	5
	Elec	Elec	Elec	Elec	Elec
Medium	0.047	0.022	0.064	0.066	0.071
	(-0.066)	*(-0.070)*	*(-0.070*	*(- 0.071)*	*(-0.072)*
Large	0.044	0.010	0.060	0.062	0.068
	(-0.066)	*(-0.071)*	*(-0.070*	*(- 0.071)*	*(-0.072)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.931***	0.926***	0.281	0.279	0.274
	(-0.066)	*(-0.066)*	*(-0.331*	*(- 0.332)*	*(-0.332)*
Observations	981	981	981	967	967
R-squared	0.00	0.04	0.26	0.27	0.27

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 8: LPM multivariate regression results - Electricity (Secondary Schools)

	1	2	3	4	5
	Elec	Elec	Elec	Elec	Elec
Medium	0.073	0.079	0.081	0.086	0.092
	(-0.078)	*(-0.079)*	*(-0.078)*	*(-0.083)*	*(-0.083)*
Large	0.082	0.086	0.079	0.084	0.092
	(-0.078)	*(-0.080)*	*(-0.077)*	*(-0.082)*	*(-0.082)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.899***	0.893***	0.919***	1.052***	1.048***
	(-0.078)	*(-0.080)*	*(-0.081)*	*(-0.035)*	*(-0.034)*
Observations	960	960	960	950	950
R-squared	0.001	0.06	0.29	0.29	0.29

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 9: LPM multivariate regression results – Internet Access (Primary Schools)

	1	2	3	4	5
	Internet	Internet	Internet	Internet	Internet
Medium	-0.012	-0.099	0.0365	0.0363	0.030
	(-0.117)	*(-0.126)*	*(-0.144)*	*(-0.146)*	*(-0.148)*
Large	0.253**	0.0194	0.138	0.136	0.127
	(-0.115)	*(-0.126)*	*(-0.145)*	*(-0.146)*	*(-0.149)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access			No	No	
Control	No	No			Yes
			-	-	
Constant	0.681***	0.408***	0.780***	0.776***	0.769***
	(-0.114)	*(-0.138)*	*(-0.27)*	*(-0.272)*	*(-0.270)*
Observations	989	981	981	967	967
R-squared	0.11	0.38	0.54	0.55	0.55

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 10: LPM multivariate regression results - Internet Access (Secondary Schools)

	1	2	3	4	5
	Internet	Internet	Internet	Internet	Internet
Medium	0.224*	0.174	0.154	0.164	0.166
	(-0.117)	*(-0.121)*	*(-0.121)*	*(-0.131)*	*(-0.133)*
Large	0.397***	0.282**	0.253**	0.257*	0.260*
	(-0.116)	*(-0.122)*	*(-0.126)*	*(-0.136)*	*(-0.137)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.450***	0.292**	0.881***	-0.174	-0.175
	(-0.114)	*(-0.139)*	*(-0.188)*	*(-0.204)*	*(-0.205)*
Observations	972	960	960	950	950
R-squared	0.05	0.27	0.50	0.50	0.50

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 11: LPM multivariate regression results – Computer Labs (Primary Schools)

	1	2	3	4	5
	Comp Labs	Comp Labs	Comp Labs	Comp Labs	Comp Labs
Medium	0.275***	0.247***	0.200**	0.173*	0.160
	(-0.039)	*(-0.070)*	*(-0.100)*	*(-0.105)*	*(-0.107)*
Large	0.527***	0.344***	0.262**	0.236**	0.219*
	(-0.041)	*(-0.075)*	*(-0.105)*	*(-0.110)*	*(-0.114)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.032	0.193***	-0.104	-0.053	-0.039
	(-0.032)	*(-0.068)*	*(-0.344*	*(-0.345)*	*(-0.348)*
Observations	989	981	981	967	967
R-squared	0.076	0.293	0.433	0.435	0.436

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 12: LPM multivariate regression results – Computer Labs (Secondary Schools)

	1	2	3	4	5
	Comp Labs	Comp Labs	Comp Labs	Comp Labs	Comp Labs
Medium	0.170	0.059	0.110	0.164	0.065
	(-0.108)	*(-0.101)*	*-0.113*	*-0.131*	*(-0.115)*
Large	0.424***	0.193*	0.213*	0.257*	0.166
	(-0.107)	*(-0.104)*	*-0.118*	*-0.136*	*(-0.121)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.289***	0.302**	0.679***	-0.174	1.128***
	(-0.105)	*(-0.125)*	*-0.178*	*-0.204*	*(-0.326)*
Observations	972	960	960	950	950
R-squared	0.07	0.28	0.46	0.50	0.47

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 13: LPM multivariate regression results – Well-Maintained Schools (Primary Schools)

	1	2	3	4	5
	Good Infra	Good Infra	Good Infra	Good Infra	Good Infra
Medium	0.153	0.020	0.011	-0.019	-0.029
	(-0.110)	*(-0.113)*	*(-0.143)*	*(-0.155)*	*(-0.155)*
Large	0.235**	0.0416	0.053	0.023	0.009
	(-0.110)	*(-0.115)*	*(-0.148)*	*(-0.159)*	*(-0.160)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.332***	0.315**	0.179	0.831**	0.843***
	(-0.107)	*(-0.131)*	*(-0.141)*	*(-0.322)*	*(-0.323)*
Observations	969	961	961	947	947
R-squared	0.01	0.13	0.34	0.34	0.34

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.

Table 14: LPM multivariate regression results – Well-Maintained Schools (Secondary Schools)

	1	2	3	4	5
	Good Infra	Good Infra	Good Infra	Good Infra	Good Infra
Medium	0.238***	0.162*	0.173	0.175	0.139
	(-0.084	*(-0.085)*	*(-0.107)*	*(-0.11)*	*(-0.103)*
Large	0.324***	0.201**	0.218*	0.215*	0.164
	(-0.084)	*(-0.088)*	*(-0.112)*	*(-0.115)*	*(-0.109)*
Province	No	Yes	Yes	Yes	Yes
Quintile	No	Yes	Yes	Yes	Yes
Municipality	No	No	Yes	Yes	Yes
Management	No	No	No	Yes	Yes
Access Control	No	No	No	No	Yes
Constant	0.162**	0.104	-0.084	0.448	0.477
	(-0.080)	*(-0.108)*	*(-0.167)*	*(-0.449)*	*(-0.451)*
Observations	951	939	939	929	929
R-squared	0.02	0.14	0.35	0.36	0.37

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Learner weights applied.