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Going beyond the Infrastructure Funding Gap: A South African Perspective

Basic Education Report

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EXECUTIVE SUMMARY

The purpose and scope of the report

This report assesses the infrastructure needs in the basic education sector (i.e., primary, including grade R, and secondary schools), in the context of South Africa's commitment to achieving the Sustainable Development Goals (SDGs) by 2030. It is one of four sectoral reports that draw on World Bank's "Beyond the Gap" methodology and is the product of a partnership between the Department of Basic Education (DBE), the Development Bank of Southern Africa (DBSA) and the World Bank. The education sector was chosen because of its important role in achieving four of the SDGs, including SDG 4 (quality education), SDG 6 (clean water and sanitation), SDG 7 (energy for all) and SDG 10 (reduced inequalities). The report aims to inform policy choices and investment decisions related to school infrastructure, by quantifying the infrastructure funding needs for the public education system for a variety of scenarios to 2030, based on the infrastructure backlog as well as the infrastructure needs arising from the anticipated expansion of the basic education system.

Methodology

The analysis undertaken in this report is based on the World Bank's "Beyond the Gap (BtG)" analytical framework (Rozenberg & Fay, 2019), illustrated in Figure ES1.

Figure ES1: Beyond the Gap analysis framework

Source: (Rozenberg & Fay, 2019)

The analysis is based heavily on the SDG 4 indicators and adapted to the South African policy context. The objectives include (i) providing equitable and quality primary and secondary education for eligible boys and girls in South Africa; (ii) providing access to quality early childhood development, care, and pre-primary education to all eligible boys and girls in order to prepare them for primary education; (iii) building

and upgrading child-friendly and disability- and gender-sensitive education facilities and providing safe, non-violent, inclusive, and effective learning environments for all; and (iv) increasing the supply of qualified teachers to sustain education service delivery in pre-primary, primary and secondary levels of education.

In order to estimate the cost of achieving the sector objectives (i.e., the final step in the BtG framework above), the analysis adopts the framework elaborated in Figure ES2, breaking down basic education infrastructure needs into two parts. The first part consists of the investments required to bring the existing stock of schools up to current DBE norms and standards. This report presents three options of upgrading infrastructure depending on the extent to which the government will address infrastructure needs in schools – whether to address 100% of the needs or less than 100%. The second part consists of the new school infrastructure required to accommodate the projected growth of the education system to respond to increase in population, at least until 2030. This part includes three main scenarios of expansion namely a baseline scenario, a full access scenario, and a full access with efficiency scenario, all based on the baseline population projections. Details of the drivers of school infrastructure needs are described in section 8 of the report.

The costs of upgrading existing infrastructure and building new infrastructure are driven by three main factors which are highlighted on the right in Figure ES2. The first relates to education performance policy decisions such as Gross Enrolment Ratio in pre-primary, primary and secondary; grade repetition in these three levels of education; average class sizes in public schools, and student to teacher ratios in public schools, and other decisions such as whether to expand public support for Early Childhood Development (ECD) and the possible introduction of a school leaving certificate at the end of Grade 9 which could potentially affect the flow of students from lower secondary to upper secondary school. An example of how these performance policy decisions affect infrastructure needs is class size. The bigger the class size (i.e., more children in one classroom), the fewer the classrooms that will be needed, though larger class sizes will affect the quality of learning. Policy makers have to weigh up the resource constraints against student performance outcomes when making such policy decisions. Higher repetition means more students would be in one class hence more classrooms will be required.

The second factor driving the costs of infrastructure is the modality for implementing school construction which essentially takes three forms in South Africa: (i) centralized implementation by the Department of

Basic Education (DBE); (ii) decentralized to the provincial level; and (iii) community-based implementation. The third factor driving costs is the size of the school, i.e., whether it is small, medium, or large as per DBE's classification. Apart from these three endogenous factors, the study also identifies exogenous factors that will influence the final costs, namely the socioeconomic scenarios of population and economic growth.

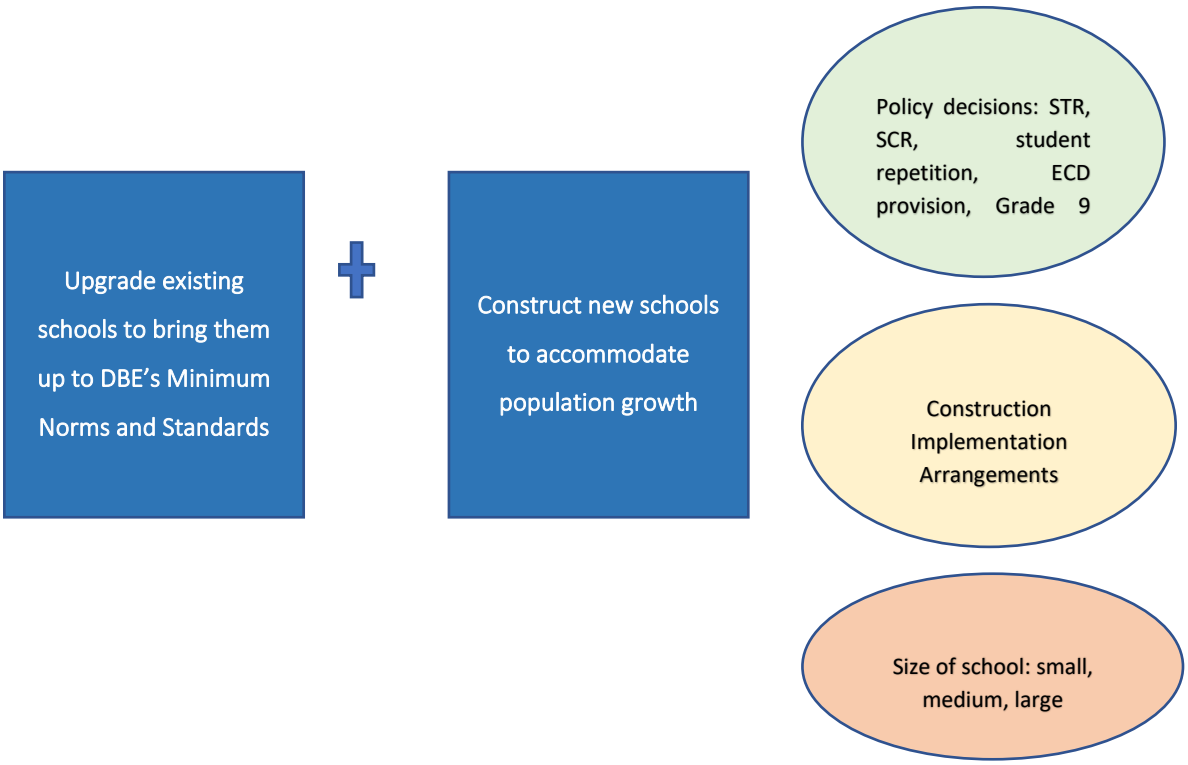


Figure ES2: Components of the infrastructure financing needs

Source: Authors' framework

Ideally, in addition to the costs of upgrading existing schools and the costs of constructing new schools, one would also want to consider the costs of upgrading schools to standards required in the future, e.g., digital connectivity. However, this has not been costed as part of this analysis because the exact nature of infrastructure needed in the future has not been defined by the DBE, nor can the costs be reliably estimated. Instead, the report discusses experiences from other countries on the impact of technology on school infrastructure, to inform policy discussions in South Africa, and trigger further study.

The authors estimated costs for various options for upgrading existing schools, as well as scenarios for constructing new schools. For the latter, the capital and recurrent[1] costs of the expansion of the basic education system were estimated. Table ES1 presents a summary of the assumptions behind each of the three options for upgrading existing schools and the three scenarios for the construction of new schools. For the third option, there was a sensitivity analysis done to analyze the costs if future population included significant rural or urban migration. It is important to note that the options under the upgrading of schools are not affected by population growth but are a function of infrastructure backlog, and that the government may determine the pace at which the backlog is addressed. Ideally, these infrastructure backlogs should be addressed within a short period, say four years. However, the costs of new schools to be constructed is driven by the various trajectories of population growth.

Table ES1: Parameters/assumptions made in the upgrade and expansion of school infrastructure

	Option/Scenario	**Objectives/Assumptions driving the option/scenarios**
1 (Backlogs): Upgrading existing stock of schools to current DBE norms and standards	Option 1	• Addressing 100% of current backlogs related to toilets (i.e., converting all toilets below VIP status into VIP toilets), electricity, water, non-permanent classrooms made of mud/wood/clay, as well as broken floors and ceilings; and 100% of needs relating to computer rooms, libraries, laboratories, and servers
	Option 2	• Addressing 100% of the needs for toilets, electricity, water, replacing of mud classrooms, floors, and ceilings • Only 70% of the needs relating to computer rooms, libraries, laboratories, and servers
	Option 3	• Addressing 100% of the needs for toilets, electricity, water, replacing of mud classrooms, floors, and ceilings • Only 50% of the needs relating to computer rooms, libraries, laboratories, and servers
2 (New infrastructure):	Scenario 1: Baseline	• Population growth profile without migration • Economy growing at 2.21%

[1] Recurrent costs include salaries for teaching and non-teaching staff, non-salary recurrent expenditure (subvention to schools, goods and services, operations and maintenance, and utilities)

	Option/Scenario	Objectives/Assumptions driving the option/scenarios
Expansion of schools to accommodate the projected growth of the education system to respond to increase in population, at least until 2030		• All education indicators remain at baseline • Maintaining the share of recurrent non-salary costs at 8%
	Scenario 2: Full Access	• Population growth profile without migration • Economy growing at 2.21% • Improving endogenous education indicators: Increasing Gross Enrolment Ratios at all levels of Education (100% in Grade R, primary, and lower secondary, 90% in upper secondary); Improving Student Teacher Ratios (Maximum of 34 in grade R and primary, and 31 in secondary); and improving class sizes (Maximum of 38 in grade R and primary, and 35 in secondary) • Maintaining the share of recurrent non-salary costs at 8%
	Scenario 3: Full access with efficiency	• Population growth profile without migration, with sensitivity tests for alternative population growth profiles (World Bank based on Stats SA, urban and rural projections) • Economy growing at 2.21% (with sensitivity tests for alternative growth rates) • Improving endogenous education indicators: Increasing Gross Enrolment Ratios at all levels of Education (100% in Grade R, primary, and lower secondary, 90% in upper secondary); Improving Student Teacher Ratios (Maximum of 34 in grade R and primary, and 31 in secondary); and improving class sizes (Maximum of 38 in grade R and primary, and 35 in secondary); Reducing repetition in primary and senior secondary; creating incentives for private pre-primary education • Improving the share of recurrent non-salary costs from 8% to 10%

Source: Authors' compilations extracted from the simulation model, (World Bank, 2021)

Study findings on the needs and cost of upgrading and expanding basic education

The cost of upgrading existing schools to DBE norms and standards

While there has been considerable improvement in the quality of existing school facilities in the last three decades, there are still a considerable number of schools without access to the minimum acceptable

ventilated improved pit (VIP) toilets. Out of the almost 567 000 toilets across pre-primary, primary and secondary levels of education, about 124 000 (or 22 percent) do not meet the minimum standards. Approximately 2 300 schools in South Africa have no access to water or have access to levels that are deemed to be grossly inadequate (about 10% of schools), while nearly 2 000 (9% of schools) do not have access to adequate electricity. It is necessary to stabilize the supply of each of these utilities in affected schools as both utilities are linked to an improved learning environment. There are also about 2 400 schools, mostly in the Eastern Cape, that are constructed using non-permanent materials like mud, clay, and wood that require substantial renovation, and are considered 'inappropriate' structures. Several classrooms require renovation to fix floors (4 300 classrooms) and restore ceilings (3 100 classrooms). 69% of all schools do not have computer rooms, 75% do not have libraries and 85% do not have any laboratories. There are several other facilities including school halls, kitchens, storage, etc., that need to comply with minimum norms and standards for schools in South Africa, however, the limited availability of data constrained this analysis. Table ES2 presents the number of facilities to be upgraded in existing schools using the latest data available in the DBE's National Education Infrastructure Management System (NEIMS).

Table ES2: Facilities that require upgrading in basic education

Facility	Primary	Secondary	Combined	Total need
Computer Room	10 630	3 232	1 746	15 608
Library	11 293	3 579	1 961	16 833
Laboratory	13 200	3 463	2 378	19 041
Server	13 578	5 393	2 989	21 960
Toilet seats needed	75 326	37 851	10 622	123 799
Water (<25%)				2 292
Electricity (<25%)				1 956
Mud/Clay/Wood	467	1 743	198	2 408
Broken floor	437	2 920	897	4 254
Broken Ceiling	272	1 688	1 124	3 084

Source: (DBE, 2021)

The cost of addressing all infrastructure backlogs related to toilets (i.e., to converting all toilets that fall below VIP level into VIP toilets), water, electricity, non-permanent classrooms made of mud/wood/clay,

as well as broken floors and ceilings is estimated to be ZAR 9 billion, with 40 percent of this cost estimated to be for upgrading/building toilets. Once the cost of building computer rooms, libraries, laboratories and servers in schools that lack these facilities is added to this figure, the cost soars to ZAR 93.2 billion. This is the first option under the upgrading component (see Table ES3). In the second option, if the DBE addressed all the needs for toilets, water, electricity, non-permanent classrooms and broken floors and ceilings; and 70% of the needs for computer rooms, libraries, laboratories and servers, the total cost for the upgrade would be ZAR 68 billion. Under option 3, if the DBE addressed all the needs for toilets, water, electricity, non-permanent classrooms and broken floors and ceilings; and 50% of the needs for computer rooms, libraries, laboratories and servers, the total cost for the upgrade would be ZAR 51 billion.

Table ES3: Cost of upgrading facilities in basic education

Facility	Area covered * (Sqm)	Coverage			Unit Cost per facility (ZAR)	Total cost of upgrade		
		Option 1	Option 2	Option 3		Option 1	Option 2	Option 3
Computer Room	99	100 %	70 %	50 %	1 287 100	20 100	14 100	10 000
Library	168	100 %	70 %	50 %	2 182 400	36 700	25 700	18 400
Laboratory	99	100 %	70 %	50 %	1 287 100	24 500	17 200	12 300
Server	10	100 %	70 %	50 %	130 000	2 900	2 000	1 400
Toilet seats	4	100 %	100 %	100 %	26 000	3 200	3 200	3 200
Water (<25 percent)	-	100 %	100 %	100 %	500 000	1 100	1 100	1 100
Electricity (<25 percent)	-	100 %	100 %	100 %	1 000 000	2 000	2 000	2 000
Mud/Clay/Wood	60	100 %	100 %	100 %	779 700	1 900	1 900	1 900
Broken floor	6	100 %	100 %	100 %	78 000	300	300	300
Broken Ceiling	12	100 %	100 %	100 %	155 900	500	500	500
Grand Total (million ZAR)						**93 200**	**68 000**	**51 100**

Source: Author's computation based on available unit cost data; the cost of accommodating the growth in students entering the basic education stream up to 2030

The cost of building new infrastructure to accommodate projected growth

Apart from upgrading existing schools, the study estimates that there will be additional learners entering the education system in South Africa by 2030 (nearly 990 000 under scenario 1; and 1.3 million under scenarios 2 and 3). Majority of these additional learners will go to public schools, with the proportion of learners going to each level of education varying from one scenario to another, but one common feature in the three scenarios is that most of the additional learners will be in secondary education. These additional learners will require more classrooms to be built and additional teachers to be hired to sustain a conducive learning environment, which is conditional to achieving the overall sustainable development goal of quality and equitable education for all. The requirements are based on the expansion scenarios outlined in Table ES1.

Of the three scenarios under the construction of new schools, scenario 3 is the preferred scenario given that it accounts for better efficiencies in the delivery of education services. This scenario assumes that the population grows without migration, and there are efficiency gains in the education system. These efficiencies relate to:

- *Improving access to all levels of education*: Increasing GER in grade R and primary to 100%, which involves heavy lifting in provinces that lag behind like Gauteng, North West and Western Cape in access to preschool to catch up with the rest of the country; increasing the GER in lower secondary to 100% for lagging provinces such as Gauteng, North West and Western Cape. By creating an option for students to pursue other avenues such as technical or vocational training, rather than academic secondary, which is aligned to DBE's new policy for the introduction of the General Education Certificate (GEC) for Grade 9 students, there will potentially be a decline in upper secondary GER, due to the anticipated transition of some students to technical and vocational training after Grade 9. A critical point to note from this scenario is that it keeps the present capacity of public Grade R constant, so that the country will not have to bear the burden of additional infrastructure at this level but expand access through private providers by providing similar subsidies availed to public schools.
- *Improving Student Teacher Ratio (STR) and Student Classroom Ratio (SCR)*: In 2020, the student to teacher ratio for primary education ranged from 30:1 to 37:1 by province (Limpopo and North West having the highest ratios) and from 27:1 to 32:1 by province for secondary education (Western Cape and North West having the highest ratios). In the same year, the SCR for Grade R and primary

education ranged from 29:1 and 42:1 (Mpumalanga and Gauteng having the highest ratios) and for secondary education, it ranged from 29:1 to 38:1 (Mpumalanga and North West having the highest ratios followed by Gauteng). This scenario assumes that all provinces will bring the maximum number of learners to 34 students per teacher for grade R and primary, and 31 students per teacher for secondary. This involves reorganizing the existing teachers through inter-school transfers and improving teacher ratios in some provinces. SCR is assumed to fall to a maximum of 38 in grade R and primary, and 35 in secondary, with particular focus on Gauteng, Mpumalanga, and North West provinces, where SCRs were the highest in 2020. These improvements are expected to facilitate more personalized learning, a key foundation of achieving better learning outcomes.

- *Reducing the repetition rate in primary and upper secondary education*: In 2020, the share of repeaters was 15 percent in primary, 8 percent in lower secondary and 15 percent in upper secondary, which is quite high. Since enrolments include repeaters, high repetition rates result in more learners in the system. Eliminating or lowering repetition rates, by reducing the number of repeating learners, not only enhances the efficiency in schooling, but also reduces the requirements for additional classrooms and teachers. Under this scenario, the expansion assumes that repetition will improve to 10 percent in primary and upper secondary, while remaining constant in lower secondary. Changes in repetition are applied to public schools only.
- *Increasing the share of non-salary recurrent spending in basic education to 10%.* Education expenditure is classified into recurrent and capital, and further into salary and non-salary expenditure in the case of recurrent expenditure. Once teachers and non-teachers are paid, it remains for the sector to see how to make use of their time in delivery of curriculum and supporting delivery of the same. Teachers have to teach using selected materials and equipment, and learners have to experience learning through selected materials. Education administrators also have to support schools through periodic interactions, most of which require movement. The non-salary recurrent expenditure is critical in facilitating these elements and supporting schools in accessing these factors that can influence quality of education. The third scenario assumes that the country will increase the share of non-salary recurrent expenditure from the 8 percent spent in 2020 to 10 percent to facilitate the purchase of textbooks for learners, guides for teachers, facilitate travels for school inspectors, etc.

Based on these assumptions in scenario 3, the Government will spend a total of ZAR 2.3 trillion in recurrent terms between 2022 and 2030 to sustain the existing and expanded system, i.e., remuneration of existing

teaching and non-teaching staff, hiring of about 25 000 additional teachers (most of whom will be required in Gauteng and KwaZulu-Natal Provinces). The average recurrent spending will be ZAR 261.8 billion annually during the expansion period. Given the baseline recurrent spending of ZAR 232.2 billion, the Government will have to gradually stretch its commitment to basic education and reach ZAR 283.5 billion in 2030, the net additional being ZAR 51.4 billion between 2020 and 2030 (see Table ES4). Compared to the recurrent costs in other scenarios, the cost estimated under scenario 3 assumptions are marginally lower than the ZAR 2.4 trillion estimated for scenario 2 and marginally higher than the estimates for scenario 1. These costs are based on the assumption that there will be no significant migration between the provinces and that the economy will grow at an annual average of 2.21%.

Table ES4: Recurrent costs in millions of ZAR due to system expansion, 2022-30

Scenario	Spending	Admin	Grade R	Primary	Secondary	Sub total
Scenario 1: Baseline	Spending in 2020	27 204	4 521	111 752	88 693	232 171
	Spending in 2030	36 267	4 767	126 421	113 109	280 565
	Additional from 2020	9 063	245	14 670	24 416	48 394
	Cumulative (2022-2030)	**291 728**	**41 975**	**1 082 281**	**925 100**	**2 341 084**
	Annual average	32 414	4 664	120 253	102 789	260 120
Scenario 2: Full access	Spending in 2020	27 204	4 521	111 752	88 693	232 171
	Spending in 2030	36 267	4 911	132 030	113 003	286 212
	Additional from 2020	9 063	390	20 278	24 310	54 041
	Cumulative (2022-2030)	**291 728**	**42 682**	**1 110 772**	**923 516**	**2 368 697**
	Annual average	32 414	4 742	123 419	102 613	263 189
Scenario 2: Full access with efficiency	Spending in 2020	27 204	4 521	111 752	88 693	232 171
	Spending in 2030	36 267	5 218	131 313	110 729	283 546
	Additional from 2020	9 063	697	19 561	22 035	51 376
	Cumulative (2022-2030)	**291 728**	**44 440**	**1 107 587**	**912 272**	**2 356 027**
	Annual average	32 414	4 920	123 065	101 364	261 781

Source: Authors' computations based on (DBE, 2020)

Capital cost requirements assumes that three modalities will be used to implement construction of new schools. The proportion implemented by each modality is projected to differ from one scenario to another as shown in Table ES5 (the baseline scenario assumes there will be no community approach to construction of schools). On average, the public school system will need to deliver more than 3 900 classrooms annually from 2022-30, to meet the demand from the eligible additional students coming to school as well as efficiency gains and policy changes discussed earlier.

Without any migration and with improvements in system efficiencies (Scenario 3), the capital cost of expanding primary and secondary education is projected to about ZAR 81 billion for the period 2022-2030. This includes ZAR 17.6 billion per year on average for the centralized implementation modality such as ASIDI/SAFE, ZAR 61 billion under the same scenario but using the provincial construction modality, and ZAR 2.2 billion per year using the community implementation modality. In comparison, scenario 3 is 7 percent costlier than the baseline scenario but 38 percent less costly when compared to the costs under the full access scenario, highlighting the impact of the efficiency parameter under scenario 3.

Table ES5: Cost of capital expansion of primary and secondary education

	Total for the expansion period (In Million ZAR, 2022-2030)	**Average per annum (In Million ZAR, 2022-2030)**
Scenario 1: Baseline	**75 589**	**8 399**
Centralized	28 632	3 181
Provincial	46 957	5 217
Scenario 2: Full access	**131 710**	**14 634**
Centralized	49 890	5 543
Provincial	81 820	9 091
Community	0	0
Scenario 3: Full access + efficiency	**81 061**	**9 007**
Centralized	17 591	1 955
Provincial	61 306	6 812
Community	2 164	240

Source: Authors' computations based on (DBE, 2020), Options to consider in school construction in South Africa

The expansion to accommodate additional learners in the basic education system will be driven mostly by recurrent expenditure as illustrated in Figure ES3, the capital costs ranging from 3 – 5 percent of the total projected costs for expansion under the three scenarios.

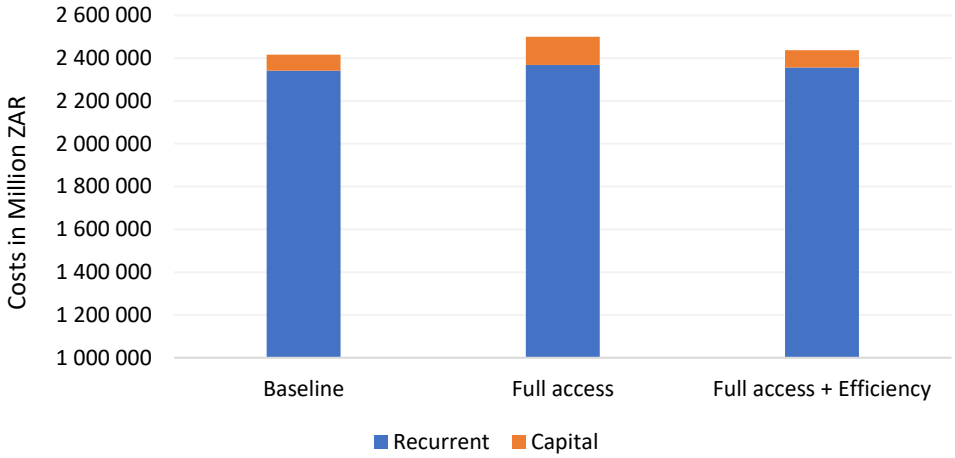


Figure ES3: Projected capital and recurrent costs by scenario, 2022-2030

Source: Authors' computations

Upgrading to the 'schools of the future'

Digital connectivity of all schools is not required under the current norms and standards for primary or secondary schools in South Africa. However, digital literacy skills are critical for a modern society. Having the required digital infrastructure in schools could transform the way teaching and learning is delivered, including transitioning to virtual libraries and simulating science experiments, which could in turn lower the requirements for expensive libraries and laboratory facilities. While Education Technology (EdTech) in South Africa has a long history, it was given impetus by the White Paper on e-Education in 2004, which called for the use of technology to improve teaching and learning. The high ambitions laid out in the Paper have not yet been achieved (as of 2020 – when all schools were supposed to have EdTech) and have been acknowledged by the DBE (DBE, 2020).

While the richer provinces have been able to mobilize funding for EdTech, many of the poorer provinces and schools rely on the Universal Services Access Obligations (USAO). Under the USAO 2004, telecom license holders (Vodacom, MTN, Cell C, and Neotel/Liquid Telcom) are required to provide several schools

with Internet connectivity and Information, Communication and Technology (ICT) equipment. ICT equipment includes student devices, teacher devices, charging facilities, software, secure storage, and local area networks to inter-connect the devices (refer Annex 6 for ICT and education in schools in South Africa).

The DBE estimates that 70 percent of all schools are now connected to the internet, with only 8 percent having "high speed connectivity" (DBE, 2020). There needs to be better monitoring of these USAOs by the Government of South Africa to ensure the most disadvantaged schools (Quintiles 1-3) are connected first, and that the connection is high speed. The digital connection priority should start with schools offering secondary education and rapidly continue to primary schools. This will not only prepare schools for future crises involving remote learning, but also promote digital literacy in schools.

Estimated funding needs and infrastructure funding gap

The total cost of expanding and upgrading basic education is projected to cost between ZAR 2.48 trillion in the baseline scenario and ZAR 2.57 trillion under the full access scenario (see Table ES6). These costs are inclusive of recurrent and capital costs, with the share of capital costs ranging from 5.8 percent under the baseline scenario to about 8 percent under the full access scenario. Capital costs as a share of the total projected costs in the preferred scenario (full access with efficiency) was estimated at 6 percent, rising from 3 percent when considering expansion alone. The capital costs include the costs of construction of new schools (the needs varying from one scenario to another) and the cost of upgrade. The cost of upgrading existing infrastructure is constant in the three scenarios and assumes that the Government considers a middle ground in addressing the infrastructure backlog, i.e., addressing 100 percent of the toilet needs, electricity, water, replacing of mud classrooms, floors, and ceilings; and tackling 70 percent of the needs relating to computer rooms, libraries, laboratories, and servers, whose cost is about ZAR 68 million, and is not fixed to a period. However, as mentioned earlier, it would be desirous that the upgrading of existing infrastructure be handled in the short to medium term period.

Table ES6: Funding needs, in millions of ZAR for system expansion and upgrade of basic education

	Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
Recurrent	2 341 084	2 368 697	2 356 027
Capital	143 589	199 710	149 061

Expansion	75 589	131 710	81 061
Upgrade	68 000	68 000	68 000
Total projected costs	**2 484 674**	**2 568 407**	**2 505 088**
Of which capital constitutes	5.8%	7.8%	6.0%

Source: Authors' estimation based on data from the National Treasury (Multiple years)

The feasibility of the expansion was tested by estimating the resources that are likely to be available to basic education during the expansion period. Given the limited information available for recurrent expenditure, the authors tested this for capital costs, with the assumption that the Government will stretch the recurrent allocations according to practical needs and fiscal space. On the infrastructure side, assuming that infrastructure funding levels in basic education remain similar to the 2020/21 level of 0.2 percent of the GDP towards IEG, IDP and SBIG interventions, and applying this rate to the projected GDP, the cumulative resources that are likely to be available to basic education for infrastructure intervention for the period 2022-2030 will be ZAR 131.6 billion, common across the three scenarios. Considering the projected capital costs and resources, the infrastructure interventions will have funding gaps ranging from ZAR 68.1 billion in the full access scenario to ZAR 12 billion in the baseline scenario (see Table ES7).

Table ES7: Funding gap, in millions of ZAR, for the infrastructure interventions, by scenario

In Million ZAR	Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
Total capital costs	143 589	199 710	149 061
Expansion		131 710	81 061
Upgrade	68 000	68 000	68 000
Projected capital resources (based on 0.2% of GDP)	**131 566**	**131 566**	**131 566**
Funding gap	**12 023**	**68 144**	**17 495**
% Gap	-9.1%	-51.8%	-13.3%

Source: Authors' estimation based on data from the National Treasury (Multiple years)

Another way to look at the infrastructure funding gap is to test different economic growth profiles on a set of education policies. For instance, holding all the education inputs constant, and thereby the infrastructure costs, the authors were able to assess the funding gaps under different economic growth contexts. Of the three macroeconomic projections, the baseline was projected to grow at 2.21 percent annually, the first alternative (urban) at 1.98 percent while the second alternative (rural) at 1.78 percent. Estimating the resources associated with the GDPs behind the projected growth, the authors ended up with ZAR 132 billion, ZAR 129.8 billion and ZAR 128.2 billion for the three GDP growth scenarios respectively. Against the projected costs in each scenario, the funding gap ranges from ZAR 12 billion to ZAR 15 billion under the baseline scenario; from ZAR 68 billion to ZAR 72 billion under the full access scenario; and from ZAR 17 billion to ZAR 21 billion under the full access with efficiency scenario (see Figure ES4.

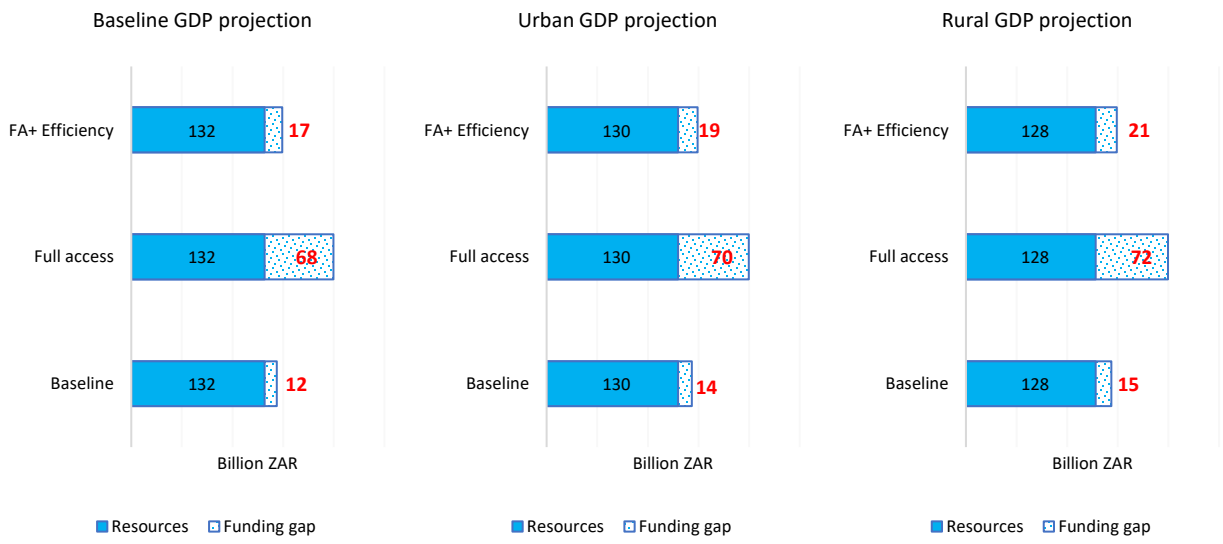


Figure ES4: Capital funding by expansion scenario and GDP projection option, 2022-2030

Recommendations on school construction moving forward

Even if the Government of South Africa can sustain a budget for capital infrastructure on basic education of ZAR 15.2 billion annually, there is a need to consider how to reduce the costs of construction given the

high costs of upgrading existing school facilities as well as expanding to accommodate additional students. A few areas to consider include:

1. Review the minimum norms and standards for schools

Given that minimum norms and standards are a key driver of costs, the following issues should be considered:

a) Prioritizing the provision of the "Minimum" package of facilities rather than the "Optimum" package of facilities

The tendency in South Africa has been to build schools that meet the optimum standards in terms of space and the type of facilities provided. Many new schools provide the "ideal" package such as a dining area or a school hall which are expensive and even classrooms space is maximized, rather than the "minimum" requirements which would clearly cost less. DBE should prioritize which facilities should be built in the first phase (the essential, minimum package) versus the facilities which could be built in the second or third phase in the same school. Priority should be given to minimum standards related to flush toilets, access to water, electricity, and elimination of inappropriate materials.

b) Shift from school-library buildings to classroom-libraries for primary school and digital libraries for secondary schools

Currently, only 25 percent of public schools have a library, and the cost of building a library/media centre is three times the cost of building a classroom. Classroom libraries in primary school and virtual libraries in secondary school could be important alternatives to conventional libraries and more sustainable to close the current gap of library-buildings. Classroom-libraries are more efficient than school-libraries in developing learners' reading skills and love for reading in primary school. Books in a classroom are more accessible to students and are more likely to be used than those central libraries that are often closed and difficult to navigate for young children. Digital libraries, particularly for secondary schools, have numerous advantages not limited to their access from anywhere; their need for less physical space in schools; access to unlimited resources; long life of resources compared to print materials; lower cost of updating materials; and ease of finding materials through cataloguing systems. While there may be some challenges related to copyright issues, challenges with connectivity, teacher capacity and skills to use digital

resources, the advantages of digital libraries over traditional libraries remain clear and given the progress South Africa has made in the provision of electricity to schools and the existing USAO requirements of the telecommunications licensing operations in South Africa, digital libraries remain a feasible option.

2. Change the implementation modality mix for school construction

The unit cost analysis illustrates that decentralizing school construction to provinces is cheaper than centralized school construction. While there can be different modalities of construction in any country, as is the case in South Africa, the international trend in school construction is moving towards increased decentralization to the local level. In South Africa, provincial school construction is dominant, accounting for 71 percent of the funding towards overall school construction and maintenance. There is however an opportunity to decentralize even further to the community level through the engagement of School Governing Boards (SGBs). Motivating factors for this approach include:

***a) There are opportunities for better value for money through engagement of communities/*SGBs**

This option could be piloted in one or two provinces – or in parts of some provinces – prior to being rolled out. Based on international knowledge, this approach is likely to be more cost-effective than the provincial level construction modality and increases communities' ownership and interest in the school construction process. Building the capacity of communities/SGBs to manage this process will take time and resources, but the benefits accrued in terms of sustainability and community ownership are probably higher.

b) Focus on small construction works rather than large ones

Moving from the current implementation strategy, towards small construction packages would open opportunities for small contractors. This approach would be in line with the recommendation to focus on addressing the school facilities deficit in existing schools which are typically "small works"; e.g., latrine blocks, additional classrooms, replacement of some sub-standard or over-aged classrooms, admin-blocks, and staffrooms, etc. Small works tendered through local competitive bidding processes can also increase competition between small contractors, of which there are several in the construction industry in South Africa, resulting in lower costs.

3. Build better data monitoring and dissemination systems for school construction to improve accountability and transparency

There is a need to improve the data collection system in the following areas to allow for regular and relevant analysis of the costs, efficacy, and efficiency of school construction:

a) Ensure that NEIMS data systems are regularly updated and linked to the Educational Management Information System (EMIS).

One critical challenge in this study was the inability to match the student enrolment data with the infrastructure data by school. There were several missing schools and while the enrolment data was from 2020, the infrastructure data was from 2018. Ensuring these datasets are complete, consistent, and updated in a timely manner, is crucial to driving evidence-based policy analysis and decision-making. Particularly the NEIMS needs to be updated with data on new schools, those that have been closed, and other facilities that have been built each year. While the provincial User Asset Management Plans (UAMPs) do provide information on needs, the current status of construction and future plans are very detailed and non-standardized, making them an ineffective tool for national level monitoring.

b) Develop a systematic process to collect data on unit costs of construction from across the country

To increase transparency and accountability in the school construction system, Implementing Agents (IAs) should be required to submit to DBE specific data on the programmes they implement, including designs, costs and outputs on an annual basis. This information was hard to collate for the study, making it challenging to estimate unit costs of construction. DBE should be capacitated to enable the collection of all the above-mentioned data, ensure its completeness, conduct an annual analysis of the construction gap, and a comparative analysis on the unit-cost of the different construction programmes. Data should also be collected from municipalities through Provincial Education Departments (PEDs) on their contribution to the provision of services (water, sanitation, and electricity) to schools. The analysis of this data should be communicated with the public to improve the overall transparency of the school construction system.

ACRONYMS AND ABBREVIATIONS

3D	3 Dimension
ASIDI	Accelerated Schools Infrastructure Delivery Initiative
BAS	Basic Accounting System
CDC	Coega Development Corporation
CPAP	Contract Price Adjustments Provisions
CSIR	Council for Scientific and Industrial Research
DBE	Department of Basic Education
DBSA	Development Bank of Southern Africa
DORA	Division of Revenue Act
DPW	Departmental of Public Works
ECD	Early Childhood Development
EdTech	Education Technology
EIG	Education Infrastructure Grant
EMIS	Educational Management Information System
EPA	Environmental Protection Agency
FET	Further Education and Training
GEC	General Education Certificate
GER	Gross Enrolment Ratio
GET	General Education and Training
GHS	General Household Survey
HIV-AIDS	Human Immunodeficiency Virus Infection and Acquired Immune Deficiency Syndrome
IAs	Implementing Agents
ICB	International Competitive Bidding
ICT	Information, Communication and Technology
IDP	Infrastructure Development budget Programme

IDT	Independent Development Trust
IGP	Infrastructure Grant to Provinces
IIEP	International Institute of for Education Planning
LCB	Local Competitive Bidding
LEF	Learner Enrolment Figures
Mn	Million
MNS	Minimum Norms and Standards
NCB	National Competitive Bidding
NCES	National Centre for Education Statistics
NDP	National Development Plan
NECT	National Education Collaboration Trust
NEIMS	National Education Infrastructure Management System
OECD	Organization for Economic Co-operation and Development
PCR	Program in Course Redesign
PEDs	Provincial Education Departments
PES	Provincial Equitable Share
PTR	Pupil Teacher Ratio
SAFE	Sanitation Appropriate for Education
SCR	Student Classroom Ratio
SDA	Service Delivery Agreement
SDG	Sustainable Development Goal
SGBs	School Governing Boards
SIBG	School Infrastructure Backlog Grant
SIGB	School Infrastructure Backlog Grant
SIPs	Strategic Infrastructure Programmes
SOE	State-Owned Enterprises
SRRP	School Rationalization and Re-Alignment Process
SSA	Sub-Saharan Africa

StatsSA	Statistics South Africa
STR	Student Teacher Ratio
TVET	Technical and Vocational Education and Training Institutions
UAMPs	User Asset Management Plans
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States
USAO	Universal Services Access Obligations
USIP	Ugandan Education Sector Improvement Programme

1 INTRODUCTION

1.1 Project background and Objectives

South Africa is committed to the SDGs set out in the United Nations 2030 Agenda for Sustainable Development, the Paris Climate Agreement, and the Africa Union's Agenda 2063 ("The Africa We Want") to achieve a prosperous society based on inclusive growth and sustainable development. The country has embodied this ambition in its National Development Plan: Vision 2030 (NDP), which is the country's blueprint for economic growth and development.

Investments in infrastructure can accelerate progress towards the SDGs. Infrastructure deficits inhibit the delivery of critical services such as health, sanitation, and education, which in turn threaten the outcomes the SDGs aim to achieve. The World Bank report titled "Beyond the Gap" (Rozenberg & Fay, 2019) moved the focus of the debate on addressing infrastructure deficits away from a singular focus on spending more, towards a focus on spending better to achieve the right objectives. The report provides a systematic approach to estimating the infrastructure funding needed to close service gaps.

1.2 SDG 4 and targets on which the study is anchored

This report assesses infrastructure needs in basic education (Grade R, primary and secondary schools), given South Africa's commitment to achieving the SDGs by 2030. It is one of four sectoral reports that draw on the approach taken by "Beyond the Gap" and is the product of a partnership between the DBE, the DBSA, and the World Bank. The education sector was chosen because of its important role in achieving four of the SDGs, namely SDG 4 (quality education), SDG 6 (clean water and sanitation), SDG 7 (energy for all) and SDG 10 (reduced inequalities). In education, specific emphasis is put on four SDG 4 targets, including:

- Target 4.1: By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and Goal-4 effective learning outcomes. This target is conditional on having adequate space for potential learners to come to school and creating necessary learning conditions to help the learners acquire desired knowledge.
- Target 4.2: By 2030, ensure that all girls and boys have access to quality early childhood development, care, and pre-primary education so that they are ready for primary education. This target, as will be

expounded in later sections, is the main driver behind the expansion of Grade R towards universalization of preschool.

- Target 4A: Build and upgrade education facilities that are child, disability, and gender sensitive and provide safe, nonviolent, inclusive, and effective learning environments for all. This target is at the core of this study, not only for the expansion of facilities to accommodate anticipated learners, but also an anchor for improving existing facilities and bringing them up to the levels prescribed in the norms and standards, which are elaborated on in later sections.
- Target 4C: By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing states. As the basic education expands, it is intuitive that the demand for teachers will increase to cope with the increased learners. This target underpins the projected future needs of teachers.

1.3 Sector performance with respect to SDG 4 and NDP

While there are many factors that affect the quality of education, this report focuses on whether there is adequate infrastructure in public schools in South Africa to provide the enabling environment for quality education. Inadequate infrastructure in schools negatively affects the learning environment and exposes learners to health and safety risks. In South Africa, despite progress in addressing infrastructure backlogs in public schools, significant infrastructure deficit contributes to inequality in access to quality education (South African Institution of Civil Engineering, 2017). This lack of infrastructure erodes the ability of teachers to provide an environment that enables learning and good educational outcomes. Some of the challenges in school infrastructure include:

- **Deterioration of existing infrastructure, maintenance backlogs, and specifically, challenges with the provision of bulk services such as water and sanitation.** Of the approximately 24 000 public schools in South Africa, the vast majority are in poor areas (DBE, 2019). The daily maintenance of schools (such as replacing windowpanes and repairing damaged door hinges) is managed by the SGBs and school principals. Audits reveal that some schools do not follow proper procurement processes in carrying gout maintenance works. Larger maintenance issues are undertaken by district and provincial

authorities. The monitoring of day-to-day maintenance funding is located at district level (through district managers and school inspectors) (DBE, 2021). In several provinces, there are challenges related to insufficient recurrent costs being directed to the development and implementation of maintenance policies as well as operational costs, including those of laboratories, libraries, workshops, and boarding facilities.

- **Underutilization of schools in rural areas.** Given the historical context of the country where school catchment areas were informed by a racially segregated population residing in defined areas, many schools were built in rural areas for black learners who lived in those rural areas. With the advent of democracy and opportunities for free movement, many South Africans migrated from villages and rural areas into urban areas. This resulted in many schools being "de-populated" (this is especially prevalent in the Eastern Cape). Of the approximately 24 000 public schools in South Africa, an estimated 23 000 are currently in use. This underutilization is juxtaposed to a shortage of classroom capacity in many urban centres in the country. For example, in the Eastern Cape there is an estimated surplus of 60 000 unutilized classrooms due to the location of these schools in rural areas where people have since migrated away from. Government is currently undertaking a programme of rationalizing and merging schools to balance the over- and underutilization (DBE, March 2019).
- **Government's predominant use of an implementing agent model to deliver school infrastructure for its national infrastructure programmes** (DBE, March 2019). This model has a range of challenges, specifically regarding the costs and to the capacity constraints that impede the timing and execution of delivery. In addition, there are capacity constraints at national and provincial levels of government regarding construction procurement, monitoring and supervision.

Challenges also relate to the future needs and capacity constraints in schools. In 2019, the South African government announced the intention to introduce a pre-Grade R (Grade RR) to address the lack of access to Early Childhood Development (ECD) facilities for young children. It is expected that this will result in an expansion of the population of school-going age and consequently increase the demand for schools and capacity to cater for a new cohort of children entering the school system one year earlier. In addition, the government will also introduce a GEC to enable learners to exit school at the end of Grade 9. This will result in several learners exiting schools earlier and possibly transitioning on to Technical and Vocational Education and Training Institutions (TVET), thereby increasing the demand for TVET colleges and reducing

the demand for upper secondary school. These anticipated changes will affect the demand for school infrastructure in the future.

Interventions to improve infrastructure in schools are high on the government's list of priorities. The NDP sets out objectives for achieving education outcomes to address the historical inequities, to improve the quality of education and training, and to spur innovation. The NDP sets out the following objectives for infrastructure for schools:

- Ensure that all schools meet minimum standards for infrastructure and commit to progressively upgrade each school's infrastructure to meet optimum standards
- Target no-fee schools when planning infrastructure to compensate for resource deficits in communities
- Ensure that libraries, laboratories, computer, and media centres are well equipped in order for learners in no-fee schools to have access to similar learning resources as those that are available to their counterparts in less poor communities
- Consider learner safety when planning for school infrastructure
- Ensure the availability and incorporation of high-speed broadband into the design of schools to enable greater use of technology in education and enhance the classroom experience for teachers and learners
- Explore the use of mobile devices such as phones and tablets in disseminating learning c

The National Development Plan (NDP) (Presidential Infrastructure Coordinating Commission, Government of South Africa, 2012) identifies 18 Strategic Infrastructure Programmes (SIPs) to elevate strategic infrastructure priorities that would require intergovernmental coordination[2]. Educational infrastructure is identified through SIP 13 which is a National School Build programme that aims to achieve uniformity in planning, procurement and contract management for the provision of basic services and to replace inappropriate school structures and address the backlog of basic services through the Accelerated Schools

[2] The National Infrastructure Plan 2050 focuses on four critical network sectors that provide a platform: energy, freight transport, water and digital infrastructure.

Infrastructure Delivery Initiative (ASIDI), the Sanitation Appropriate for Education (SAFE) initiative, and the Provincial School Build programmes.

The purpose of this report is to, among others, inform policy choices and investment decisions related to school infrastructure. It does so by analysing the infrastructure needs for the public education system and the systemic factors that determine these needs. The primary audience of this report is policymakers in basic education. The report accounts for the infrastructure needs arising from the expansion of basic education that is necessary to meet South Africa's 2030 basic education objectives. It also analyses, to the extent possible, the infrastructure implications of technological and economic advancements that will shape basic education of the future.

2 METHODOLOGY

The analysis undertaken in this report is based on the approach of the World Bank's "Beyond the Gap" analytical framework (Rozenberg & Fay, 2019), illustrated in **Error! Reference source not found.**.

Figure 1: Beyond the Gap analysis framework

Source: (Rozenberg & Fay, 2019)

The analysis is based heavily on the SDG 4 indicators and adapted to the South African policy context. The objectives include (i) providing equitable and quality primary and secondary education for eligible boys and girls in South Africa; (ii) providing access to quality early childhood development, care, and pre-primary education to all eligible boys and girls in order to prepare them for primary education; (iii) building and upgrading child-friendly and disability and gender sensitive education facilities and providing safe, non-violent, inclusive, and effective learning environments for all; and (iv) increasing the supply of

qualified teachers to sustain education service delivery in pre-primary, primary and secondary levels of education.

In order to estimate the cost of the achieving the sector objectives (i.e., the final step in the BtG framework above), the analysis adopts the framework elaborated in Figure 2, breaking down basic education infrastructure needs into two components. The first component consists of the investments required to bring the existing stock of schools up to current DBE norms and standards. This report presents three options of upgrading infrastructure depending on the extent to which the government will address infrastructure needs in schools – whether to address 100% of the needs or lower than 100%. The second component consists of the new school infrastructure required to accommodate the projected growth of the education system to respond to an increase in population, at least until 2030. There are three main scenarios of expansion including a baseline scenario, a scenario with access parameters extending to maximum possible in each education level (full access), and a final scenario with maximum access possible and improvement of internal efficiency (full access with efficiency). Details of the drivers of school infrastructure needs (upgrade and expansion) are described in the section 8 of the report.

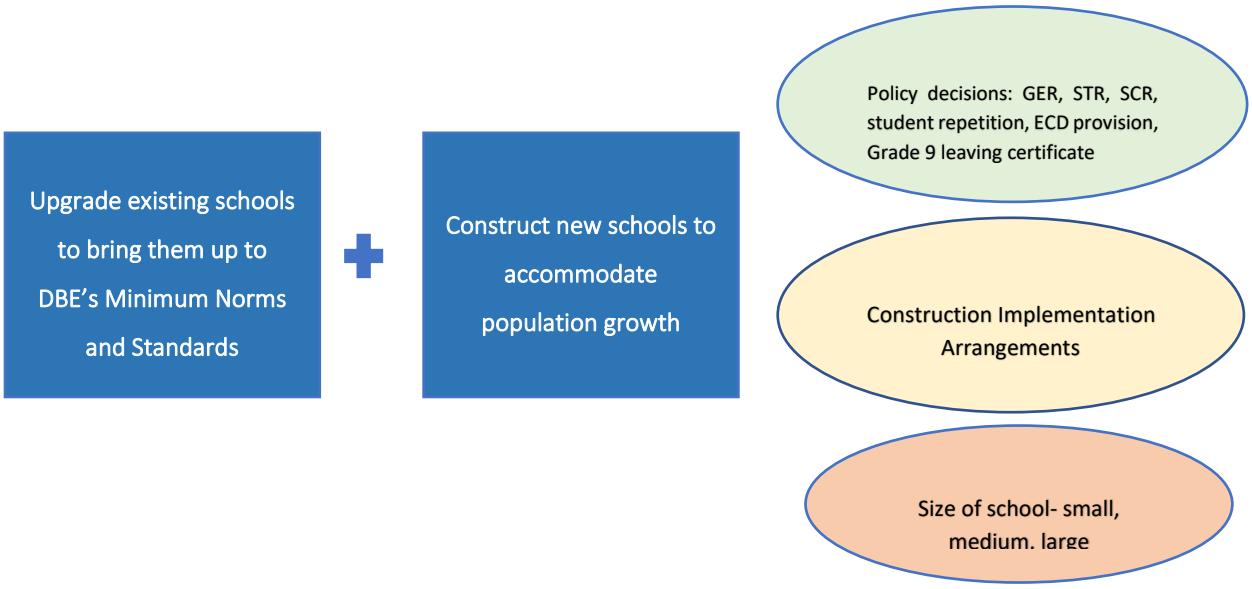


Figure 2: Components of the infrastructure financing needs

Source: Authors' framework

The costs of building new infrastructure are driven by three factors highlighted on the right side of Figure 2. The first relates to education performance policy decisions such as Gross Enrolment Ratio in pre-primary, primary and secondary; grade repetition in these three levels of education; average class sizes in public schools, and student to teacher ratios in public schools, and other decisions such as whether to expand public support for Early Childhood Development (ECD) and the possible introduction of a school leaving certificate at the end of Grade 9 which could potentially affect the flow of students from lower secondary to upper secondary school. An example of how these performance policy decisions affect infrastructure needs is class size. The bigger the class size (i.e., more children in one classroom), the fewer the classrooms that will be needed, though larger class sizes will affect the quality of learning. Policy makers have to weigh up the resource constraints against student performance outcomes when making such policy decisions. Higher repetition means more students would be in one class hence more classrooms will be required. The second factor driving the costs of infrastructure is the modality for implementing school construction which essentially takes three forms in South Africa: (i) centralized implementation by the Department of Basic Education (DBE); (ii) decentralized to the provincial level; and (iii) community-based implementation. The third factor driving costs is the size of the school, i.e., whether it is small, medium or large as per DBE's definition. Apart from these three endogenous factors, the study identifies exogenous factors that would influence the final costs which are the socioeconomic scenarios on population and economic growth.

The authors developed a simulation model for the second infrastructure component, simulating the number of children who are likely to come to basic education from the projected population (and school-age population) and the teachers who are likely to be hired to manage instruction (refer Annex 4 for background to simulation models). The authors used legacy costs like the cost to teachers and administrators as well as operational costs to project future recurrent costs. Using norms on infrastructure, the authors simulated the number of facilities that would be needed based on the norms and standards. Using unit costs generated from past infrastructure projects, the authors estimate how much it would cost to have the projected facilities. Details of the scenarios are described in section 8. The analysis in the report is aggregated at the national and provincial levels. Local level differences between schools are not considered due to a lack of data. Additional issues, for example, teachers teaching multi-grades are not considered due to data limitations. Annex 1 provides details of the data sources used to

analyse each component of the infrastructure financing gap. The sum of these components is the total basic education infrastructure investment needed up to 2030 for the country to meet its policy commitments.

3 CONTEXT OF THE BASIC EDUCATION SECTOR IN SOUTH AFRICA

3.1 Structure of the Education System in South Africa

The most recent classification of the structure of schools in South Africa is shown in

Table 1, where Classification 1 divides the school system into two bands: the General Education and Training (GET) Band, and the Further Education and Training (FET) Band. The GET Band comprises three phases – Foundation, Intermediate and Senior – covering grades R to 9. The FET Band covers grades 10-12. Another classification which is used in some documents from the DBE follows Classification 2 and divides the system into three levels: pre-schools (Grades R and RR), primary schools (Grades 1 to 7) and secondary schools (Grades 8-12).3 The two classifications do not share the same grade level limits and overlap in some grades. For the purposes of this study, Classification 2 will be used, with the exception that pre-school only refers to Grade R, since Grade RR has not been rolled out across the country, and for children ages 0-4, we refer to ECD centres/programmes. Another modification is a split in secondary to accommodate lower and upper secondary, founded on the proposed introduction of a GEC after Grade 9, an introduction that will certainly influence flow of enrolments in basic education. A combined school refers to a school where both primary and secondary education are offered.

Table 1: The structure of South Africa's Education System

[3] "Education in ordinary schools could be grouped in terms of either the GET and FET bands or the traditional primary and secondary phases. The GET band (Grades R to 9) caters for the following phases: foundation phase (Grades R to 3), intermediate phase (Grades 4 to 6) and senior phase (Grades 7 to 9). The FET band caters for Grades 10 to 12 and excludes learners in FET colleges. GER is defined as the number of learners, regardless of age, enrolled in a specific school phase (e.g., primary phase for Grades 1 to 7) as a percentage of the total appropriate school-age population (e.g., seven- to 13-year-olds for the primary phase)." (DBE, 2018)

Age	Grades	Classification 1		Classification 2	Classification for this study
0-4	Gr. RR or 00	Pre-Grade R		Preschool	ECD
5	Gr. R	Foundation phase Gr. R-3	GET Band		Preschool
6	Gr. 1			Primary School Grades 1-7	Primary School Grades 1-7
7	Gr. 2				
8	Gr. 3				
9	Gr. 4	Intermediate phase Gr. 4-6			
10	Gr. 5				
11	Gr. 6				
12	Gr. 7	Senior phase Gr. 7-9			
13	Gr. 8			Secondary School Grades 8-12	Lower Secondary School Grades 8-9
14	Gr. 9				
15	Gr. 10	FET Band Gr. 10-12			Upper Secondary School Grades 10-12
16	Gr. 11				
17	Gr. 12				

Source: Consolidated from DBE documents (DBE, 2018)

Notes: Grade R means Reception Year. Grade RR or Grade 00 means: Pre-grade R

In 2021, compulsory grades started from grade 1 corresponding to age 7, however, children of age 6, born before 30 June are allowed to enter grade 1. The Basic Education Laws Amendment (BELA) Bill introduced in 2017, which is still under discussion, proposes to make two years of pre-primary education compulsory (i.e., Grades R and RR). If passed, children aged 5, or children aged 4 born before 30 June, will be required to enter Grade RR. As of 1 April 2022, the DBE is also responsible for coordination of ECD services, inheriting this function from the Department of Social Development (DSD). For the purposes of this study, the school-age population is assumed at 5 to 17 years of age, or approximately 14 million children and youth in 2020 (i.e., 24 percent of the total population of about 60 million people). The bottom limit of 5-year-olds is chosen because according to the 2019 General Household Survey (GHS), most children of age 5 and 6 were enrolled in primary schools.

The share of school-age population shows high variations between provinces with a strong correlation with the provincial rural/urban distribution. Figure 3 shows that Limpopo and Eastern Cape have the highest share of the school-age population of 29 percent and 28 percent, respectively. Limpopo and Eastern Cape are also the provinces with the highest share of the rural population (61 percent and 87 percent, respectively). At the same time, the lowest share of the school-age population is in the Western Cape and Gauteng at 20 percent and 18 percent, respectively, which are the most urbanized provinces in the country (90 percent and 97 percent of the population, respectively, are in urban areas).

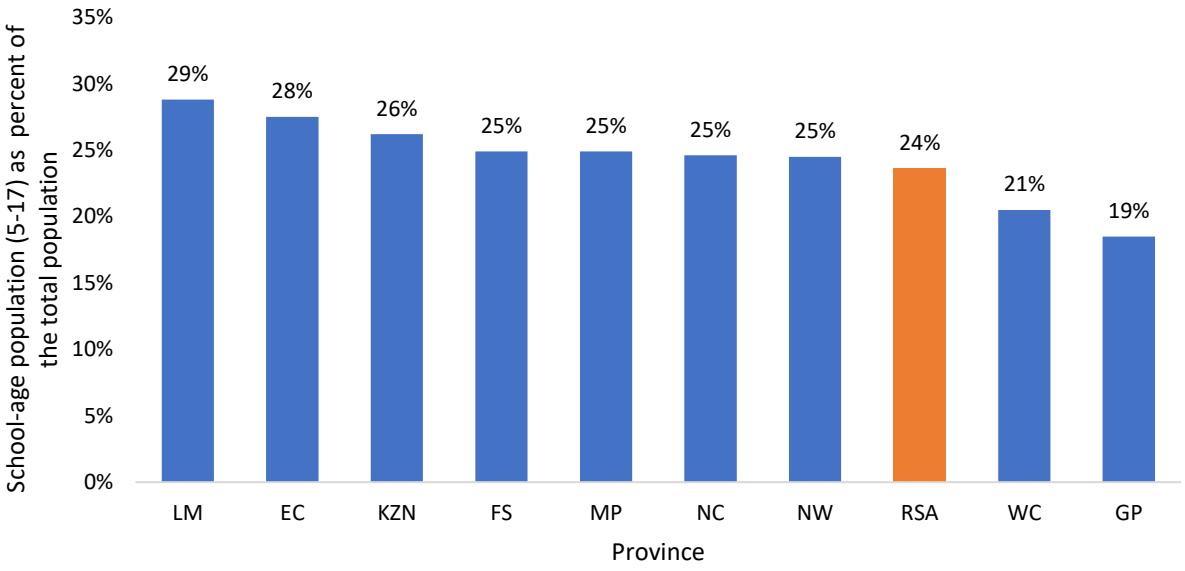


Figure 3: Share of school-age population 5-17 compared to total population by province, 2020

Source: Authors' graph with data from (StatsSA, 2020)

While the percentage share of the school age population is low in absolute numbers, Gauteng and KwaZulu-Natal have the highest number of individuals of school-age compared to other provinces. Figure 4 shows the age structure of provinces. In Gauteng, the most urbanized province, the number of 30-year-olds is almost double the number of 15-year-olds. In contrast, the age-profile of the most rural provinces of Limpopo and Eastern Cape, shows that the population at age 30 is not as high, proportionately, as the population of early ages. This trend is also visible in KwaZulu-Natal, although at a smaller magnitude. Provinces with relatively high numbers of 30-year-olds as compared to 15 to 25-year-olds are attributed

by Statistics South Africa to the high mortality rate in 1996-2000 Human Immunodeficiency Virus Infection and Acquired Immune Deficiency Syndrome (HIV-AIDS) epidemic, and to migration to big cities such as Johannesburg and Cape Town (StatsSA, 2012) (StatsSA, 2020).

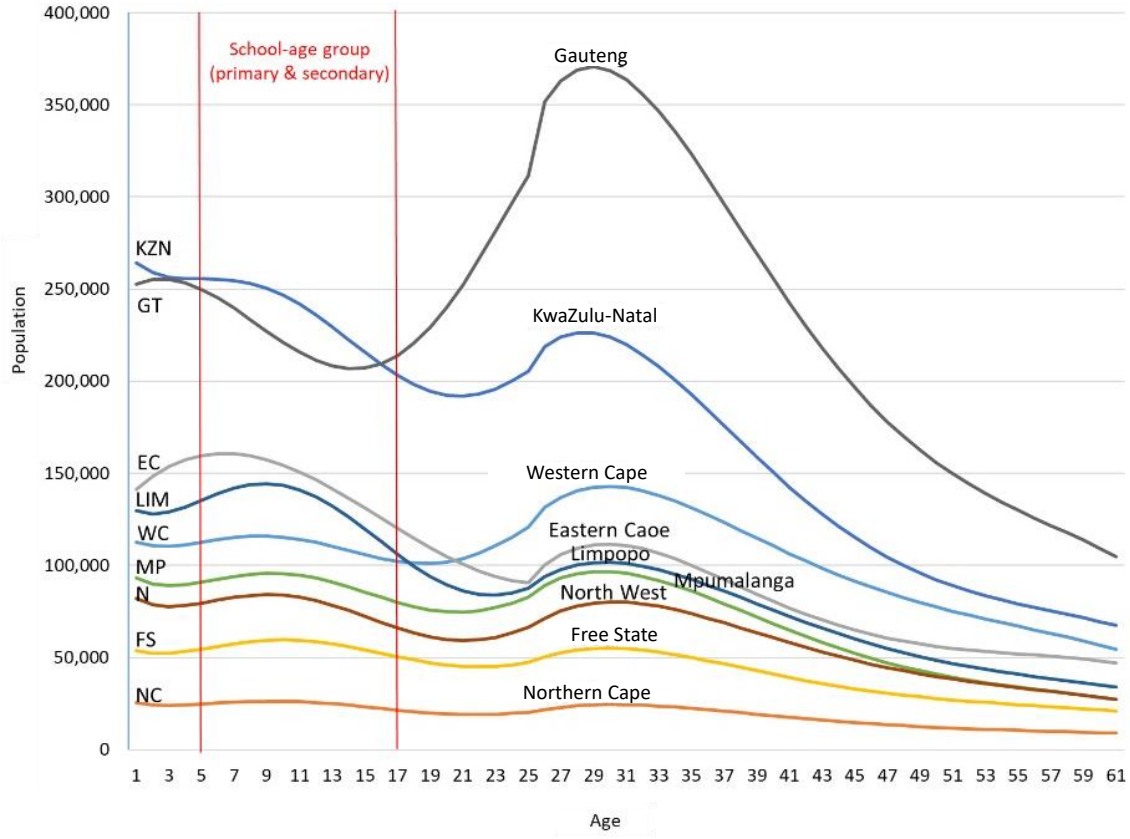


Figure 4: Provincial age structure in 2020

Source: Authors' graph with data from (StatsSA, 2020)

3.2 School enrolment in public and independent (private) schools

South Africa has achieved nearly universal access to primary and secondary education. According to the latest administrative statistics (DBE, 2021), there were over 13.5 million learners enrolled across 25 199 public and independent (private) schools, with about 440 000 teachers (see Table 2). There were more than 1.1 million learners in grade R, 7.7 million learners enrolled in primary, and nearly 4.7 million learners in secondary school.

Table 2: Number of learners and teachers at public and independent schools, 2020

	Grade R	Primary G1-G7	Lower Secondary G8-G9	Upper Secondary G10-G12	Total
Learners					
Public	760 184	7 293 413	1 994 556	2 484 148	12 532 301
Independent	389 579	408 550	96 223	116 277	1 010 629
Total	**1 149 763**	**7 701 963**	**2 090 779**	**2 600 425**	**13 542 930**
Teachers					
Public	23 373	225 182	151 539		400 093
Independent	3 706	24 822	15 119		43 647
Total	**27 078**	**250 004**	**166 658**		**443 740**

Source: (DBE, 2021)

The province of KwaZulu-Natal has the largest number of learners enrolled in public schools, followed by Gauteng, Eastern Cape, Limpopo, and Western Cape (see Figure 5). Gauteng and KwaZulu-Natal alone account for more than 40 percent of the enrolments in basic education. Northern Cape, which is a sparsely populated province, has the lowest number of learners enrolled in both public and independent schools. The largest number of learners enrolled in independent schools is in the Gauteng province followed by Eastern Cape, Limpopo, and Western Cape, however the private sector's contribution to overall enrolment in South Africa is small, at 5 percent.

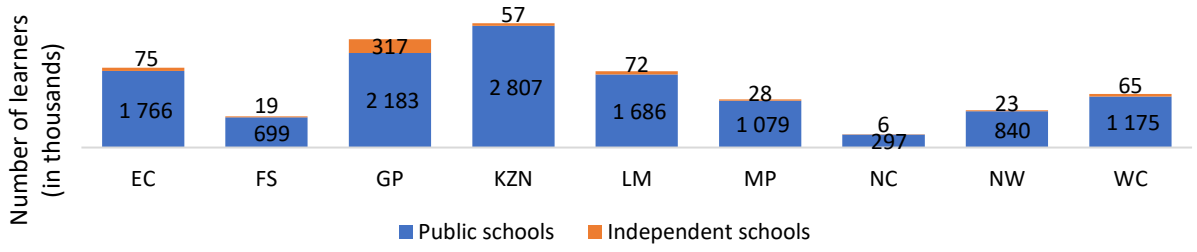


Figure 5: School enrolment by province, 2020

Source: (DBE, 2020)

While the growth in private school enrolment has increased over the last ten years, it is dwarfed by enrolment in public schools. Over the last ten years (2010-20), enrolment in public schools has generally increased across provinces, particularly in Gauteng and Western Cape (23 percent increase in each province) except for Eastern Cape where enrolment in public schools decreased by 11 percent. The increase in enrolment in independent schools has been substantial, particularly given the very low starting base in provinces such as the Northern Cape, followed by North West, Gauteng, Western Cape, and Limpopo (see Figure 6). The exception is in KwaZulu-Natal province where enrolment in independent schools decreased by 5 percent.

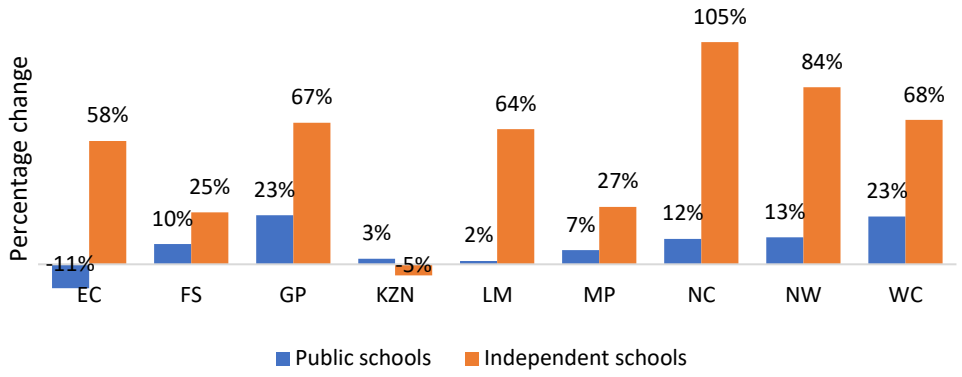


Figure 6: Percentage Change in School Enrolment (2010-2020)

Source: (DBE, 2020) (DBE, 2010)

The GER[4] generally indicates the capacity of the education system to accommodate the children eligible for the considered phase of learning and is desirable when in the neighbourhood of 100 percent[5], which indicates the adequacy of the system to accommodate the age group for that level of education (UNESCO, 2022). The GER can go beyond 100 percent if there are overage and underage children in school. The /GER

[4] GER is the number of learners enrolled in each level of education, regardless of age, expressed as a percentage of the official school-age population corresponding to the same level of education.

[5] A GER above 100 percent may not be desirable in some cases since it indicates overage children which happens if a system is 'catching up' or inefficient with late entry into education or a large number of repeaters.

for Grade R, reflected in Figure 7 as "Pre-primary," averages approximately 102 percent and ranges from a high of 130 percent in Limpopo to only 71 percent in Gauteng. The pre-primary education GER reflects children enrolled in Grade R in public and independent primary schools as well as children enrolled at this level in ECD centres. The high percentage of GER in provinces like Limpopo (130 percent) and Northern Cape (120 percent), indicate a high number of children who are either under-age or over-age enrolling in pre-primary.

In primary school, the enrolled learners represent 97 percent of the children eligible for primary education, showing that available places in primary are generally adequate for the primary school-age children. In some provinces – Eastern Cape, Free State, Limpopo, and Northern Cape – the GER is above 100 percent highlighting the low need for infrastructure expansion in these provinces. The GER in secondary is equally as high as in primary, the enrolment lower and upper secondary 102% and 90% of the children eligible for lower and upper secondary respectively. Limpopo once again tops the coverage in lower and upper secondary, where the reported GER was 113 percent and 70% for the two levels respectively, and which are 30 percentage points higher than the 78 percent reported in Western Cape (see Figure 6).

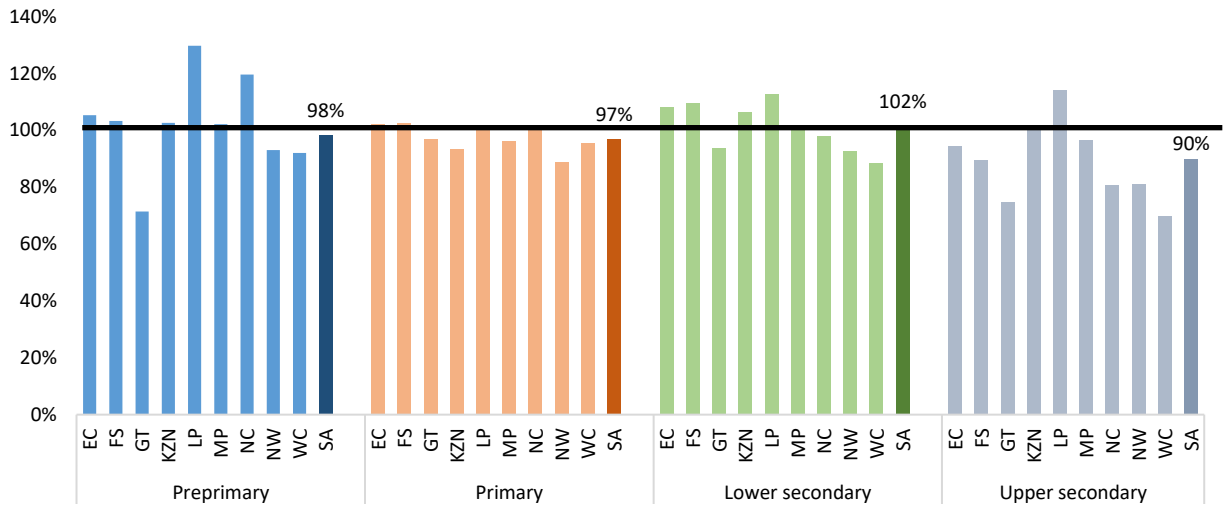


Figure 7: GERs, per education level, 2020

Source: Authors' graph with data from (DBE, 2020) (StatsSA, 2020)

The GER is generally over 90 percent and stable throughout the school grades, with a slight decline in grade 12 indicating that some students do not complete senior secondary education in South Africa (See Figure 8).

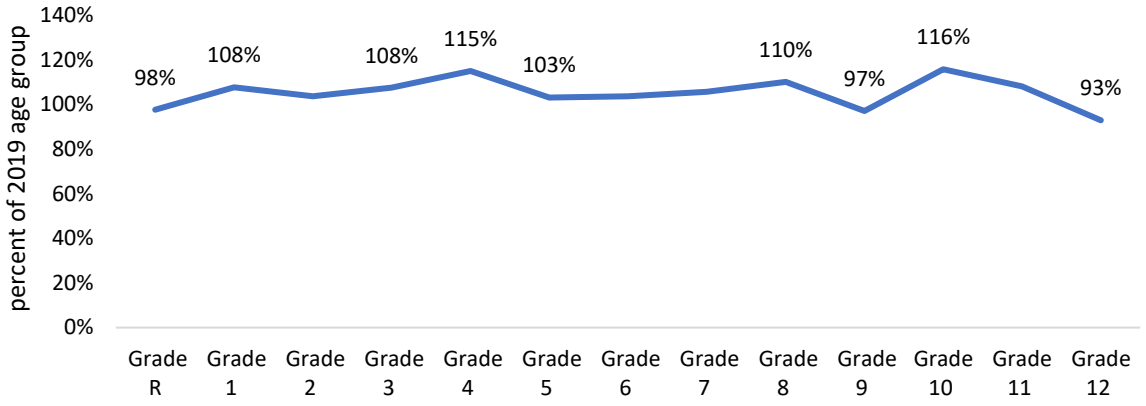


Figure 8: GER per grade, national (2019)

Source: Author's computation based on data from (DBE, 2019)

Various factors may contribute to the lower GER in the last grades of lower and secondary school, including grade repetition in earlier grades. According to "The cost of repetition in South Africa" report, estimates indicate that over 1 million public school learners repeated a grade in 2019, with the highest repetition taking place in secondary phase and particularly in grade 10, with at least 1 in every 5 grade 10 learners repeating the grade (Berg, et al., 2019). Once learners reach grade 12, repetition rates decrease as learners take the matric examination in that grade (Branson & Lam, 2010).

3.3 Trends in enrolments and numbers of schools

In 2020, 12 532 300 learners were enrolled in 23 000 public schools, increasing by 6 percent over the last 10 years, while the number of schools decreased by approximately 6 percent as seen in Figure 9. The decrease in the number of public schools may be due to an increase in independent (private) schools, especially in urban areas, as well as closure of schools according to the School Rationalization and Re-Alignment Process (SRRP) (see Box 5) (DBE, 2017). Between 2019 and 2020, the number of public schools increased mainly in urban provinces with densely populated areas such as Gauteng and KwaZulu-Natal.

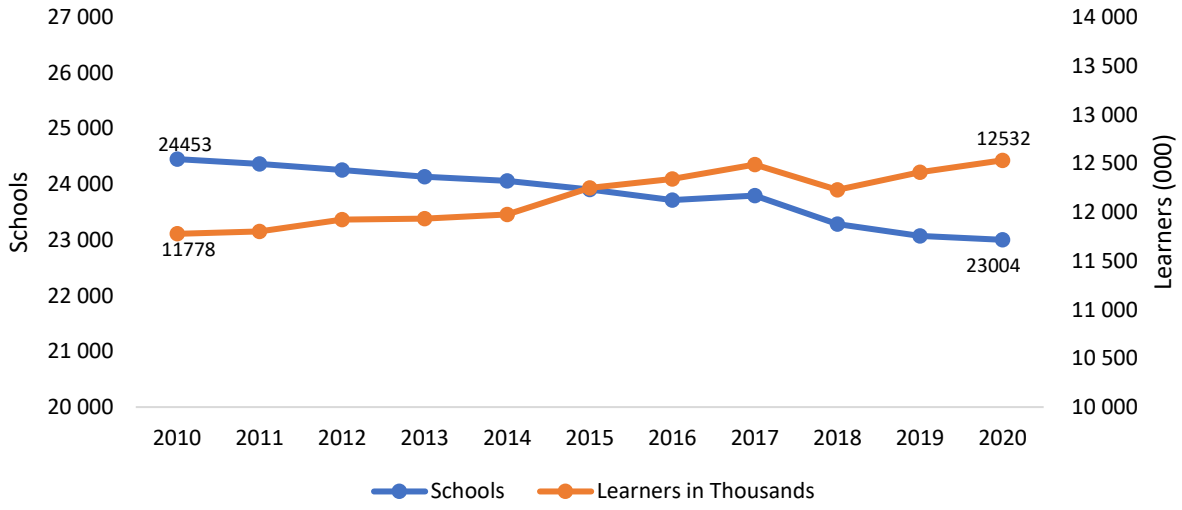


Figure 9: Trends in the number of public schools and learners: 2010-2020

Sources: (World Bank, 2000) (EMIS, 2022)

The trends in public school closures and openings vary across provinces. Between 2010 and 2020, only the province of Gauteng increased the number of its public schools by 56, representing approximately 3 percent of its stock in 2010. In Eastern Cape and Free State, approximately the same number of public schools – 375 and 377, respectively – have been closed. For Free State, public school closures represent nearly one third (27 percent) of the stock of schools in 2010, while for Eastern Cape, public school closures represent approximately 7 percent of the stock of schools in 2010. In Western Cape, the number of public schools has been generally stable (see Figure 10).

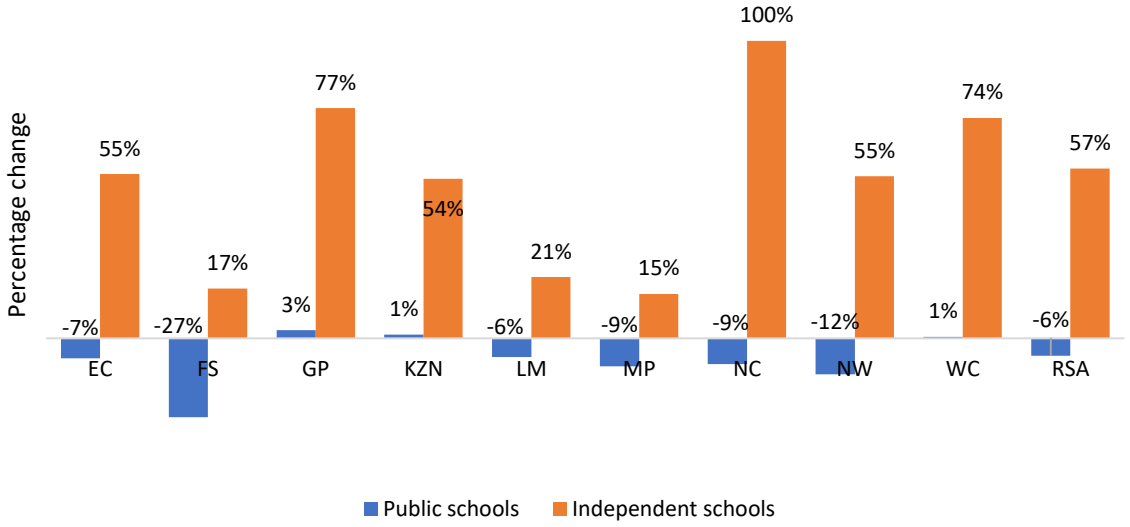


Figure 10: Change in the number of public schools per province between 2010 and 2020

Sources: (World Bank, 2000) (EMIS, 2022)

During the same time, the number of independent (private) schools increased every year in each province. The total number of independent schools has increased by 57 percent from 1 397 independent schools in 2010 to 2 195 independent schools in 2020, with a corresponding increase in the number of learners from about 433 000 to 661 400 over the ten-year period. Across all provinces, the share of independent schools is generally below this national average share, except for the highly populous and urban provinces of Gauteng and Western Cape that have a dynamic private school subsector, whose share increased from 19 percent to 29 percent and 10 percent to 17 percent, respectively, between 2010 and 2020 (See Figure 11).

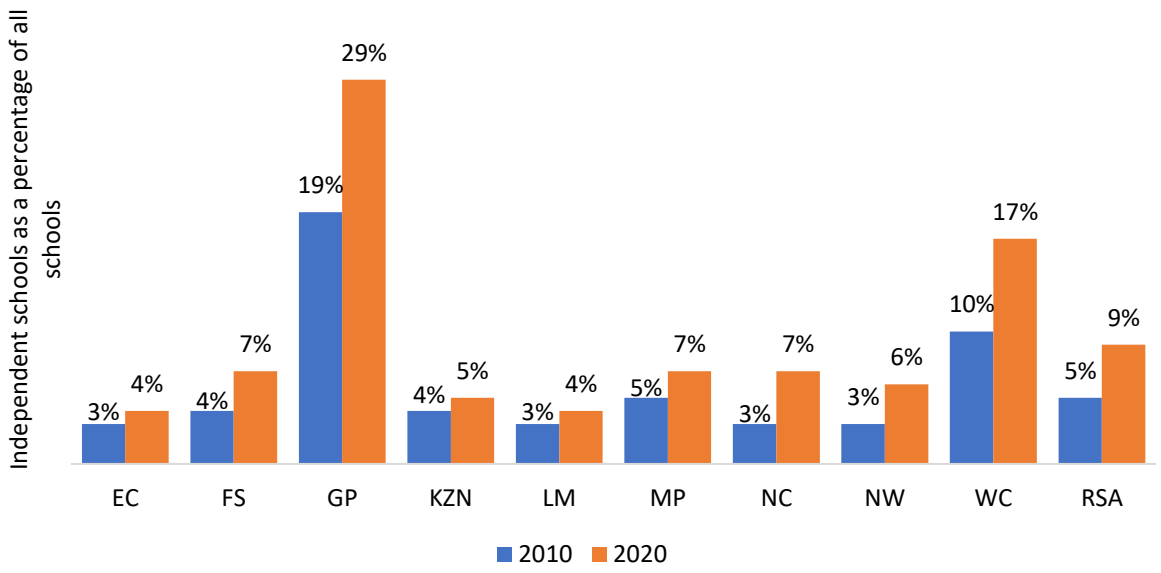


Figure 11: Trends of provincial share of independent schools by province between 2010 and 2020

Sources: (World Bank, 2000) (EMIS, 2022)

3.4 Availability of teachers and classrooms

Although student teacher ratios (STRs) in South Africa's school system compare unfavourably with developed countries, they are among the lowest in the Sub-Saharan Africa (SSA) region for all the levels of basic education. Basic education is attended to by more than 400 400 teachers, 56% who teach in primary schools (see

Table 3). Against the cumulative enrolments in the different phases of basic education, the overall STR is around of 31:1, with variations between provinces and phases of learning. In Grade R, the STR ranges from 30 students to a teacher in the Eastern Cape, to 37:1 in Limpopo. Similar patterns are observed in primary schools, while in secondary, only marginal variation is observed between the provinces.

Table 3: Number of teachers and STRs in public basic education schools, 2020

Province	Teachers			Student teacher ratios		
	Grade R	Primary	Secondary	Grade R	Primary	Secondary
Eastern Cape	3 781	35 125	19 805	30:1	30:1	31:1
Free State	1 180	12 507	8 687	33:1	33:1	29:1
Gauteng	3 236	40 365	27 974	33:1	33:1	27:1
KwaZulu-Natal	5 717	50 342	36 315	31:1	31:1	29:1
Limpopo	3 222	25 416	20 333	37:1	37:1	31:1
Mpumalanga	1 919	18 406	13 456	33:1	33:1	30:1
Northern Cape	664	5 861	3 431	31:1	31:1	28:1
North West	1 502	14 618	9 429	34:1	34:1	31:1
Western Cape	2 152	22 542	12 109	32:1	32:1	31:1
National	23 373	225 182	151 539	**33:1**	**32:1**	**30:1**

Source: Authors' computations based on (DBE, 2020)

Sub-Saharan Africa (SSA) trends show that the country compares favourably in STRs especially at pre-primary and primary levels of education, where the SSA averages are estimated at 30 learners for every teacher in pre-primary, and 37 in primary, considerably higher than the status in South Africa (World Bank, 2022). In secondary, the SSA average is higher in South Africa compared to the region, whose average is estimated at 21 students per teacher. In contrast, the STRs in high income countries are relatively low, averaging 14 in pre-primary and primary, and 13 in secondary (World Bank, 2020). Even among the Organization for Economic Co-operation and Development (OECD) countries, which includes some non-high-income countries, the ratios remain low (OECD, 2021). STRs generally indicate the level of workload for teachers and the contact teachers have with learners, especially in cases where students need individual learning attention. Teachers attending to large numbers of students are less likely to be available for consultation with students and may have difficulty in providing quality support to learners. The STR, especially with regional and international comparison, can highlight measures that may be taken by the government in emulating learning experiences in better performing systems, and hope for similar results. It is important to note that lowering STRs would mean recruitment of additional teachers to serve the existing learners as well as those who are expected to join the education system.

Aside from having adequate numbers of teachers, the size of a class (i.e., number of learners per class) influences the quality of instruction by teachers. Small class sizes facilitate individualized interactions between teachers and learners. Teachers in classes with fewer learners are more likely to practice participatory learning as they find it easier to hold the learners' attention, leaving them more time to concentrate on instruction. Although there are mixed results on effects of class size on student performance, small class sizes are beneficial to children from marginalized communities, who need special attention from teachers. In 2020, it is estimated that there was a total of 361 500 classrooms (21 300 in Grade R; 203 600 in primary; and 136 600 in secondary). Against the enrolments in basic education, these classrooms result in average class sizes of 35, with variations between provinces and phases of learning as shown in

Table 4. There are notable variations across the provinces, a signal of the varying workloads for teachers. Mpumalanga has the highest Student Classroom Ratio (SCR) across education levels, followed closely by Gauteng and North West. Eastern Cape has the lowest SCR across the three levels of education, though the relatively low provincial SCRs may not reflect within province variations.

Table 4: No. of Classrooms and average class sizes in public basic education schools, 2020

Province	Classrooms			Average class sizes		
	Grade R	Primary	Secondary	Grade R	Primary	Secondary
Eastern Cape	3 954	36 735	20 713	29	28	29
Free State	1 123	11 904	8 268	35	34	30
Gauteng	2 542	31 707	21 974	42	41	35
KwaZulu-Natal	5 071	44 661	32 217	35	35	33
Limpopo	3 272	25 808	20 647	37	37	30
Mpumalanga	1 514	14 520	10 615	42	42	38
Northern Cape	644	5 688	3 330	32	32	29
North West	1 285	12 505	8 066	40	40	36
Western Cape	1 914	20 043	10 766	36	36	35
National	**21 319**	**203 572**	**136 596**	36	36	33

Source: Authors' computations based on (DBE, 2013) for classrooms and (DBE, 2020) for enrolments

The DBE's Guidelines for Rationalization and Realignment of Public Schools: A Holistic Approach provides a maximum standard of 40 learners per class (DBE 2017:16), which is aligned with the SCR of 40 that is typically used in most SSA low-income countries as an objective to achieve[6]. However, South Africa's average SCR is higher than that of middle-income countries (2015), which stands at 25 (UNESCO, 2022).

4 FACTORS AFFECTING THE NEED FOR ADDITIONAL INFRASTRUCTURE

Aside from Government policy on average SCR, school infrastructure needs are driven by several factors including: (i) the Government's policies in terms of acceptable travel distance to school as well as acceptable school size; (ii) the conditions within existing schools and the need for renovations/rehabilitation to meet minimum norms and standards for school construction; and (iii) population growth and the pressure it places on the education system to expand to accommodate additional students. This section describes each of these factors in the South African context.

4.1 Government policies on travel distance to school and school size

The maximum distance norm is the most fundamental norm among all norms for school construction planning. It defines the maximum radius of a catchment area to be served by a school, i.e., the maximum walkable distance beyond which, the length of walking has a negative impact on learners' access and performance. However, despite this universal norm, each country establishes its own parameter, depending on the perceived trade-offs between equity and the economy. In South Africa, the norm has

[6] This figure was chosen because it was the average SCR of the "best" performers in SSA when estimating the cost of achieving "Education for All" (Alain Mingat, 2002), and it was considered a *cost-effective* ratio adopted as a common objective for low-income countries. During the subsequent two decades, most low-income countries, which had primary education SCRs exceeding 40, succeeded in achieving this cost-effective ratio (SCR 40), while some countries, such as Tanzania and Rwanda, have maintained higher SCRs (78 in Tanzania in 2016 and 82 in Rwanda in 2018).

undergone various changes over the last two decades, with an increasing trend in the acceptable distance from a catchment area to a school.

In 2000, the Red Book guidelines for human settlement planning set the maximum distance between home-to-school at 1.5 km equivalent for primary schools and 2.25 km equivalent for secondary schools (CSIR, 2012). Following several changes over the years, the current guidance from the revised Red Book of the Department of Human Settlements (Department Human Settlements, 2019) uses the maximum distance of 5km from home to school and indicates the required population thresholds in the catchment area to be between 2 200 and 6 600 people for primary schools and 4 000 to 10 000 people for secondary schools. The 2013 DBE's revised Minimum Norms and Standards (MNS) does not address the distance norm, but the 5 km norm applies (DBE, 2013).

This current maximum distance from home-to-school of 5 km is larger than benchmarks set at international level. Most countries have specific maximum distance to school norms which are different for pre-primary, primary, and secondary schools, acknowledging that travel will be more difficult for younger children. Typically, most countries have adopted a maximum distance of 2 or 3 km for primary and between 3 and 5 km for lower secondary. For example, in Madagascar the maximum distance from home to school is 2 km for primary and 5 km for lower secondary, whereas in India, it is 1 km for primary, and 3 km for secondary. In the case of young children, long commutes to school tend to have negative impacts to schooling and learning. The list of negative direct impacts is long and includes, parents enrolling their children later than the required age to enter school, children arriving at school tired and hungry, children arriving late at school with more frequent absenteeism (Mahapa, 2010), as well as the higher risk of harassment on the way to school.

According to the General Household Survey of 2019 (StatsSA, 2020), learners spend a considerable amount of time commuting to school. Although the proportion of learners walking all the way to school decreased from 73 percent in 2013 to 62 percent in 2019, the share remains high. Also notable is the increase in the share of learners using motorized transport, mainly taxis or cars, which are privately funded (see Figure 12).

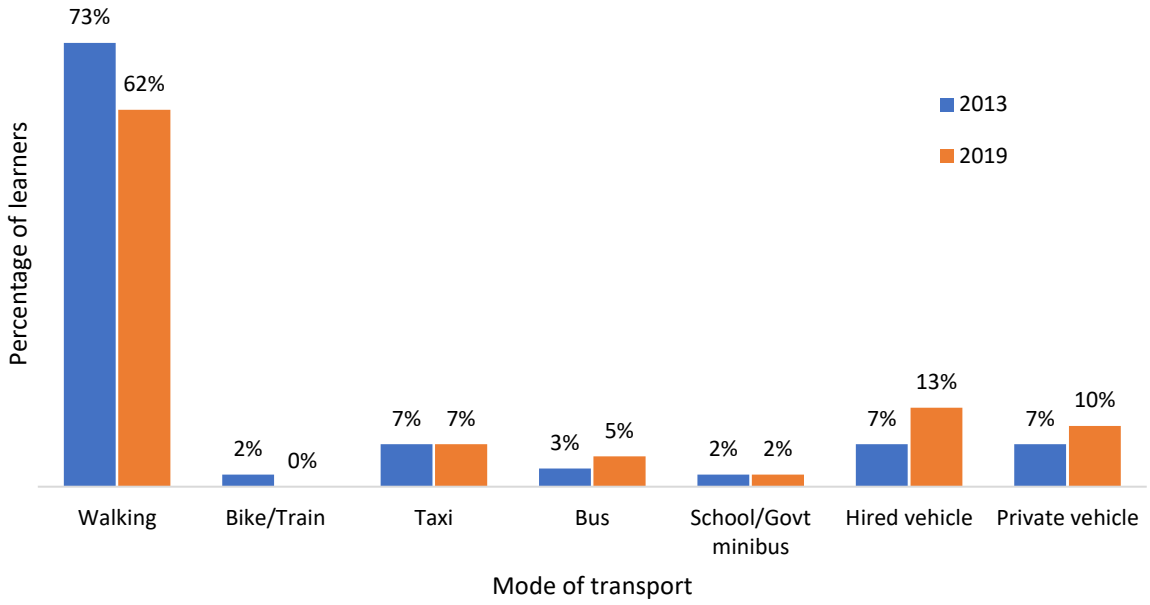


Figure 12: Change in learners' transport modality to school, 2013-2019

Source: (StatsSA, 2013) (StatsSA, 2020)

Across all means of transport (foot, bicycle, public or school buses, taxi, private cars) the overall percentage of learners travelling more than one hour to get to school decreased between 2013 and 2019 (Figure 13). In Free State, however, more children spent more than an hour getting to school in 2019 compared to 2013. In KwaZulu-Natal and Free State provinces, close to 4 percent of learners commute for more than an hour to school. Travelling to school, especially over long distances can pose particular access related challenges, with the consequences differing from context to context as highlighted in Box 1.

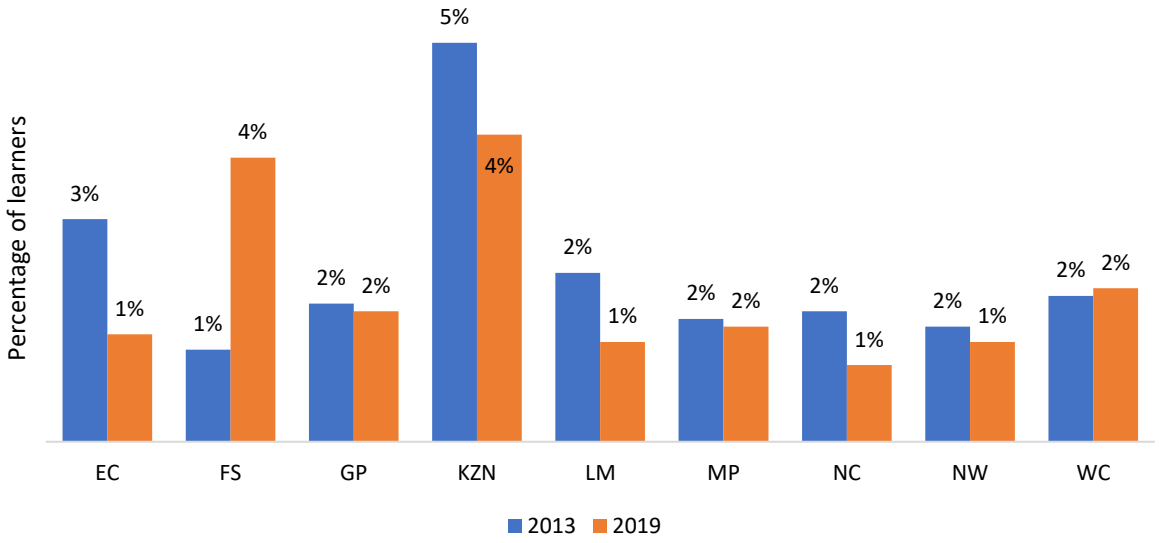


Figure 13: Percentage of learners commuting over one hour to school

Source: (StatsSA, 2013), (StatsSA, 2020)

Box 1: Consequences of long distances to school

As highlighted in the Statistics on Children report for South Africa, a school's location and distance from home can pose a barrier to education. School access is also affected by poor roads, inadequate transportation options – transportation that is unavailable, unaffordable, or of poor quality – and danger along the way. Distance to school, and the cost, risk, and effort to get there, can influence decisions regarding attendance and participation in extramural and afterschool activities (Human Rights Watch, 2001). Students who travel long distances can be tired and hungry, which can affect their ability to learn. Poor weather can also affect whether children who must travel long distances attend school.

The risks for girls and boys differ and is likely to be greater when children travel alone. Girls who must travel long distances to school on public transportation are at risk of being subjected to threats of sexual violence, sexual harassment, and assault while commuting. This has led to isolated cases of such girls being withdrawn from school and to pressure from parents for schools to be built closer to their homes. Poverty and fear, as well as dependence on existing travel options, can make it difficult for girls, especially

young girls, to resist and complain when sexually propositioned, contributing to their vulnerability to assault.

Lack of public transport is likely to have a negative impact on children with disabilities who may have to walk long distances between buses/taxi stands and home or school, may have difficulty in getting on and off transport, and may be restricted on travel as taxi drivers sometimes refuse to pick them up and/or are aggressive towards them. Those having a motor or visual impairment may find it hard to cope with muddy, uneven, rocky, and unpaved roads, in particular in informal settlements. Their journeys to and from school become more tiring and longer and thus reduce their time for learning both at home and at school. Their access to school depends on the availability of their parents or other relatives who may be obliged to co-ordinate their daily organization with the school timetable and thus may be forced to stop working or leave the child at home. Without appropriate transportation for students with disabilities, education may become a burden and may come to be considered unnecessary by learners, as well as their families.

Transport schemes have included the traditional school bus system, subsidizing of bicycles, and escorting student walkers to school, and considerations for transportation provision have included reduction in transport tariffs and issuing public transport vouchers to students.

Sources: (Hall, 2019); (OECD, 2008); (Human Rights Watch, 2001); (Department of Education, 2003)

School size is another important element to consider when analysing school networks and planning for school construction. In South Africa, the DBE's norms and standards (DBE, 2013) categorizes primary schools into five sizes, starting from micro and small schools, to medium, large and mega schools, and specifies the maximum enrolment of learners by size of school as detailed in Table 5. Secondary schools do not have the micro size. The school-size norms are only applicable to standalone primary and secondary schools and not schools that combine grades across school levels. The rationale for some of the primary school thresholds, such as 135 learners or 310 learners or 931 learners, is not clear.

Table 5: Categorisation of schools by size and education levels

Size	Primary schools	Secondary schools
Micro schools	Less than 135 learners	
Small schools	Between 135 and 310 learners	Between 200 and 400 learners
Medium schools	Between 311 and 620 learners	Between 401 and 600 learners
Large schools	Between 621 and 930 learners	Between 601 and 1 000 learners
Mega schools	More than 931 learners	More than 1 000 learners

Source: (DBE, 2013)

In addition to the South African context, Box 2 offers some insight to the international experience in the classification of small and large schools, which can be useful in the implementation of the South African policy promoting large schools in the country.

Box 2: Large schools vs. small schools: Perspectives from international experience

South Africa's school planning strategy aims to promote large and mega schools and close small schools, which are considered as not educationally and economically viable for teaching and learning (DBE, 2016). South Africa is in the top 10 of SSA countries when it comes to large school size - with 540 learners per ordinary public school (primary and secondary together) - while most of the other countries in the region have lower average learner per school ratios in both primary and lower secondary schools. Experience from other countries has shown, however, that small schools do not necessarily inhibit achieving quality education.

An approach of prioritizing larger schools was followed in the United States (US) from 1930-2010 where the school consolidation strategy adopted by the education sector was informed by the experience garnered in the industrial sector[7] and influenced by the development of the school bus system (National Centre for Education Statistics (NCES, 2012). In 2011, however, building on the body of research that had

[7] The objective was to build a "modern" school system with the same methods used by the "scientific industrial management" model of the manufacturing industry. In the years 1900-1950, this idea was popularized in the Education system by Harvard and Stanford Universities (Conant, 1959).

established that small primary and lower secondary schools perform better on learning outcomes than large ones (globally) and that, in the US, violence in large schools is four times higher than in small schools[8], the US shifted its strategy to small schools, issuing guidelines recommending to reverse the past tendency towards school consolidation and move back towards small schools located within communities[9].

In Europe, some countries have maintained a large network of small schools, close to the villages, which was compatible with the rural to urban migration that took place during the 20th century with the industrial revolution. Countries such as Austria, France, Switzerland, Ireland, Germany, Sweden, the Netherlands, and the United Kingdom (UK) have maintained relatively lower learner to school ratios than in South Africa. In Europe, the average primary school enrols 162 learners, ranging from approximately 100-130 learners per school in Austria, France, Switzerland, and Ireland, to approximately 175-270 learners per school in Germany, Sweden, the Netherlands, and UK, while lower secondary school, which are larger than primary schools, average less than 400 learners per school.

Sources: (Theunynck, 2019) (Theunynck, 2020) (Fowler & Walberg, 1992) (Eberts & Kehoe, 1984) (Kuziemko, 2004) (Leithwoo & Jantzi, 2007) (Lee & Smith, 1995) (Cotton, 1996) (Mcmullan, et al., 1994) (Pittman, 1987) (Hylden, 2005) (Bickel & Howley, 2000)

In South Africa, across education levels, micro and small schools represent the majority of primary schools (65 percent), and medium and large schools represent the majority of secondary schools (58 percent). Secondary schools tend to be larger than primary schools - there are no small secondary schools in any of the provinces, and 62 percent of mega schools are secondary schools. Combined schools – those that offer primary and secondary grades jointly – represent 14 percent of the schools and are of all school sizes

[8] "Serious violence" happens 4 times more in large schools (more than 1000 learners) than in small schools (less than 300 learners) (NCES, 2005).

[9] These Federal Guidelines were issued by the Federal US Environmental Protection Agency (EPA) as a translation in the education sector of the US commitment to reduce energy consumption (United States Environmental Protection Strategy., 2011).

except those with 800 -1000 learners. For the purposes of this report, the authors will use the categorization of micro, small, medium, large, and mega schools as per the disaggregation in Figure 14.

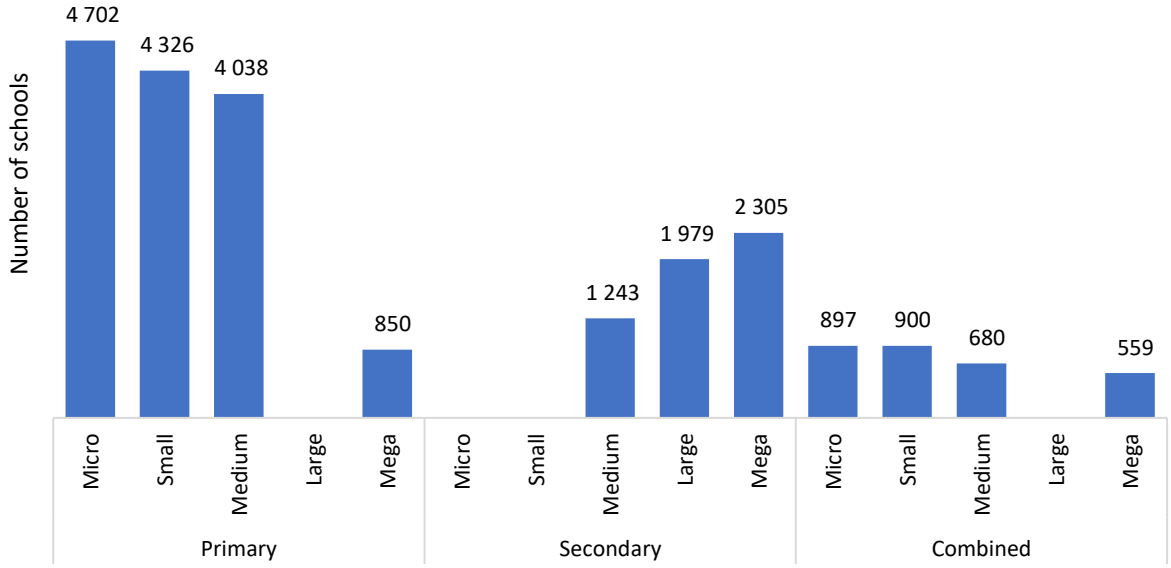


Figure 14: Number of schools by size and level

Source: (DBE, 2020) (DBE, 2018)

School size continues to be one of the strategic elements driving DBE's public school construction planning at the national and provincial levels. The DBE's Guidelines for Rationalization and Re-alignment of Public Schools: A Holistic Approach (DBE, 2017)) describes the national policy to address the challenges faced with the smallest schools (Box 53. These guidelines follow the 2009 DBE Guidelines for the merger and closure of Rural and Farm schools (Directorate of Rural Education, 2009), which estimated that approximately 11 percent of school infrastructure was poor and thus schools should be closed or merged. Implementation of these guidelines over the last 20 years has resulted in a decrease in the number of public schools.

Box 3: School Rationalization and Re-Alignment Process (SRRP)

South Africa comprises a mix of rural, farm, township and urban communities. Some of the rural areas and farm settlements are located in remote areas with population sizes of less than 2 500. Prior to 1994,

as the government of these areas and settlements were not economically strong, many rural communities pursued the goal of educating their children by building some schools themselves. Schools were built as close as possible to the population catchment areas, which led to a relatively small number of schools being built in the rural and farm communities. Post 1994, when the South African Homelands ceased to exist, learners were free to move to schools of their choice. Informed by parents seeking better job opportunities and the desire to attend schools that were perceived to be well-run and had better Matric (grade 12) pass rates, many learners chose to move from "rural and township" schools to urban schools, and from less economically strong provinces with relatively lower Matric pass rate to more affluent provinces with relatively higher Matric pass rates (for example, many learners moved to Western Cape and Gauteng).

At the same time, DBE found that managing very small/micro schools was limiting its ability to, among other responsibilities, provide curriculum support effectively and efficiently, ensure an adequate number of teachers, and guarantee appropriate school facilities with enough classrooms and other functional spaces. Learners in micro schools, for example, do not have a broad choice of subjects to study, are affected by the quality of the multi-grade teaching, and have limited opportunities to engage in sports and other extracurricular activities.

Rationalization and re-alignment of public schools

The Guidelines for Rationalization and Re-Alignment of Public Schools: A Holistic Approach (DBE, 2017) were introduced to guide the SRRP of public schools, particularly of those schools that are deemed not viable to be sustained at an acceptable level of quality.

The primary objective of the School Rationalization Process is to "continue providing universal access by learners to quality basic education in a rational manner, doing so cost effectively with respect to resource provisioning, where the costs being referred to are not only limited to monetary costs but also socio-economic imperatives" (DBE, 2017). The main focus of the School Rationalization Process is to ensure that, where possible, schools that are operating below the minimum threshold of Learner Enrolment Figures (LEF) for small schools are merged with nearby schools to improve the quality of education offered in such schools to reduce the cost of providing education, and to ensure return on investment that is

associated with the provision and maintenance of school facilities. The Guidelines provide, among other procedures, parameters for closing micro schools and considerations for allowing micro schools to continue operating. For example, only schools that are classified as micro schools, i.e., primary schools with LEF of less than 135 and secondary schools with LEF of less than 200, should be considered for closure and merger as part of the School Rationalization Process.

Source: (DBE, 2017)

Provinces are applying the national strategy to close micro schools and these plans are reflected in their respective User Asset Management Plans (UAMPs). Eastern Cape is one of the most active provinces in its efforts to close schools. In 2019, the province decided to 'rationalize' 59 percent of its schools by 2024 and started closing them from the total of 5 086 (in 2020) schools in the province. This will result in the closure of approximately one third of its schools. The process for rationalization is provided in Box 4.

Box 4: The Eastern Cape's long-term plan for public school rationalization (2019-2025)

According to information provided by the Eastern Cape's Provincial Education Department, the status of the school rationalization programme is as follows:

- The total number of public schools in 2020 in Eastern Cape was 5 086 (primary, secondary, and combined)
- Approximately 59 percent of the schools (2 984) have been identified for rationalization
- Out of these 2 984 schools, 75 percent are subject to realignment and 25 percent (742 schools) are subject to closure by 2024. An additional 954 schools are being considered for closure, with a total of 1 696 schools expected to be closed by 2024
- Primary, secondary, and combined schools represent 82 percent, 5 percent, and 13 percent respectively of the total number of schools to be closed by 2024
- Most primary schools that are not scheduled for rationalization or closure will remain as primary schools after rationalization
- Very few secondary schools (4 percent of all secondary schools in Eastern Cape) are subject to the 2019 rationalization plan

- Combined schools, which are scheduled to Realignment, will become primary schools only, suggesting that their current enrolment is mostly at the primary level

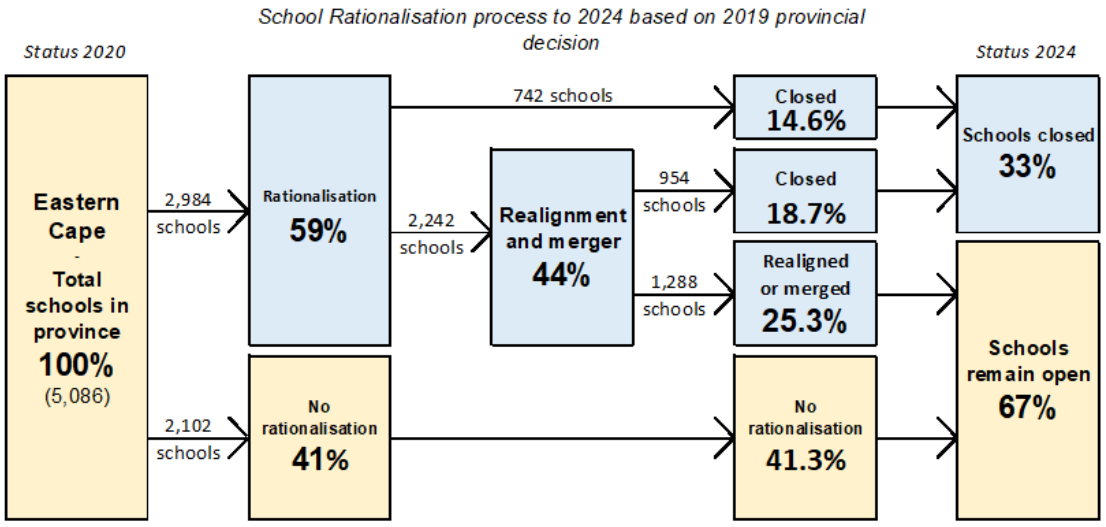


Figure B4.1: School Rationalisation process to 2024 based on 2019 provincial

Source: (DBE, 2021)

4.2 Infrastructure conditions in existing stock of schools

The condition of the existing stock of schools in South Africa is unacceptable and many schools do not meet the DBE's 2013 MNS for Public School Infrastructure. In 2015, the DBE developed an action plan, (Action Plan to 2019) and another follow-up in 2019 (Action Plan 2019-2030), to address the infrastructure backlog, with four key milestones to be achieved from 2016 to 2030 as follows:

- By 2016, all schools should meet minimum standards with respect to water, toilets, electricity, and materials used for the school building (i.e., no 'mud' constructions and no asbestos)
- By 2020, all schools should have at least a minimum number of classrooms relative to enrolment, as well as electronic connectivity and fencing
- By 2023, all schools should have libraries and laboratories

- By 2030, all remaining standards should be in place in all schools (e.g., sport facilities, administration, etc.)

These national policy goals were translated into Provincial implementation plans through their respective UAMPs. In addition, the DBE introduced a national programme in 2010, the Accelerated Schools Infrastructure Delivery Initiative (ASIDI) as its flagship school construction programme to achieve the first milestone above to eradicate, by 2016, the backlog of 'inappropriate infrastructures' that were identified, i.e., the unsafe schools built from mud, wood, or other non-durable materials (DBE, 2016). The numbers of schools targeted in 2011 and what was achieved by 2019-20 is shown in

Table 6 below. It is clear that the actual implementation went far slower than planned and after nine years ASIDI had only been able to reach less than half its original target of addressing inappropriate structures in schools, raising questions about the efficiency of the implementation modalities. The poor performance of ASIDI was identified as early as 2012-2013 (DBE, ASIDI, 2013), and has persisted with no significant changes to the way the programme has been delivered.

Table 6: Actual delivery of school infrastructure programme by ASIDI by 2019-20

ASIDI	Inappropriate Structures
Eastern Cape	145
Free State	20
Gauteng	0
KwaZulu-Natal	1
Limpopo	3
Mpumalanga	5
North West	2
Northern Cape	1
Western Cape	25
Objective (2011)	510
Delivery by 2019-20	237
Percentage completed by 2019-20	46%

Source: (DBE, ASIDI, 2013)

Another key priority of the Government, as contained in the Action Plan to 2014, Action Plan to 2019, and Action Plan to 2024, has been the "improvement of school physical infrastructure and environment that inspires learners to learn and teachers to teach", including the eradication of pit latrines in all schools in the country. All the action plans implement the broad vision of the NDP 2030. In 2018, the President of South Africa launched the SAFE initiative, which is also managed by DBE and dedicated to school sanitation, eradicating pit latrines and other forms of inappropriate sanitation. This programme has seen replacement of toilets in about 30 percent of schools where toilets were to be replaced, in a span of two years (See

Table 7).

Table 7: SAFE Initiative: Target number of schools by province and achievement by August 2021

	Total number of schools where toilets need to be replaced (2018)	Progress to practical completion (Aug 2021)
Eastern Cape	1 098	178
Free State	122	75
KwaZulu-Natal	974	379
Limpopo	387	118
Mpumalanga	117	116
North West	55	37
Total	2 753	903

Source: (SAnews.gov.za, 2021)

While there has been considerable improvement in the quality of existing school facilities in nearly three decades, there are still a considerable number of schools without access to the minimum acceptable ventilated improved pit (VIP) toilets. Out of the almost 567 000 toilets across preschool, primary and secondary levels of education, about 124 000 (or 22 percent) do not meet the minimum acceptable standard of VIP toilets. More than one quarter of schools don't have access adequate water during school sessions. Moreover, 3 percent of schools don't have access to any power source, and this rises to 9 percent when considering schools have insufficient access to electricity whenever schools are in session. Even fewer schools have access to facilities that can enhance transition to digital delivery of the curriculum.

Only 31 percent of schools have access to computer rooms; 25 percent to libraries, and only 15 percent have access to laboratories.

Table 8 shows the aggregated number of facilities to be upgraded in existing schools using the latest data available in DBE's NEIMS database (DBE, 2018).

Table 8: Facilities that require upgrading in basic education across the country

Facility	Primary	Secondary	Combined	Total need
Computer Room	10 630	3 232	1 746	15 608
Library	11 293	3 579	1 961	16 833
Laboratory	13 200	3 463	2 378	19 041
Server	13 578	5 393	2 989	21 960
VIP toilet seats needed				123 799
Water (<25%)				2 292
Electricity (<25%)				1 956
Mud/Clay/Wood				2 408
Broken floor				4 254
Broken Ceiling				3 084

Source: (DBE, 2018)

Gauteng and Western Cape fair better than other provinces on access to these basic facilities, while Eastern Cape, Limpopo, KwaZulu-Natal, and Mpumalanga have several facilities that require upgrading. The latest data from NEIMS for 2018 shows that nearly all schools – primary and secondary, regardless of size – in Gauteng and Western Cape have flush or VIP toilets (see Figure 15 and Figure 16). Limpopo, Eastern Cape, KwaZulu-Natal, and Mpumalanga lag behind in meeting the minimum standards in primary and secondary schools. Schools in these provinces are the primary target of the SAFE initiative. In Limpopo province, for instance, more than half of micro and mega sized primary schools have flush or VIP toilets while one third of small and medium sized schools have flush toilets. In the Eastern Cape, Free State, Kwa-Zulu Natal, Mpumalanga and North West have considerable need for upgrading to VIP toilets, especially in the medium-sized schools.

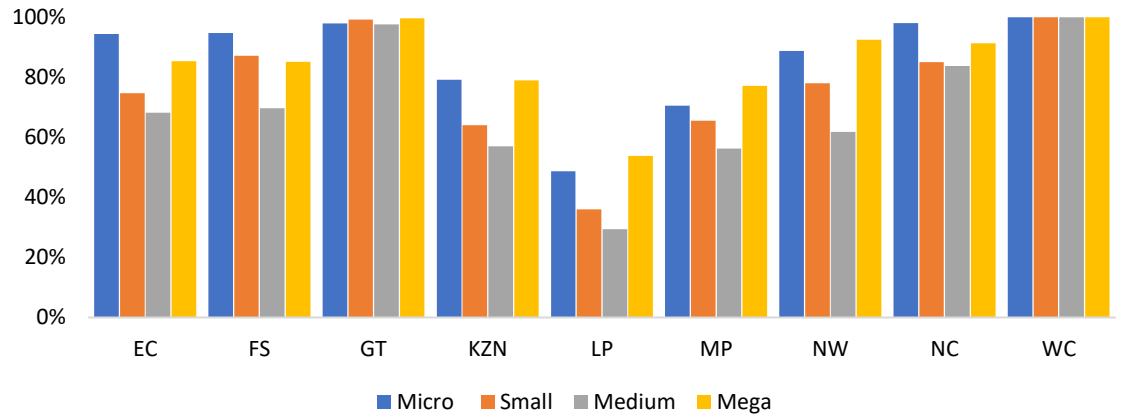


Figure 15: Percentage of primary schools, by school size, with flush and VIP toilets

Source: (DBE, 2018)

In secondary education, Limpopo and Mpumalanga provinces fall behind the other provinces on access to flush or VIP toilets, with only 3 in 10 and 4 in 10 medium schools in the two provinces respectively having access to at least VIP toilets. North West is slightly better off than KwaZulu-Natal in terms of the proportion of schools that have access to flush or VIP toilets in secondary schools, but all four provinces, Limpopo, KwaZulu-Natal and Mpumalanga, lag on access to flush or VIP toilets in secondary schools and primary schools. North West and Free State provinces are better off compared to the last four but still require support to improve access to flush toilets, especially for medium sized secondary schools.

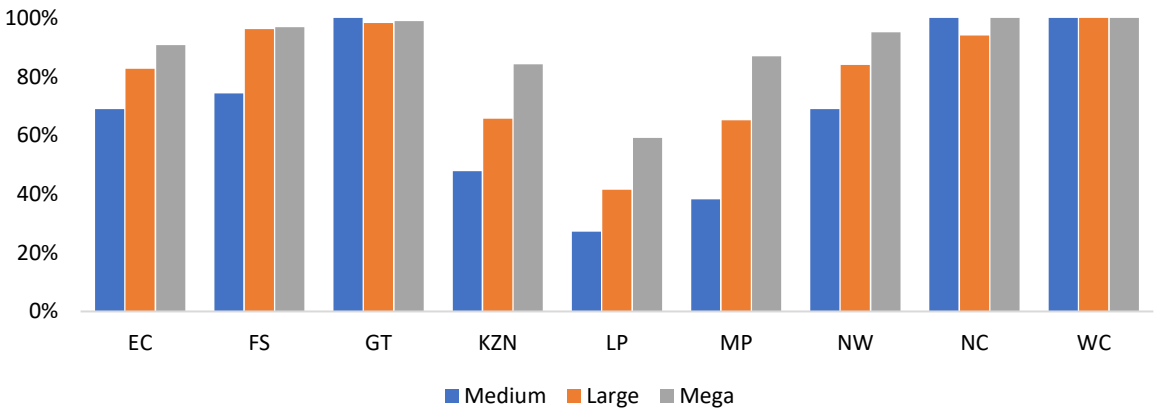


Figure 16: Percentage of secondary schools, by school size, with flush and VIP toilets

Source: (DBE, 2018)

Figure 17 highlights the water challenge in schools across the various levels of education, where a majority of schools have water only rarely. The water shortage is most prominent in medium primary schools where nearly one fifth of the schools have no access to water at all. In secondary, 12 percent of medium sized schools have no water, with a similar pattern observed in small and medium combined schools.

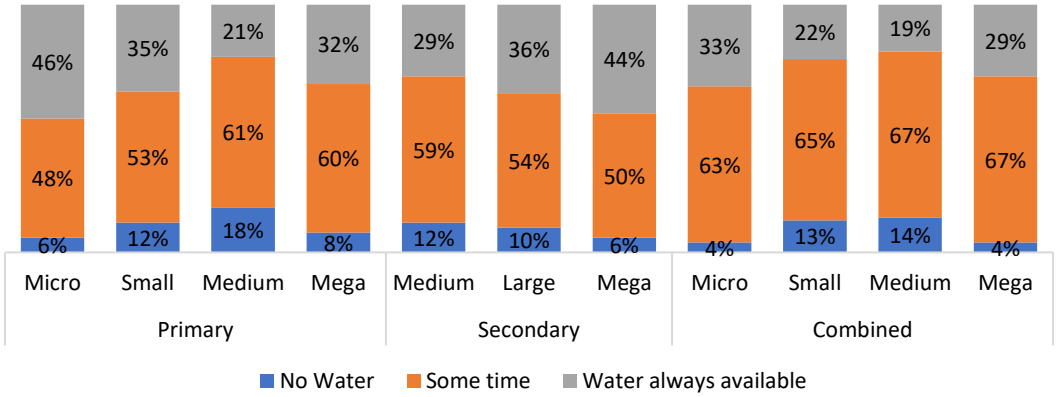


Figure 17: Water availability by school size and education level

Source: (DBE, 2018)

Following ASIDI, the country has made positive progress in phasing out classrooms constructed using non-permanent building materials. In 2018, 2 400 existing classrooms were constructed from mud or wood, with 85 percent of these classrooms found in the Eastern Cape Province. Out of the more than 2 000 classrooms constructed from non-permanent materials in Eastern Cape, 1 500 were established to be constructed from mud while 535 constructed from wood (Figure 18). To demonstrate the progress that has been made under ASIDI, these non-permanent classrooms in Eastern Cape represent only 3 percent of the total classrooms in the province. KwaZulu-Natal, with less than 200, comes a distant second in terms of the number of classrooms built from non-permanent materials. In other provinces, there were an average of 18 classrooms constructed from the undesired materials.

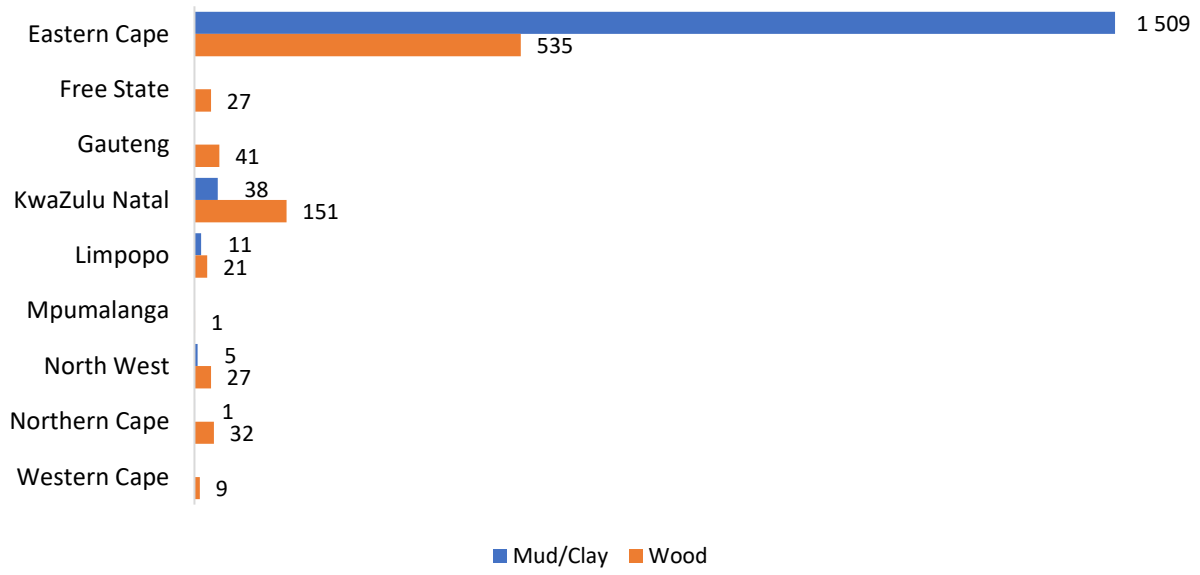


Figure 18: Classrooms constructed in mud or wood by province

Source: (DBE, 2018)

Across provinces, all primary and secondary schools in Western Cape have electricity, and very few schools are without electricity in Free State, Gauteng, and Mpumalanga. Approximately 17 percent of schools in Eastern Cape, 14 percent of schools in KwaZulu-Natal, and 7 percent of schools in North West do not have access to electricity (Figure 19). At the secondary level, approximately 16 percent of schools in Eastern Cape, 7 percent of schools in KwaZulu-Natal, and 8 percent of schools in North West do not have access to electricity (Figure 20). Once again, medium sized primary and secondary schools are more likely not to have electricity compared to micro, small, large, and mega schools.

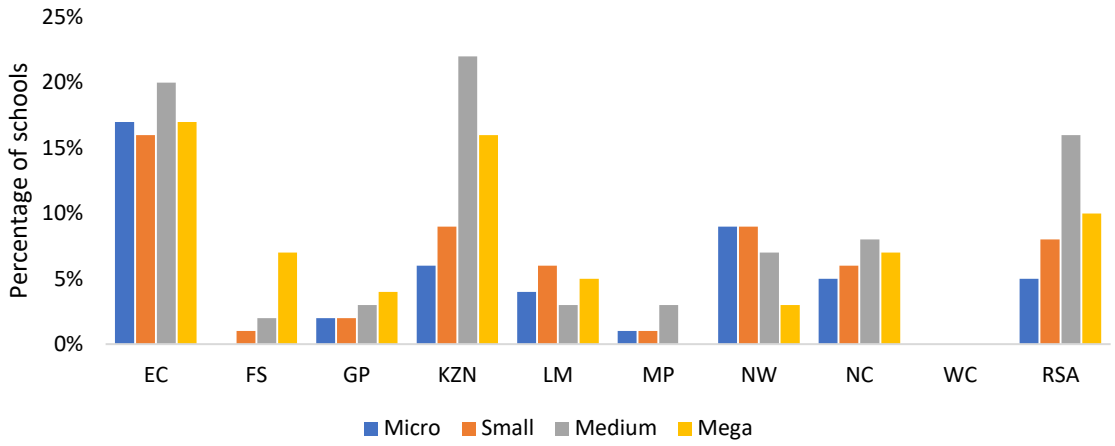


Figure 19: Percentage of primary schools without electricity, by provinces

Source: (DBE, 2018)

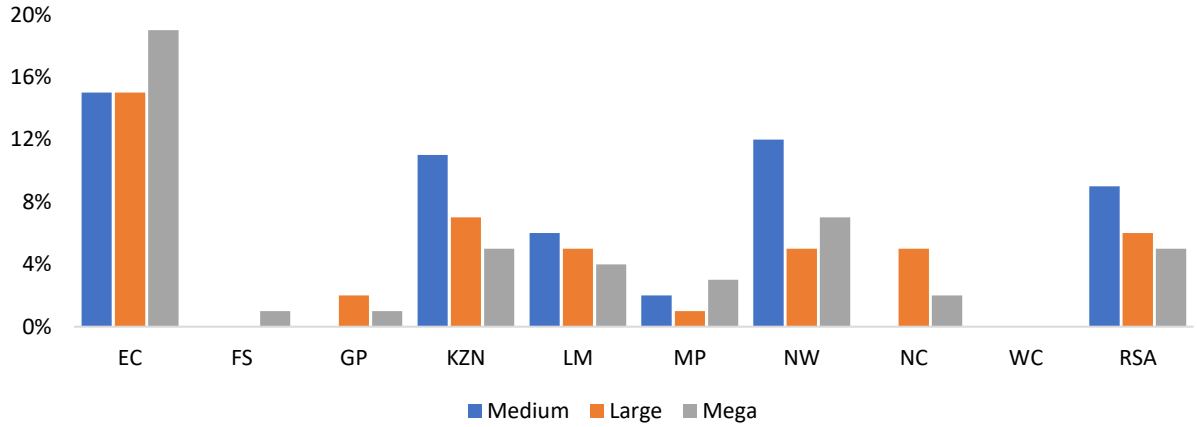


Figure 20: Percentage of secondary schools without electricity, by provinces

Source: (DBE, 2018)

Besides the considerable share of schools having issues with electricity, a significant share has no connectivity to the internet. Although there is no data available on digital connectivity in schools, access to a computer server can be used as a proxy for access to the internet, where only 2 percent of primary, secondary and combined schools have access to a server room (Figure 21). Only about 40 percent of secondary and combined schools have computer rooms and even less for primary schools where only 1 in

4 schools have computer rooms. Access to libraries ranges from about 1 in 3 secondary and combined schools to 1 in 5 primary schools. At the same time, 37 percent of secondary schools have access to laboratories compared to only 5 percent of primary schools.

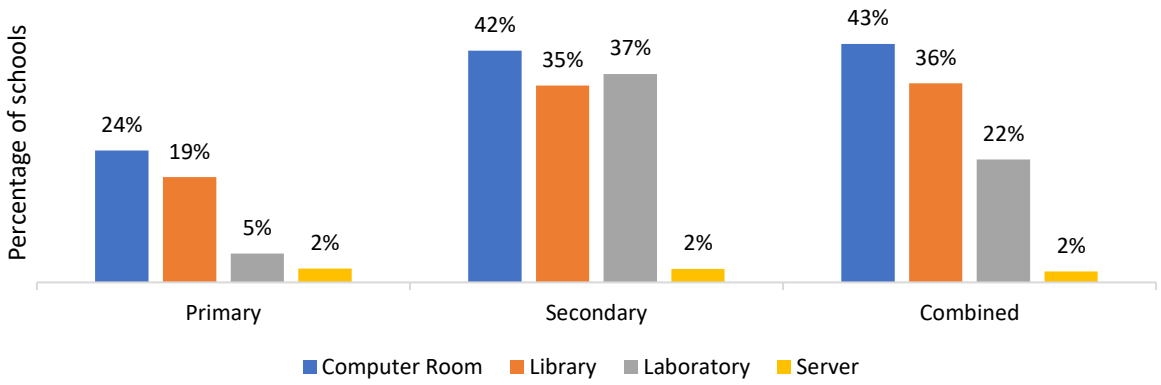


Figure 21: Percentage of public schools with computer rooms, libraries, laboratories, and servers, 2020
Source: (DBE, 2018)

The levels of access to libraries and laboratories demonstrate the differentiated needs of schools at the province level. Irrespective of the level of education, only 15% of public basic schools have access to laboratories, and only 1 in 4 have access to libraries, with stark disparities across provinces (see Figure 21). In Gauteng province, two thirds of public schools have access to libraries, compared to only 7% in Limpopo. The administrative data further shows that only 1 in 3 schools has access to a laboratory in Western Cape, where access is the highest, compared to Limpopo's 6%.

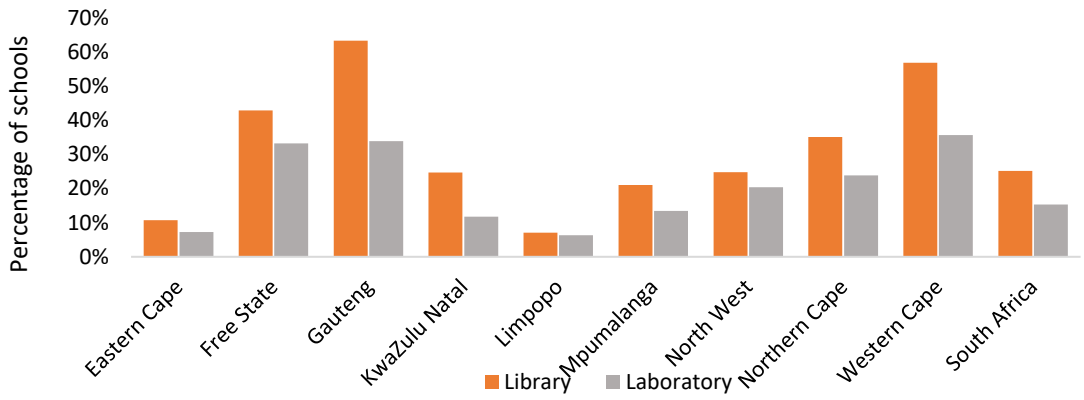


Figure 22: Percentage of public schools with libraries and laboratories, all levels, by province

Source: (DBE, 2018)

In summary, there has been good progress in eliminating classrooms constructed of inappropriate/non-permanent materials in South Africa. However, a considerable percentage of schools in Limpopo, Eastern Cape, KwaZulu-Natal, and Mpumalanga provinces do not have flush or VIP toilets and consistent access to water when schools are in session. There are also many schools in the same provinces that don't have access to consistent electricity. Access to digital connectivity is not known, but less than half the secondary and combined schools in South Africa have access to computer rooms and only 1 in 5 primary schools have access to digital connectivity. Ensuring that all schools in South Africa have access to basic services such as water, flush toilets, electricity, and digital connectivity, should be sustained as a priority. In the medium term, ensuring that at least all secondary schools have access to laboratories and digital libraries should also be a priority.

4.3 Population growth

The total population of South Africa is projected to increase by 8.1 million people from 59.6 million in 2020 to 67.7 million in 2030 (StatsSA, 2020). StatsSA projection provides not only the total population in 2030 but provincial distribution as well. In addition to StatsSA's Baseline provincial population projections, there are two alternative population growth scenarios: the 'Urban scenario' and the 'Rural scenario' to project the population distribution, within StatsSA's total population for 2030 that is likely to be in the

rural as compared that which will potentially be in urban areas. In all these three scenarios, the overall population estimates for 2030 remains the same, with differences observed at provincial levels for the different scenarios. The methodological differences for the population projection scenarios are as follows:

- The StatsSA's 2030 projection – which is the 'Baseline' scenario – is based on demographic past-trends only, both for total and provincial populations. These projections show a total population growth of 15 percent between the 2011 Census and the 2020 population estimate, corresponding to 7.9 million additional people. This scenario estimates a 14 percent population growth between 2020 and 2030 corresponding to 8.1 million additional people. The distribution of the population growth per province is provided in Annex 5.
- The present study updates StatsSA's 2030 projections by using a more comprehensive methodology based on the pull- and push-factor analysis between different categories of urban and rural human settlements (World Bank, 2021) and the subsequent migration between them, as well as the impact of both Urban and Rural scenarios as regards governmental socio-economic policies. They are broken down into two scenarios: an 'Urban scenario' and a 'Rural scenario' depending on possible urban versus rural-oriented socio-economic policies
- The Urban scenario assumes that urbanisation will continue, with migration from the Eastern Cape, Mpumalanga, Limpopo and North West to the provinces with large urban areas (mainly Gauteng and the Western Cape) expected.
- The Rural scenario assumes that the government will regenerate rural economies, and the urbanisation rate will decrease. Interventions in provinces like KwaZulu-Natal, Eastern Cape, Limpopo, Mpumalanga and North West are most likely to reduce out-migration.

The differences in population projections are not related to the national totals (for 2020 and 2030) – which are identical across the three projection scenarios – but are found in the distribution of the population at the provincial level as illustrated in Figure 22. The projected population in these scenarios varies at the provincial level. The direction of population growth for the Urban and Rural scenarios (orange and green columns) are consistent for all provinces but differ on the rate of growth. However, compared to the Baseline scenario, the Urban and Rural scenarios show a reversal of the growth-direction, from negative-to-positive trend for Eastern Cape, and from positive-to-negative trend in Limpopo, Mpumalanga,

Northern Cape and North West. This study applies these differentiated population growth profiles to the "Beyond the Gap" framework, whose key elements include the use of scenarios to demonstrate how investment needs change based on various endogenous and exogenous, with endogenous factors being trade-offs of different assumptions and policy decisions on education sector norms and standards, all towards achievement of SDG 4.2A (see Section 1.2). These include school participation rates, pupil teacher ratios, pupil classroom ratios, and class sizes. Exogenous factors include the three socioeconomic scenarios on population and economic growths, i.e., baseline, urban and rural scenarios.

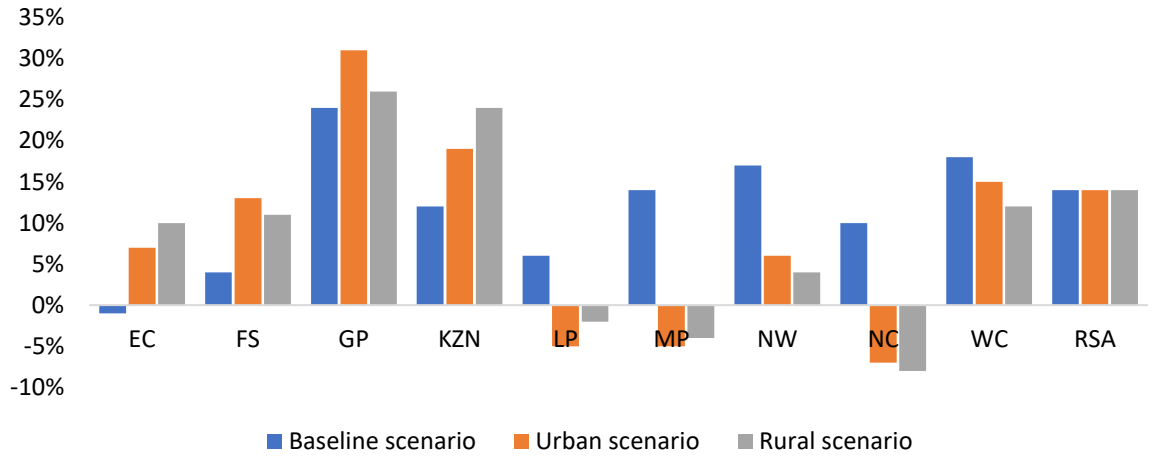


Figure 23: Comparison of the provincial projected population growth trends in StatsSA and the World Bank's update of the StatsSA population projections between 2020 and 2030

Source: (StatsSA, 2020) (World Bank, 2021)

Based on population growth, the provinces that will need to expand their infrastructure to account for population growth in all three scenarios in early grades, include Gauteng, KwaZulu-Natal, Western Cape, Free State and Eastern Cape. In the Eastern Cape, even with the rationalization of small schools, a 7 to 10 percent growth in population will require a relook in terms of the growth in numbers of schools, particularly if the preference is for larger schools. Provinces like Limpopo, Mpumalanga, Northern Cape and North West will have a decline in population growth (in the urban and rural population projection scenarios) so will not have to expand infrastructure for a growing population but may need to expand to

deal with the high SCR rates such as the case of Mpumalanga for Grade R and primary education (where the SCR is 42).

5 COST DRIVERS OF SCHOOL INFRASTRUCTURE

The two main cost drivers of school infrastructure are (i) the package of facilities that need to be built for a standard school, which are based on the minimum norms and standards for school construction; and (ii) the implementation arrangements by which the construction is undertaken. This section describes each of these drivers in the South African context.

5.1 School Minimum Norms and Standards

The DBE developed a set of national Minimum Norms and Standards (MNS) in 2013. Two key documents – the Regulations relating to minimum uniform norms and standards for public school infrastructure, (DBE, 2013), and the Guidelines relating to planning for public school infrastructure (DBE, 2012) – provide details on the composition of the package of facilities and the normed areas for each facility. The MNS covers 52 types of rooms/areas organized into 3 groups, i.e.

- 27 Education areas, divided into 8 minimum education areas[10] and 19 optional education spaces subject to curriculum choice[11]

[10] Classrooms, Grade R classroom, Science laboratory, Computer room, multipurpose classroom, School library/Media center, Multimedia center (library and compute function), and Storage areas.

[11] Arts and culture classroom, Technology classroom, Physiotherapy room (for special schools), Speech therapy room (for special schools), Incontinence room (for special schools), Dace studies, Dramatic art room, Music room, Hospitality studies room, Visual art room, Social Sciences room, Agricultural Sciences room, Engineering graphic and design room, Agricultural technology workshop, Civil technology workshop, Electrical technology workshop, Mechanical technology workshop.

- 14 Education support areas[12]; and
- 11 Administration Areas[13] (DBE 2013).

It is important to note that although boarding facilities are not included in the MNS, DBE developed separate Guidelines for boarding facilities (DBE, 2012) which provide the standard area for each type of boarding-related facility. There are two main differences between the Regulations relating to minimum uniform norms and standards for public school infrastructure (2013), and the Guidelines relating to planning for public school infrastructure (2012) viz:

- The *MNS* include norms and standards for *micro-Schools* (up to 125 learners), while the *Guidelines relating to planning for public school infrastructure* does not mention micro schools.

- The *MNS* presents only a minimum size for each type of classroom (for example, 48m^2 for a classroom), while the *Guidelines relating to planning for public school infrastructure* recommends "*minimum*" and "*optimum*" areas of different functions in a school. For instance, the classroom area is 48m^2 as a minimum and 60m^2 as the optimum. Table 9 provides the minimum and optimum areas of the main rooms as prescribed in the Guidelines.

Table 9: Minimum and optimum Standard areas of the Minimum package of education areas

Minimum Education Area	Minimum area (m^2)	Optimum area (m^2)
Classroom	48	60
Grade R classroom	60	80
Multi-purpose room	60	80
Science Laboratory	60	80
School library/ Media centre	60	120

[12] Food garden, Tuck-shop, Pastoral Care Center, Nutrition Center, Caretaker room, storage area, security room, multipurpose hall, parking bays, walkways, learners' toilets, Physical education, sport and recreational areas, refuse areas.

[13] Principal' s office, Deputy principal's office, Administration office, Reception areas, Storage area, Strong room, Staff room, Head of Department Office, Staff kitchenette, Staff toilets.

Multi-media centre	80	120
Storage per classroom	12	15
Toilet	1.2	1.8
Principal office	15	20
Administration office	15	20
Strong room	6	10
Staff room	48	60
Kitchenette	12	20

Source. Authors' table with data from (DBE, 2012)

The MNS are adjusted to nine sizes of schools which are divided into 3 main categories: micro-schools (which are all primary schools), primary schools, and secondary schools. Each category is further subdivided into 3 sub-categories: small, medium, and large schools, and the MNS provides the minimum package of facilities for each of the nine sub-categories. See Table 10 below for ranges of enrolment and classroom numbers for different categories and sub-categories of schools. The smallest is a micro school with less than 25 students enrolled and 1-2 classrooms while the largest is a primary or secondary school with 621 to 1 000 students enrolled and 16-23 classrooms. Annex 7 provides details on the minimum and optimum areas for each of the facilities.

Table 10: Ranges of enrolment and classroom areas of the minimum package of education areas

Category of school	Description	Subcategory of schools		
		Small	**Medium**	**Large**
Micro primary school	Enrolment	<25	26-65	66-125
	Number of classrooms	1 to 2	2 to 4	4 to 6
Primary school	Enrolment	126-320	321-620	621-930
	Number of classrooms	5 to 8	9 to 15	16 to 23
Secondary school	Enrolment	200-400	401-600	601-1 000
	Number of classrooms	6 to 10	11 to 15	16 to 23

Source: Authors' calculations with data from (DBE, 2013)

In addition to the classrooms, floor areas are suggested for educational functions (multipurpose hall laboratories, libraries etc.), education support functions (covered dining area, toilets, recreation room, physical education room, nutrition centre etc.), and administration functions (principal room, staff room, strong room, sick room etc.). These functions and number of rooms required for each function are increased depending on category and sub-category of school.

The total constructed area ranges from 335 m2 for a small micro school, to more than 1 700 m2 for a large secondary school. Table 11 shows that the economy of scale (i.e., ratio of classroom area to total area of the school), is not substantial across the three categories of schools (micro, primary and secondary), but is substantial between sub-categories (small, medium, and large). This ratio ranges from a maximum of about 2.2 to 2.5 for all small schools and to a minimum of 1.6 to 1.4 irrespective of them being micro, primary, or secondary schools. Detailed numbers for economy of scale for each school type and its sub-categories are given in Table 11 below. The very small micro school enrolling less than 13 learners in 1 classroom is an exceptional case, with a high ratio of 3.1. The very low number of learners may encourage downsizing the minimum package of facilities without compromising the quality of education, thus reducing the over-dimension of the total area to be built compared to the educational areas.

Table 11: Ratio of classroom area to total area for Micro, primary and secondary schools in the minimum education norms and standards

		Small		**Medium**		**Large**	
Micro primary schools	Total area (m^2)	335	384	383	480	471	569
	Classroom area (inc. Gr R) (m^2)	108	156	156	252	252	348
	Ratio of classroom area / total area [1]	3.1	2.5	2.5	1.9	1.9	1.6
Primary schools	Total area (m^2)	665	819	972	1 355	1 501	1 842
	Classroom area (inc. Gr R) (m^2)	300	444	552	900	948	1 284
	Ratio of classroom area / total area [1]	2.2	1.8	1.8	1.5	1.6	1.4
	Total area (m^2)	731	925	1 008	1 205	1 358	1 707

Secondary schools	Classroom area (inc. Gr R) (m^2)	288	480	528	720	768	1104
	Ratio of classroom area / total area [1]	2.5	1.9	1.9	1.7	1.8	1.5

Source: Authors' calculations with data from (DBE, 2013)

Provision of certain functions and floor areas for some functions in different categories and sub-categories of schools needs to be reviewed and downsizing of certain non-education functions may be considered for cost-efficiency for equitable quality education in different categories of schools. See Annex 2 for detailed analysis of different categories and subcategories of schools and recommendations to achieve cost efficiency.

5.2 Implementation arrangements for school construction

Different countries choose different management and implementations arrangements for school construction, depending on their history and experience, and their current or intended level of decentralization. Since 1994, South Africa decentralized school construction management to PEDs, and the management of the provision of bulk services (water and electricity) to Municipalities, while the national DBE is responsible for policy development and establishing national norms and standards to be implemented by provincial and municipal governments. Despite the important increase of school infrastructure budgets managed by provinces since the late 1990s, the assessment of the situation in 2011 revealed significant infrastructure backlogs – notably the persistence of "mud" schools -- which led to the decision to create the ASIDI and re-centralize management with the expectation to improve performance and deliver the programme objectives within a four-year period (DBE, 2011). However, as mentioned earlier, nine years after the introduction of ASIDI, only about half of the results were achieved and the unit costs of implementation remained high (see section 7). In comparison to other countries in the region (See Box 5), both construction implementation modalities (either by PEDs or DBE) can be considered as "centralized", because they neither involve lower levels of government, such as the municipal government, nor local grassroots level, such as the school governing bodies. In fact, the latter is considered only as "affected" entities in the National Treasury Guidelines (National Treasury, 2016).

Box 5. Decentralizing school construction: Perspectives from international experience

Few countries have empowered the provincial level administrations to take on school construction, in a similar fashion to South Africa. Of the high-income countries, Canada is one of the rare examples where decentralization is to the provincial level equivalent, rather than the local level. Most high-income countries decentralized school construction to lower levels. The US, for instance, has decentralized school construction to specific Local Governments and the US 'school districts' comparable in number (13 800) to municipalities (19 429) in the country. A study of 28 European countries conducted in 2014 offers another interesting perspective. All these countries completed their rural-to-urban migration in the 20th century and their school network is mature. In Western Europe, the local level school construction management/implementation system has been in place for centuries, while newcomers from Eastern Europe have shifted from previously centralized approaches to more decentralized ones. Figure B5.1 illustrates the situation in 2014 (the total exceeds 28, as some are implementing different mechanisms within the country, such as Belgium). On aggregate, countries that decentralize school construction to communities and schools are a strong majority.

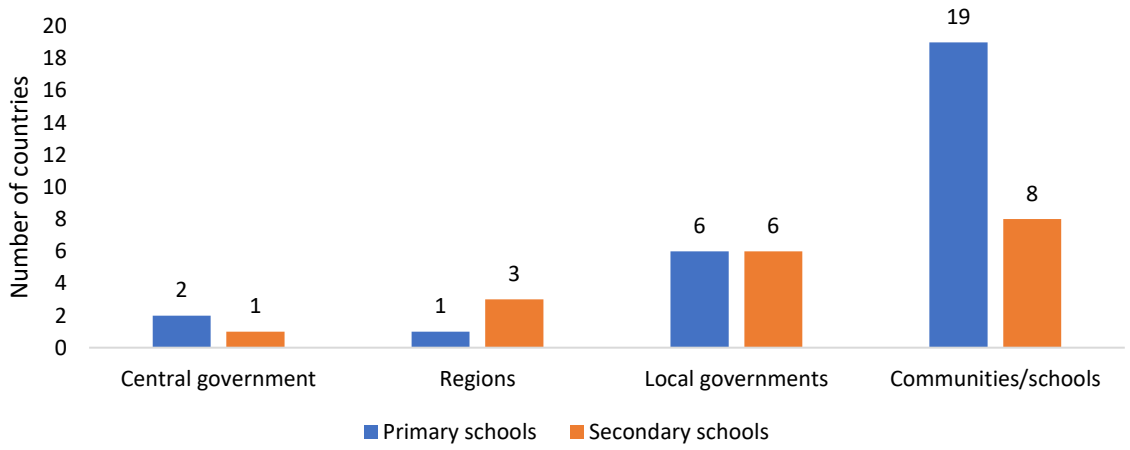


Figure B5.1. School construction management/implementation in European countries (2014)

Source: Graph by authors with data from (European Commission, 2014)

A central feature of South Africa's school construction implementation modality is the systemic use of specific entities named Implementing Agents (IAs) by both the national DBE for ASIDI/SAFE and the PED. The IA is an important entity supporting the school construction system, in addition to the Users and the Custodians defined by the 2007 Government Immovable Asset Management Act (Government of South Africa, 2007), as described below:

- A *User* utilizes the immovable asset. Regarding school buildings, users are PEDs. They prepare UAMPs.
- A *Custodian* provides the immovable assets to the User and is responsible for ownership. Regarding school buildings, a Custodian is the provincial Department of Public Works.
- An IA is a professional Service Provider that assists the User and the Custodian to implement school construction, which at times includes procurement of architectural engineering services and procurement of works. For school construction, they are chosen either through a) DBE directly for its centrally managed ASIDI and SAFE programme; and b) PED together with the provincial department of Public Works for the provincially managed school construction programmes.

Implementing Agents exist in two main categories and serve DBE or PEDs through a Service Delivery Agreements (SDA). The two categories of IAs, both pertaining to the public sector, include:

- The provincial Departmental of Public Works (DPW), which is the default IA in the absence of others, and is considered as an "imposed" IA (DBE 2019a), in addition to its Custodian role. However, for its role as an IA, the respective provincial DPWs are compensated through fees.
- State-Owned Enterprises (SOEs). South Africa has a long history of using SOEs for its development (Fourie, 2001). They are public entities that are commercially run under government ownership. Their role has been significant since 1994 (Kikeri, 2012). To implement school construction, DBE and some PEDs have selected a handful of SOEs, including the DBSA, the Independent Development Trust (IDT), Coega Development Corporation (CDC), Mvula Trust and the National Education Collaboration Trust (NECT).

Section 6 on Funding for Schools construction indicates that the financial volume of school construction implemented by SOEs acting as IA for DBE is only 12 percent of the total volume of public funds for school construction. Section 7 on Unit cost of construction provides information on the relative performance of provincial Departments of Public Works acting as IAs for PEDs relative to SOEs acting as IAs for DBE, suggesting that the central management of school construction by large SOEs acting as IAs for DBE is costlier than the decentralized management of school construction by provincial DPW acting as IAs for PEDs – more than double the provincial unit cost and up to four times the cost of community based approach. Section 8 provides information on the actual construction needs for school improvement, as regards additional or replacement of classrooms, latrines, or other school facilities. In fact, as in other countries, the immense global volume of construction needs is fragmented into a myriad of small individual school construction needs disseminated over the school network. The needs can be, for example, one or two classrooms in one school, a latrine block in another school, the administrative block in a third one, etc. Many of these needs are not addressed as part of a national construction strategy but are rather dealt with at a local level where communities build the required facilities, but these initiatives are neither recorded nor supported. This is a current situation in many SSA countries.

In South Africa, there has been a similar management and implementation strategy in school construction where the focus has been on the construction of large new schools and the closure of non-standard small schools, rather than fixing the specific small missing elements of each school in need of support regardless of its size and location. The current national policy does not provide support to community-based initiatives in a structured manner, though some provinces are doing this of their own accord. The reason often cited for not supporting local/community initiatives is a preconceived assumption that communities do not have the capacity to implement school construction projects. However, there have been some successes in community-initiated school construction supported by the Western Cape PED where a remote farm school successfully initiated, planned, implemented, and delivered a school construction project14. This large school of 1 000 learners was rapidly built at an economic price and good quality (see Section 7 on Unit costs of construction). This initiative, often labelled as “Ubuntu” initiative, is an inspiring

[14] The Jakes Gerwel Technical School in Bonnievale, Cape Winelands District, Western Cape

case showing that an alternative option could strategically be further explored. Box 6 below provides data on community-based programmes in Africa.

Table 12: Distribution of IAs across provinces

Type of Implementing agent		Acronym	IA name	DBE	Provincial Department of Education								
				ASIDI or SAFE	Eastern Cape	Free State	Gauteng	KwaZulu Natal	Limpopo	Mpumalanga	North West	Northern Cape	Western Cape
State-owned companies	Construction	CDC	Coega Development Corporation	X									
		DBSA	Development Bank of Southern Africa	X									
		IDT	Independent Development Trust	X									
		ECDC	Eastern Cape Development Corporation										
		BNM	Brinkman Ndayi McAll										
		FS DoE	Free State										
		eTM	eThekwini Municipality										
	Water	AW	Amatole Water		X								
		WRC	Water Research Commission		X								
		DEA	Department of Environmental Affairs	X									
		MT	Mvula Trust	X									
		NECT	National Education Collaboration Trust	X									
		MW	Mhlatuzi Water	X									
Provincial Departments of Public Works		DPW	Department of Public Works					X		X			
		ECDPW	Eastern Cape Department of Public Works		X								
		DPWI	Department of Public Works & Infrastructure			X							
		DPWR	Department of Roads & Public Works								X	X	
		DPWT	Department of Transport & Public Works										X
		GDID	Gauteng Department of Infrastructure				X						

Source. Table by authors with data from DBE and Provincial UAMP

Box 6. Implementing school construction through community-empowerment: global experience

The analysis of data of about 250 construction projects supported by development partners over 30 years sheds light on the cost-effectiveness of the various implementation approaches, through the classification by procurement agency and the specific lens of the average unit cost (per m^2) achieved by these various agencies (Theunynck, 2009).

- The study unequivocally establishes that community-based implementation outperforms all other arrangements, with an average of 105 USD/m^2 (value 2006), about 40 percent lower than centralized implementation
- All the other implementation arrangements, either through direct implementation by the Education Department, or any form of supporting Implementing Agent, achieve about the same flat range of unit cost (between 160 and 190 USD/m^2). Their common feature is to use National Competitive Bidding (NCB)
- The other main feature is the high cost of International Competitive Bidding (ICB), which is of the same magnitude as the differences of unit costs in South Africa of construction by central IAs serving DBE compared to provincial IAs serving PEDs

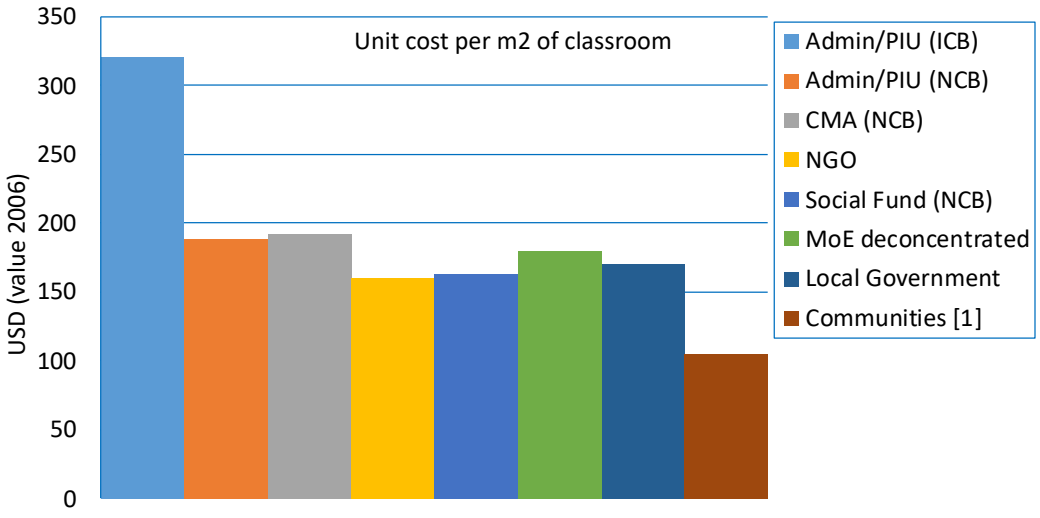


Figure B6.1: Unit cost per m2 of a classroom by IA and procurement method

Subsequent analysis of projects/countries where similar comparisons were possible during the 2006-2020 period confirm similar results in Ivory Coast, Malawi, Mauritania, Senegal, Togo, Rwanda, Sudan, Uganda, and Tanzania. Community-based implementation of school construction through Local Competitive Bidding (LCB) is between 50 percent and 30 percent less expensive than centrally implemented school construction through NCB, with similar construction quality assessed by technical audits. Naturally their common feature is to be small projects.

Community-based implementation is at the heart of "big bang" school construction programmes that took place in Africa, such as the Ugandan Education Sector Improvement Programme (USIP, 1999-2004) during which 29 000 classrooms were built by School Management Committees, the Tanzanian Education Development Programme (2000-04) where 30 000 classrooms were built; and more recently, Rwanda's Quality Education Project for Human Capital Development (2019-21) during which communities built 22 000 classrooms and 35 000 latrines at the cost-effective unit cost of USD9 000 per classroom.

Source: (Theunynck, 2009) (Theunynck, 2018)

6 FUNDING FOR SCHOOL CONSTRUCTION AND OPERATIONAL COSTS

The main sources of financing for school construction and maintenance funding are funds managed by the nine PEDs, particularly the Provincial Education Infrastructure Grant (EIG); and the Provincial Equitable Share (PES)[15]. These funds are allocated to school construction and maintenance under the PEDs'

[15] A separate math, science and technology conditional grant "provides for ICT, workshop equipment and machinery to schools" (National Treasury, 2021). A small portion of the NSNP grant is spent on nutrition related equipment (DPME estimated less than 1 percent) (Department of Planning, Monitoring and Evaluation, 2016). Figures for this entire section use the revised 2020-21 budget; the 2018-19 Preliminary Outcome; and audited actuals for other years except for EIG payments to provinces (all audited actuals).

Infrastructure Development budget programme (IDP)[16]. Secondly, smaller funds managed centrally by DBE comprise the national School Infrastructure Backlog Grant (SIBG) – which finances the ASIDI and SAFE Initiative. Between 2011-12 and 2020-21 in nominal terms, EIG has represented 71 percent of all nationally and provincially managed expenditures; PEDs' allocations from their own revenues and the equitable share have represented 17 percent of those expenditures; and ASIDI and SAFE has represented 12 percent of those expenditures (in nominal terms).

In addition to provincially and nationally managed funds, schools spend significant sums on school maintenance from the capacitation grants to schools (a nationally mandated minimum of around ZAR 15.2 billion in 2020-21)\17, which is substantially augmented by parents. Even if just 10 percent of the minimum capacitation payments mandated by national government to be carved out of the provincial equitable share are spent on maintenance and construction, this amount is around ZAR 1.5 billion in 2020-21 (Dyk & White, 2019). When combined with parental contributions – for public schools, parents paid an estimated ZAR 14 billion in fees in 2019 (StatsSA, 2020), it is likely that school-managed funding far outstripped provincially managed discretionary funding of ZAR 1.9 billion in 2020-21 (Figure 24). Total estimated funding for maintenance and construction equated to around ZAR 1 183 (USD 72) per child aged 5-17 in 2019-20.

[16] A small amount of capital expenditure for buildings and other fixed structures is allocated via other programmes, based on authors' examination of the 2021 EPRE documents (Department of National Treasury, Republic of South Africa, 2021). Capital expenses for transport to school are often allocated under a different expenditure classification.

[17] Based on June 2020 enrolment counts and quintiles, combined with gazetted rates. Provinces often top up these capitation grants.

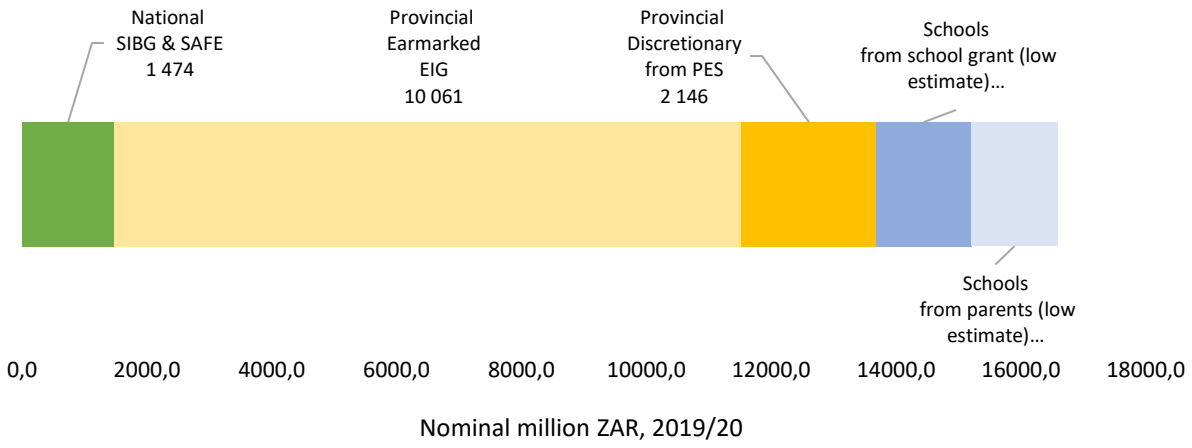


Figure 24: Overview of funding for school construction and maintenance in 2019/20

Source: (StatsSA, 2020), (National Treasury, multiple), (Dyk & White, 2019), author calculations based on DBE 2019 school quintiles and 2020 capitation rates

6.1 Provincial funds through EIG and the equitable share

The EIG is the main source of funds for school construction and maintenance. The EIG is a specific-purpose conditional grant provided to provinces exclusively to finance school construction and maintenance of existing school facilities (including school upgrades and refurbishment). The EIG was created in 2011/12 through the Government restructuring of the Infrastructure Grant to Provinces (IGP). The EIG represents 71 percent of all nationally and provincially managed funds, consisting of a small (6 percent) incentive component predicated on compliant provincial planning, and a larger (94 percent) basic component. All provinces received the incentive component in 2021-22 (National Treasury, 2021). The allocation to each province is not based on a formula, but rather a process of negotiation between the provinces and DBE.

The distribution of EIG across provinces has generally followed the population distribution across provinces, with KwaZulu-Natal, Eastern Cape, and Gauteng receiving most EIG, and North West, Free State, Mpumalanga and Northern Cape receiving the least in EIG (Figure 25).

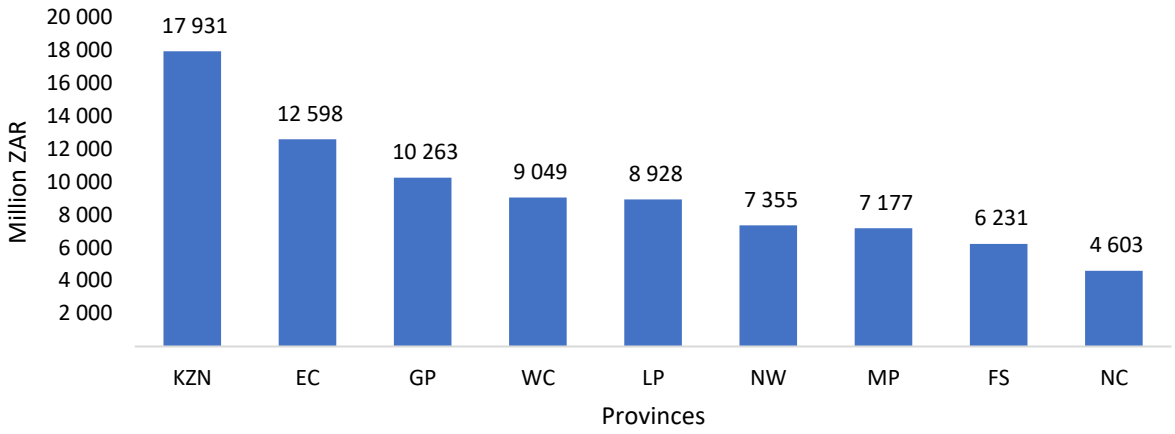


Figure 25: Distribution of EIG by provinces over the last 10 years (2011-2021) in million ZAR

Source: Authors' graph with data from (National Treasury, 2021)

During the same period, provinces spent approximately ZAR 84 billion in EIG, representing between 92.5 percent and 100 percent of the EIG made available to them, with an average of 96.3 percent of EIG spent (see Table 13). The spending has however been in the context of varied EIG allocations over the last 10 years. EIG funding in nominal terms in Gauteng, for example, increased by more than three times in six years (from 2011-12 to 2017-18) before a slight decrease. EIG funding in KwaZulu-Natal doubled in nominal terms during the same period, also followed by a decrease. North West experienced a three-year peak in 2015-2018 before a sharp decline starting in 2019 and further continuing in 2020-21, a level close to 2011-12.

In nominal ZAR terms, EIG funding increased by 72 percent over a 10-year period from 2011/12, with large variations across provinces. For example, Gauteng's EIG increased by 173 percent between 2010 and 2020, while Limpopo had the lowest increase, where the EIG allocation increased by only 11 percent (see Table 13).

Table 13: EIG Expenditure by Province over past 10 years in million ZAR

Province	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	Northern West	Western Cape	South Africa (R 10^6)
2011-12	797	421	467	1 176	894	587	290	522	385	5 539
2012-13	937	512	513	1 423	565	528	249	296	431	5 454
2013-14	1 131	399	538	1 306	1 147	536	365	661	822	6 906
2014-15	997	489	618	1 386	1 096	623	346	564	1 008	7 127
2015-16	1 136	755	1 336	1 979	864	853	429	1 051	1 095	9 497
2016-17	1 505	533	1 386	2 050	938	683	487	1 012	1 079	9 673
2017-18	1 583	852	1 468	2 333	839	701	609	1 070	1 149	10 604
2018-19	1 710	632	1 373	2 018	953	780	568	690	1 022	9 745
2019-20	1 579	827	1 290	2 287	636	1 045	640	630	1 128	10 061
2020-21	1 222	811	1 275	1 973	996	841	619	860	929	9 526
Total 10 years	12 598	6 231	10 263	17 931	8 928	7 177	4 603	7 355	9 049	84 133
	15 %	7 %	12 %	21 %	11 %	9 %	5 %	9 %	11 %	100 %
Diff. last – first year	425	390	808	797	102	254	328	338	544	3 987
	53 %	93 %	173 %	68 %	11 %	43 %	113 %	65 %	141 %	72 %

Source: (National Treasury, 2021)

In 2021-22 real terms, spending per child increased by 30 percent between 2011-12 (ZAR 743) and 2015-16 (966), plateaued for three years before commencing a descent which has seen the average spending per child fall below the ZAR 743 seen in 2011-12 to reach ZAR 700 (see Figure 26).

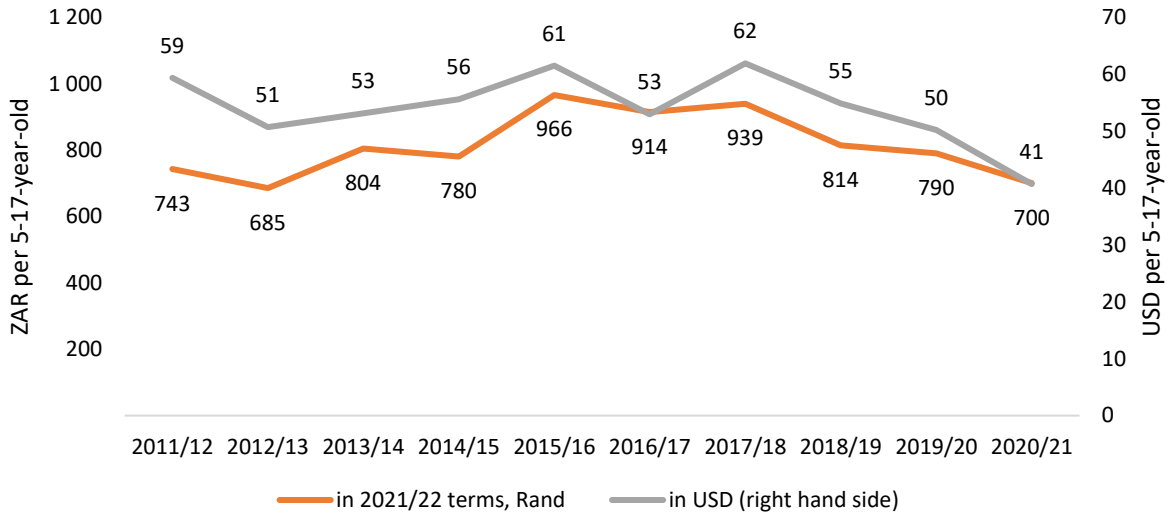


Figure 26: EIG spending, per child aged 5 to 17 in USD and 2021-22 ZAR

Source: (National Treasury, multiple) (National Treasury, 2021) (Department of National Treasury, Republic of South Africa, 2021) (South African Reserve Bank, 2020) (Department of Statistics South Africa, 2017)

Over the decade, cumulative EIG spending, has been pro-poor to some extent, although KwaZulu-Natal and Limpopo have received relatively fewer resources when compared to some less population-dense provinces like Northern Cape which received the most per child over the decade (see Figure 27).

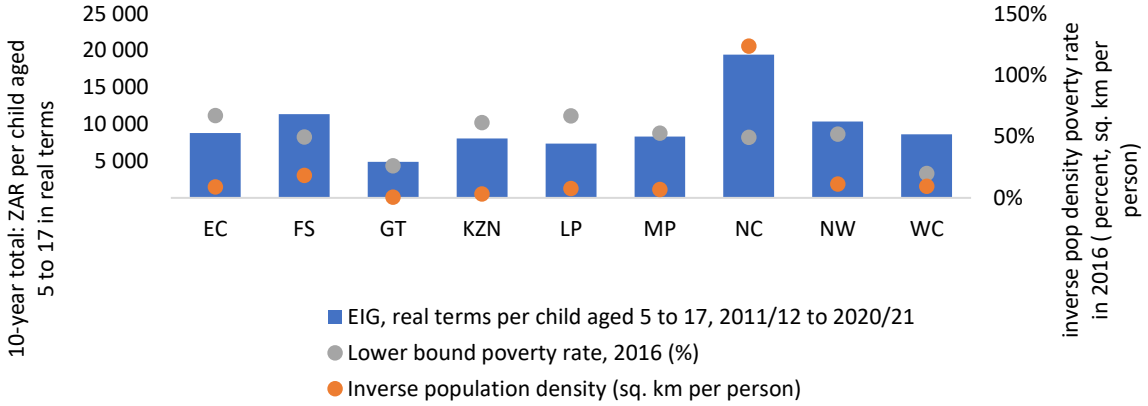


Figure 27: Ten-year EIG spending per 5-17-year-old, population density (inverted), and poverty rate

Source: (National Treasury, multiple) UCT Children Count (StatsSA, 2020)

In real per child spending terms, EIG spending in Limpopo has been reduced dramatically over the period to 2019-20 (Figure 28).

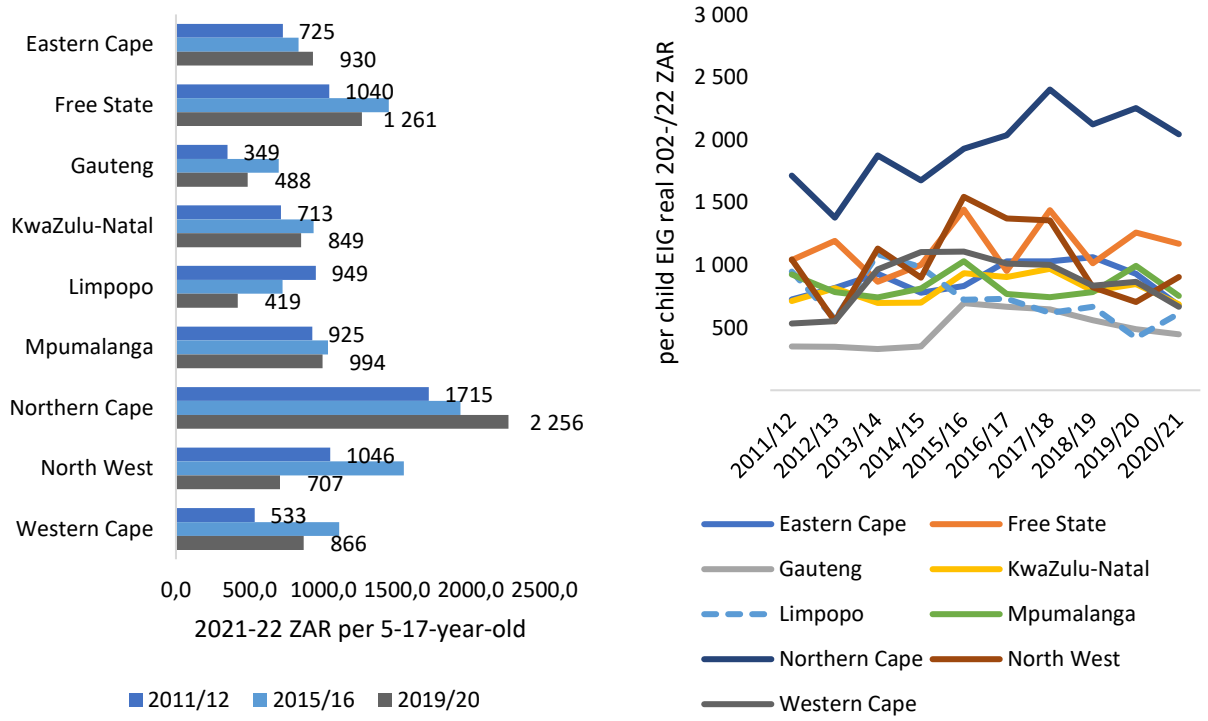


Figure 28: EIG spending per 5-17-year-old in 2021-22 ZAR, 2011-12 to 2020-21

Source: (National Treasury, multiple) (StatsSA, 2020)

In addition to the EIG, provinces supplement financing for school construction and maintenance through discretionary allocations[18] from the PES and their own-raised revenues.[19] The PES can be spent in any

[18] While the equitable share is "discretionary" mandates and poor cost control for centrally negotiated salaries have reduced the amount of actual discretionary spending (Spaull & Hoadley, 2018).

[19] Hereafter referred to as provincial equitable share only.

sector consistent with provinces' constitutional and legal mandates and is allocated among provinces using a highly pro-poor formula[20]. Over the eight years to 2020-21 (based on available data), provinces spent ZAR 25.9 billion[21] from their PES under the budget programme for infrastructure development, which is 21 percent of all national and provincially managed spending on school construction and maintenance (see Table 14).

Table 14: Infrastructure development programme funded by provinces out of their equitable share

	2013-14	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**8-year Total**
Eastern Cape	428	104	22	61	200	4	1	-	819
Free State	29	5	5	3	17	15	10	9	92
Gauteng	1 091	1 143	1 460	1 465	509	270	225	240	6 403
KwaZulu Natal	1 166	839	623	544	243	356	471	963	5 203
Limpopo	21	209	214	107	257	2	1	-	811
Mpumalanga	177	157	189	142	199	446	195	80	1 585
North West	77	15	14	13	0	0	8	8	136
Northern Cape	7	50	2	73	3	2	2	2	140
Western Cape	232	431	455	494	526	1 047	793	647	4 624
Total (Mn ZAR)	**3 227**	**2 951**	**2 983**	**2 901**	**1 953**	**2 143**	**1 705**	**1 949**	**19 813**

Source: Authors calculations with financial data from (National Treasury, multiple)

Together, wealthier Gauteng and Western Cape, and the most populous KwaZulu-Natal account for three-quarters (76 percent) of the total amount of discretionary IDP spending during the last 8 years, and 51 percent of the children aged 5 to 17.

[20] See the annual Budget Review Annexure W1 for the formula (Department of National Treasury, Republic of South Africa, 2021).

[21] The Infrastructure Development Programme is composed in DBE audited financial statements of "*Earmarked and specific funds*" and "*Voted funds discretionally*"

There are substantial differences across provinces in complementing EIG funding with IDP. Figure 29 compares the funding by provinces for school construction with IDP to their EIG. Although the national average is 27 percent, the difference across provinces varies. In Gauteng, the provincial contribution through IDP is equivalent to 69 percent of its EIG allocation during the last 8 years. This is consistent with its relative wealth, ability to raise its own revenues, higher share of children in private schools (13 percent versus the national average of 5 percent) and resulting less generous central funding. Northern Cape, North West and Free-State, however, have accessed relatively few IDP resources to fund school construction. KwaZulu-Natal and Mpumalanga have used a substantial part of their Equitable Share to complement their EIG for school construction in line with the national average (DBE, 2022).

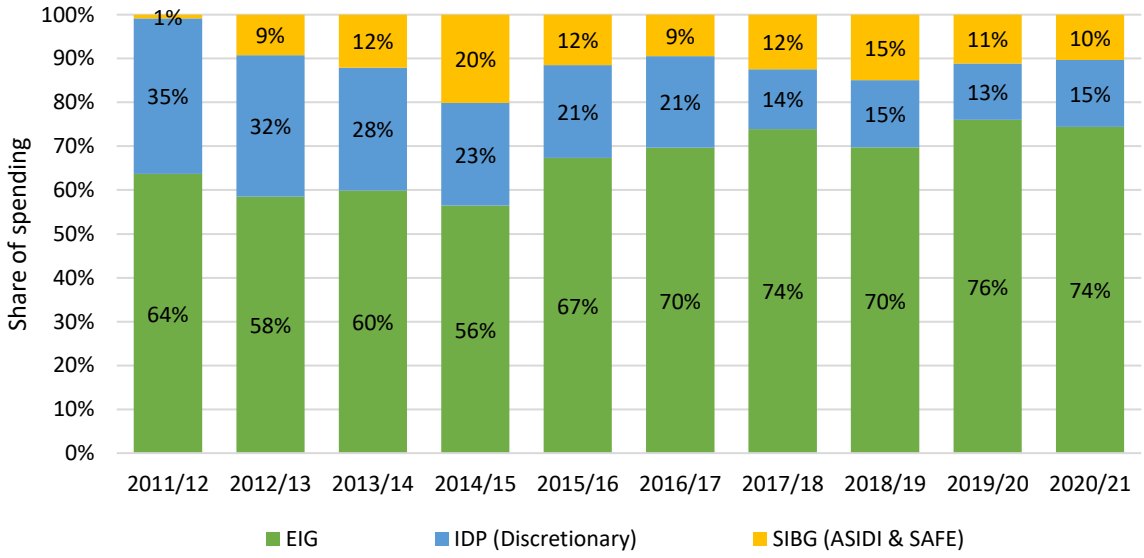


Figure 29: Discretionary provincial funding from the equitable share for school construction compared to the EIG and central government managed funds

Source: Authors' graph with data from national (National Treasury, multiple), (National Treasury, 2015), and (National Treasury, 2021)

6.2 National funding of construction through SIBG and SAFE

The School Infrastructure Backlog Grant (SIBG) funds the ASIDI programme which was created in 2011 and has been operational since 2012 (DBE, 2011) (DBE, ASIDI, 2013). It is set to be absorbed into the provincially managed EIG from the 2023-24 budget (Department of National Treasury, Republic of South Africa, 2021). ASIDI was introduced in parallel to the EIG and in response to the 2011 court action on the issue of so-called 'mud schools,'[22] and it specifically aimed to support the eradication of all mud schools/inappropriate structures. Purportedly, to ensure the "accelerated" nature of this response, it was decided that SIBG will be centrally managed by DBE, as opposed to EIG that is managed by the provinces. SIBG funding supports school construction to replace schools identified in 2011 that were entirely built from non-standard materials such as mud, wood, or other non-durable materials, and those schools that have never had provision for water, sanitation, or electricity. The number of schools up for replacement was initially estimated at 492 schools (

Table 15) and later increased to 510 schools in 2012-13 (Parliamentary Monitoring Group, 2012). The biggest focus of the ASIDI was to be in the Eastern Cape which had more than 85 percent of the schools with inappropriate structures.

Table 15: The initial ASIDI programme

ZAR millions	Inappropriate Material	Schools with no	Schools with no Sanitation	Schools with no Water	Total	
Eastern Cape	424	317	345	619	1 705	54 %
Free State	30	129	26	99	284	9 %
Gauteng	2	2	21	0	25	1 %
KwaZulu-Natal	3	116	139	229	487	15 %
Limpopo	3	141	77	121	342	11 %
Mpumalanga	5	129	8	17	159	5 %
North West	2	41	33	13	89	3 %

[22] On February 2011, the court action of the Legal Resource Center (on behalf of 7 schools) and the Center for Child Law mandated commitment from DBE commitment to eradicate 'mud schools' in the country between 2011 and 2014 (Abdoll & Barberton, 2014)

ZAR millions	Inappropriate Material	Schools with no	Schools with no Sanitation	Schools with no Water	Total	
Northern Cape	1	0	19	6	26	1 %
Western Cape	22	7	21	3	53	2 %
South Africa	**492**	**882**	**689**	**1 107**	**3 170**	**100 %**

Source: (Parliamentary Monitoring Group, 2012)

The SAFE initiative, which was introduced in 2018, complements the SIBG and funds ASIDI for the sanitation part. SAFE is also managed by DBE and dedicated to eradicating traditional pit latrines and other forms of unacceptable sanitation. Budgets and expenditure of SAFE and SIBG are recorded together in the Division of Revenue Act (DORA) and Basic Accounting System (BAS) documentation.

SIBG and SAFE spending has been a total of ZAR 14.5 billion over the last 10 years and is considerably smaller in amount compared to what the provinces spend through the EIG and IDP. After the initial two years, the annual expenditures fluctuated between ZAR 1.3 billion and a maximum of ZAR 2.5 billion (see Table 16)[23].

Table 16: SIBG and SAFE budget from 2011-12 to 2020-21

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	10 years
Eastern Cape	-	-	-	1 598	1 084	1 492	1 159	1 742	1 362	1 094	9 531
Free State	-	-	-	515	478	237	657	113	77	52	2 129
Gauteng	-	-	-	13	11						24
KwaZulu-Natal	-	-	-	183	138	107	15		245	790	1 478
Limpopo	-	-	-	77	104	83	317	117	136	333	1 167
Mpumalanga	-	-	-	106	129	83	15			136	469
Northern Cape	-	-	-	16	34	24					74

[23] Management expenditures of DBE are included in the 'unallocated' category.

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	10 years
North West	-	-	-	33	68	36	17	1	9	70	234
Western Cape	-	-	-	-	-						0
Unallocated	700	2 065	1 956	-	-	119	0	239	158	-60	5 177
South Africa	**700**	**2 065**	**1 956**	**2 541**	**2 047**	**2 181**	**2 180**	**2 212**	**1 987**	**2 415**	**20 284**

Source: Table by authors with data from DORA (Government of South Africa, 2021)

Given the overall funding available of ZAR 20.3 billion over the last 10 years (Table 16), and the actual expenditures of ZAR 14.5 billion over the same period (Table 17), only 71 percent of the available budget has been used, this being indicative of the limited implementation capacity. The section on infrastructure conditions in existing schools makes the case that ASIDI has been slow to implement, whereas the SAFE initiative seems to be moving at a faster pace thus far.

Table 17: SIBG and SAFE actual expenditures from 2011-12 to 2020-21

In Mn ZAR	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	10 years
Eastern Cape	-	-	378	1 348	1 016	647	952	1 573	1 041	818	7 773
Free State	-	-	90	527	187	169	366	118	27	35	1 521
Gauteng	-	-	-	9	3	1	0	0	0	0	14
KwaZulu-Natal	-	-	66	157	56	62	45	30	21	114	551
Limpopo	-	-	3	107	28	88	252	227	106	107	919
Mpumalanga	-	-	0	136	51	83	3	0	0	0	274
Northern Cape	-	-	0	30	10	0	0	0	0	0	40
North West	-	-	0	91	18	3	0	0	0	0	113
Western Cape	-	-	3	2	4	-2	0	0	0	0	7
Unallocated	76	860	853	135	248	265	167	138	278	251	3 271
South Africa	**76**	**860**	**1 392**	**2 543**	**1 622**	**1 316**	**1 786**	**2 086**	**1 474**	**1 326**	**14 482**

Source: Author's calculations with data from (National Treasury, multiple)

Total expenditure on school construction and maintenance over the last 10 years totalled more than ZAR 124.5 billion from EIG, IDP, SIBG and SAFE. The total spending increased by nearly 50 percent from ZAR 8.7 billion in 2011-12 to ZAR 12.8 billion in 2020-21, with a high of approximately ZAR 14 billion between 2015-16 and 2018-19 and a quasi-stagnation from 2015-16 to 2020-21. During this period, EIG accounted for nearly 70 percent of all infrastructure related expenditure, IDP about one fifth, while ASIDI and SAFE accounted for about a tenth (See

Table 18).

Table 18: Consolidated table of all main sources of school construction public funds

In Mn ZAR	EIG	IDP & CC (non-EIG)	SIBG &SAFE	South Africa
2011-12	5 539	3 079	76	**8 695**
2012-13	5 454	3 010	860	**9 323**
20130-14	6 906	3 227	1 392	**11 525**
2014-15	7 127	2 951	2 543	**12 622**
2015-16	9 497	2 983	1 622	**14 103**
2016-17	9 673	2 901	1 316	**13 890**
2017-18	10 604	1 953	1 786	**14 344**
2018-19	9 745	2 143	2 086	**13 975**
2019-20	10 061	1 705	1 474	**13 240**
2020-21	9 526	1 949	1 326	**12 801**
Total 10 years	**84 133**	**25 902**	**14 482**	**124 517**
	68 %	**21 %**	**12 %**	**100 %**

Sources: Authors tables No 2, 3, 4 and 5 (National Treasury, multiple)

The equivalent value in USD consistently declined from the peak in 2013-14 to 2020-21 with a final value lower than the 2011-12 equivalent value (see Figure 30). This evolution partly explains the substantial escalation rate of construction cost in South Africa, and the increasing tension between the construction needs and the fiscal space.

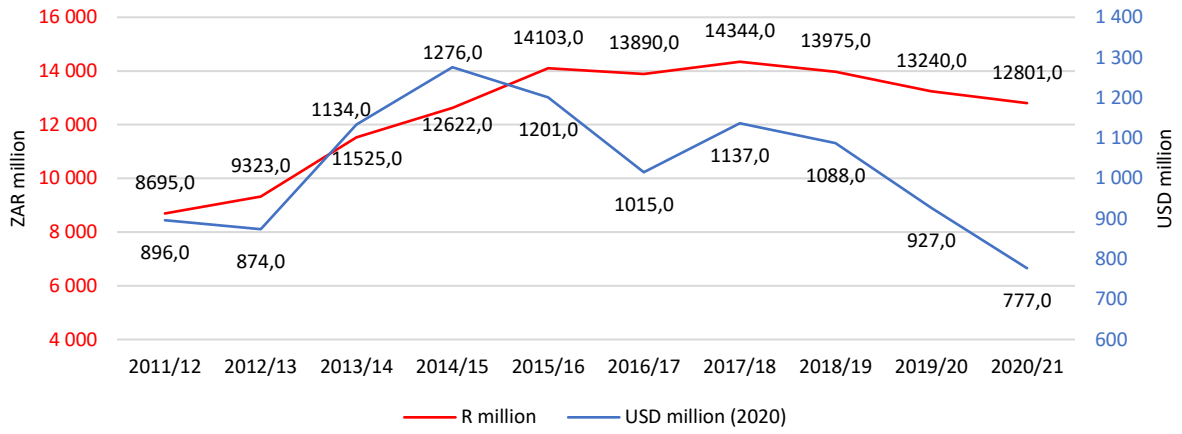


Figure 30. Evolution of the total school construction funding during the 10 year-period

Source: Authors' graph with data from (National Treasury, multiple)

The distribution of total school construction and maintenance funds across provinces during the last 10 years shows that KwaZulu-Natal has the received the most funds (20 percent of the total), followed by Eastern Cape (18 percent), Gauteng (14 percent) and Western Cape (12 percent). Table 19 provides the distribution of the total funding between provinces.

Table 19: Distribution of total school construction and maintenance funds from EIG, IDP, and ASIDI across provinces over last 10 years

R millions	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total 10 years	
Eastern Cape	921	994	1 937	2 448	2 174	2 213	2 735	3 288	2 621	2 040	21 371	17 %
Free State	497	531	519	1 020	947	705	1 235	765	863	855	7 938	6 %
Gauteng	1 530	1 669	1 629	1 770	2 799	2 852	1 977	1 643	1 515	1 515	18 899	15 %
KwaZulu-Natal	2 197	2 696	2 538	2 382	2 658	2 655	2 621	2 404	2 779	3 050	25 978	21 %
Limpopo	1 221	564	1 171	1 413	1 106	1 132	1 349	1 182	743	1 103	10 984	9 %

R millions	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total 10 years	
Mpumalanga	598	660	714	916	1 093	908	903	1 226	1 241	921	9 180	7 %
Northern Cape	371	294	372	426	441	560	612	570	642	621	4 909	4 %
North West	550	304	738	670	1 083	1 028	1 070	689	638	869	7 639	6 %
Western Cape	734	751	1 057	1 441	1 554	1 571	1 675	2 069	1 920	1 576	14 348	12 %
Unallocated	76	860	853	135	248	265	167	138	278	251	3 271	3 %
South Africa	8 694	9 323	11 525	12 622	14 103	13 890	14 344	13 975	13 240	12 801	124 517	100 %

Source: Authors' addition of data from previous tables (EIG, IDP and SIBG-SAFE)

The national average spending on school construction per school-aged learner in the last 10 years is estimated to be ZAR 1 223 in real terms,[24] and the distribution across provinces shows important differences, ranging from ZAR 975 in Gauteng to ZAR 2 099 in Northern Cape (see Figure 31).

[24] Calculated by taking the ratio of funds invested in South Africa for school construction per school-age child/youth, and its breakdown by provinces in order to get a measure of inter-province equity.

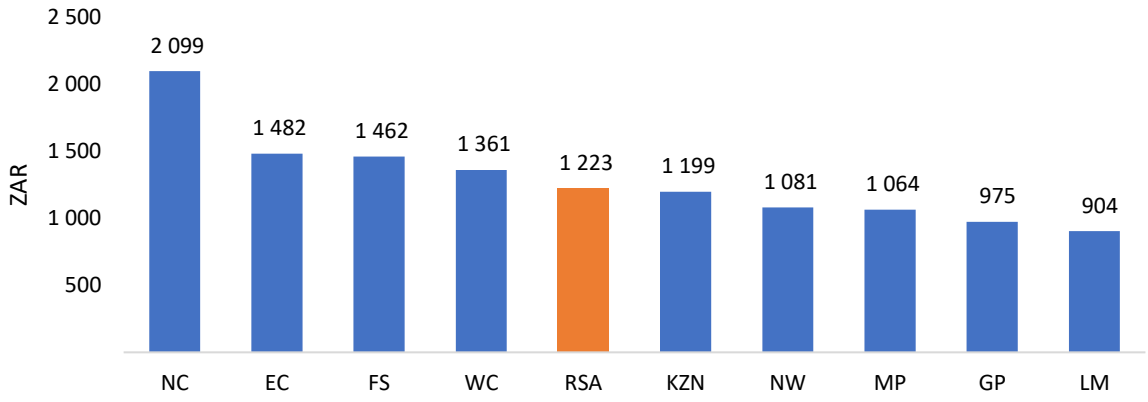


Figure 31: Annual average per 5-17 year old child-youth spent on school construction, 2-10-2020

Source: Author's calculations

Specifically, Northern Cape spent, per school-age child, 172 percent of the national average and about twice what Gauteng has spent during the last ten years. Eastern Cape and Free State spent one-third more than the national average primarily due to funding from the SIBG, while Limpopo trails the pack at a little over ZAR 900 per child. Given the stability in the share of the EIG over the last ten years, its contribution to the average spending per child has been inherently higher compared to the part taken up by discretionary IDP and SIBG and SAFE combined. Figure 31 illustrates the composition of the average spending per child, showing the inherent dominance of the EIG in the construction funding matrix.

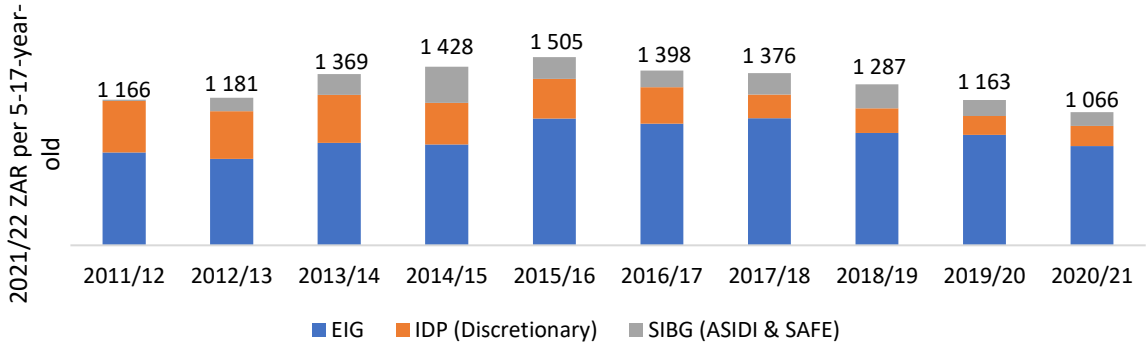


Figure 32: Evolution of spending in real ZAR per child, by management arrangement

Source: Authors' graph with data from (National Treasury, multiple)

Expenditure for school construction in South Africa over the 10 years – 2010-11 to 2020-21 – has totalled ZAR 124.5 billion (in 2020 prices), averaging USD 1.05 billion per year. International comparisons are, however, difficult because of a lack of similar corresponding data available in other countries. Even so, it is worth looking at how much other countries are spending on school construction. In the case of Rwanda, the country invested USD 250 million[25] in a two-year programme (2019-2021) and built 22 000 classrooms and 30 000 latrines aligned with good construction international standards (World Bank, 2021). By analogy, the USD 10.8 billion equivalent for school construction spent by South Africa during the last ten years would have translated into the construction of 550 000 classrooms – i.e., much more than the current stock of classrooms – and 750 000 latrines. It should be noted, though, that approaches to school construction vary across Rwanda and South Africa, with Rwanda introducing and implementing a 'home-grown school construction approach' that utilizes organized communities to construct in alignment with high quality standards. The South Africa Government has shown commitment to addressing the issue of school infrastructure development by directing substantial financing to it, but the implementation of the various school infrastructure programmes has been slower than envisaged and costly.

6.3 Operational expenditure in basic education

Given that any upgrade or expansion of education infrastructure would require a concurrent increase in operations and maintenance costs of the additional facilities and potentially an increase in the number of teachers required if the policy is not to increase the prevailing student to teacher ratio, this sub section highlights the recurrent expenditure in basic education – focusing on the volume of resources spent directly at schools on the one part and administration costs on the other. This will be critical in subsequent sections for making choices on the feasibility of the upgrade or expansion. Operational costs, mainly recurrent expenses, include staff salaries and other non-salary expenditure (goods and services, operations and maintenance, subsidies etc.).

[25] Half of the funds (USD 125m) was provided by the domestic budget and the other half (USD 125m) by the World Bank, both under the Rwanda Quality Basic Education for Human Capital Development Project (World Bank, 2021).

Nearly half of the recurrent expenditure in basic education is on primary education, with only limited input on Grade R. In 2020, the government spent a total of ZAR 232.2 billion (see Table 20**Error! Reference s ource not found.**) on recurrent education programmes. ZAR 27.2 billion (or 12 percent) was spent in administration while ZAR 205 billion (88 percent) was spent directly in schools. Of the direct spending in schools, ZAR 4.5 billion was on Grade R; nearly ZAR 112 billion on primary; and ZAR 89 billion on secondary. In terms of the share, the spending on primary accounted for 48 percent of the recurrent spending and secondary education accounted for nearly 40 percent of the recurrent spending with only limited amounts associated with Grade R. Other important details from the spending shows that salaries and wages – at central and provincial administration, as well as schools – accounted for nearly 90 percent of the recurrent expenditure, leaving only a small complement for other recurrent expenditure, which include operations and maintenance.

Table 20: Recurrent spending in basic education, 2020

Level of expenditure execution	Salaries and wages (Mn ZAR)	Other recurrent expenditure (Mn ZAR)	Sub Total (Mn ZAR)	Percent of recurrent expenditure
Administration	16 270	10 934	27 204	11.7 %
Central	498	1 847	2 344	1.0 %
Province	15 773	9 087	24 860	10.7 %
				0.0 %
Spending at schools	**189 561**	**15 405**	**204 966**	**88.3** %
Grade R and Primary	109 358	6 915	116 273	50.1 %
Grade R	3 662	859	4 521	1.9 %
Primary	105 696	6 056	111 752	48.1 %
Secondary	80 203	8 490	88 693	38.2 %
Grand Total	**205 831**	**26 339**	**232 171**	100.0 %
percent of total recurrent expenditure	88.7 %	11.3 %	100.0 %	

Source: Authors' computation based on Expenditure data from the (DBE, 2021)

Teacher salaries rise with advancing levels of education, with a large pay gap between teachers in Grade R and those in primary and secondary. In 2021, the public wage bill for teachers is reported to have been ZAR 189 billion (see Table 21**Error! Reference source not found.**). Of this, ZAR 105.6 billion (more than 55 p ercent of the wage bill in basic education) was spent on teachers teaching primary, while 42 percent went to secondary. On average, each teacher earned ZAR 473 000 in 2020, ranging from a high of ZAR 529 000 for secondary school teachers to ZAR 157 000 in Grade R. In general, teachers in primary and secondary are fairly well remunerated, compared to their counterparts in SSA[26], with secondary teachers earning more than six times the per capita GDP (PCGDP) and their primary counterparts earning more than five times. Even within the country, the advantage between teachers in primary or secondary over those teaching in Grade R is glaring, primary teachers earning three times their counterparts in Grade R while those in secondary earn nearly four times as much.

Table 21: Teacher wage bill and salary, 2021

Phase of education	Wage bill (Million ZAR)	Average salary (ZAR)	As percent of PCGDP
Grade R	3 662	156 700	1.8
Primary	105 696	469 400	5.4
Secondary	80 203	529 300	6.1
Total	189 561	473 400	5.5

Source: Authors' computation based on Expenditure data from the (DBE, 2021)

7 UNIT COST OF CONSTRUCTION

This section highlights the background as well as the resulting unit cost for constructing facilities in schools. The unit cost is estimated for a square meter, such that at the point of application, the facility size prescribed in the norms and standards would yield the difference from one facility to another. From

[26] According to consolidated data from the International Institute of Education Planning (IIEP)-UNESCO Dakar, primary teachers in Sub Saharan Africa earn 3.7 multiples of the PCGDP while their counterparts in secondary earn 5.4 multiples (Office of Africa, Internatioanl Institute of for Education Planning , n.d.)

the onset, this report has stated that developing knowledge on the actual cost of school construction – and the average unit costs of each school facility – is a difficult task in South Africa. Tracking actual unit costs of school construction is neither a regular activity of the DBE at the national level nor the PDE at the provincial levels. Despite the delegation of implementation to IAs, developing knowledge based on actual costs of school construction is not an activity carried out by IAs that have been implementing school projects for DBE for the last 10 years (such as CDC and DBSA), or for PEDs (such as the provincial Departments of Public Works). Without systematic knowledge on the actual costs of school construction, it is challenging to assess the actual value for money obtained from the ZAR 124.5 billion Government investment in school construction over the last 10 years.

With support from the DBE, this study aimed to collect data from a wide range of stakeholders involved in school construction, but in the end received data from only six sources drawn from seven provinces as shown in Table 22. The main sources of information are two State-Owned Enterprises (CDC and the DBSA) working with DBE as IAs for the construction of the schools funded by ASIDI. For these two sources, the average unit costs of a fully furnished classroom[27] are statistically robust, confirmed by the parameters estimated from a regression model estimating the costs[28] (see

[27] A classic classroom in this context is defined as a 60 square meter built with concrete floors, cement or brick walls, rooves made of modern materials. The classroom is furnished with relevant furniture and has a capacity of 40 learners.

[28] Regression analysis on DBSA dataset. Number of observations: 160; R2: 0.596; Sig: 0,000

Table 22). For DBSA, the validity of the result of the regression analysis is supported by the evidence of the average unit cost directly calculated on a sample of 10 well detailed contracts. Unit costs of CDC and DBSA are approximately of the same magnitude (USD 143 500 (ZAR 2.2 million) and USD 109 300 (ZAR 1.7 million) respectively per classroom).

Other unit costs for Mpumalanga, Gauteng and Western Cape provinces are based on one contract in each province, though the resulting unit costs of classrooms across provinces falls in the same range (USD 40 500 (ZAR 600 000) – USD 57 200 (ZAR 900 000) per classroom). See Annex 3 for workings on unit costs.

Table 22: Summary of the cost-data collected, and results as regards unit costs of classrooms

Province	Organization	Responsibility	Source of information	Detail on information	Date	Method	Unit cost per classroom (USD 2020)
Eastern Cape	CDC	Implementing Agent for DBE	Database comprising 51 contracts for small to large schools	Total cost of contract and detailed distribution of facilities (classrooms, latrines, etc.,) but no unit cost per facility	2012-2019	Regression analysis	143 500
Eastern Cape and Free State	DBSA	Implementing Agent for DBE	Database comprising 130 contracts for small to large schools	Total cost of contract and detailed distribution of facilities (classrooms, latrines, etc.,) but no unit cost per facility	2011-2020	Regression analysis	109 300
			10 school contracts. All large schools (average 14 classrooms)	Detailed cost data for each block, and related areas	2016-2018	Direct calculation	118 000
Eastern Cape	Department of Education	Funding entity	UAMP	Detailed estimation for budget purpose	2019	Direct calculation	53 500
Mpumalanga	DPWRT (Public Works)	Implementing Agent for PED	1 contract for large school Kufakwezwe Secondary School	Detailed cost data for each block, and related areas	2019	Direct calculation	40 500

Province	Organization	Responsibility	Source of information	Detail on information	Date	Method	Unit cost per classroom (USD 2020)
Gauteng	Infrastructure Development	Implementing Agent for PED	Contract for large school Rethabiseng School	Detailed cost data for each block, and related areas	2015	Direct calculation	48 500
Western Cape	Jakes Gerwel Trust	Self-Implementer	Mega-large school Jakes Gerwel Technical School	Detailed cost data for each block, and related areas	2018	Direct calculation	57 200

Sources: Authors' calculations based on data provided by concerned entities

Two ranges of actual unit costs emerge from this analysis. The unit costs are from actual contracts, actualized to 2020 using the Contract Price Adjustments Provisions (CPAP) standard escalation rate (Association of South African Quantity Surveyors, 2022), and converted to 2020 prices to align with other baseline measures used in the study, including enrolments. The costs include all construction costs, i.e., the cost of the building itself and the prorated cost of external works, as well as taxes (Value added tax). The details of the methodologies used to calculate these unit costs are available in a background note detailed in Annex 3. Figure 33 illustrates these results with two ranges of unit costs detailed as follows:

- A high range of actual unit costs, averaging the equivalent of USD 119 000 (ZAR 1.8 million) per classroom (value 2020). This group is composed of large construction programmes centrally managed by DBE and implemented by IAs, which are large SOEs. They include a large number of projects and span a wide range of project sizes from micro-schools to mega-schools.
- A low range of actual unit costs, averaging the equivalent of USD 48 800 (ZAR 700 000) per classroom (value 2020). This group is composed of large construction projects managed either by the PEDs and implemented by provincial IAs such as the DPWs, or by the SGB, through the SGB-based trust fund.

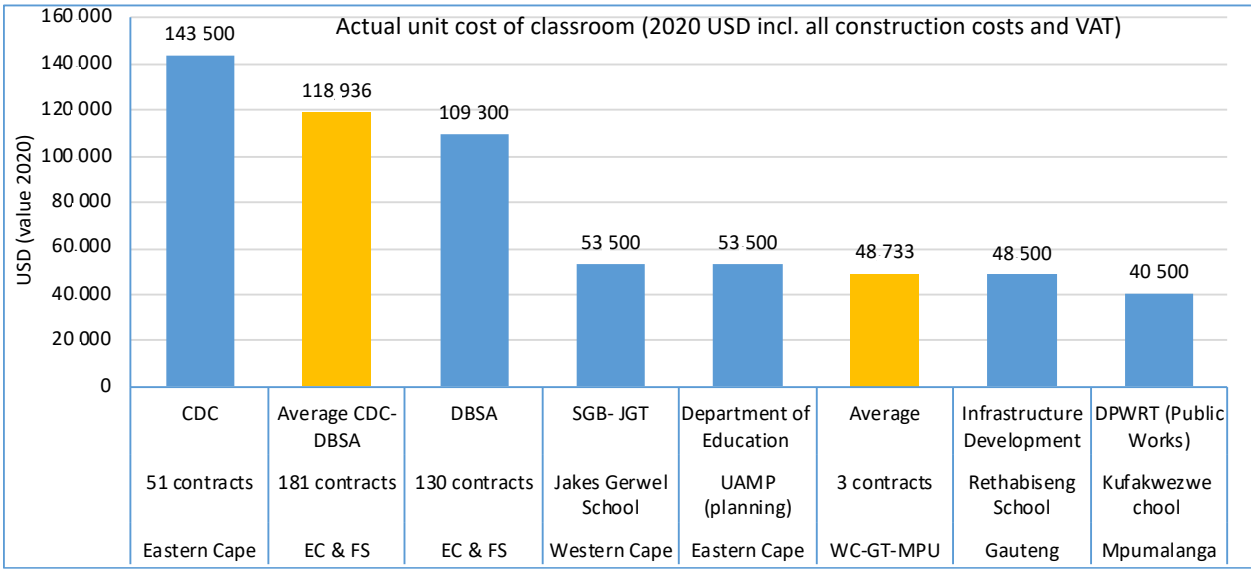


Figure 33: Unit cost of classrooms in South Africa, 2020 USD prices incl. VAT

Source: Authors' graph with data from Table 20

The composition of the actual unit cost of classrooms in Figure 34 shows that a substantial part of the cost is due to the external works[29] that account for 60 percent of the building cost of the classroom including electricity and all other costs in addition to the building cost. Despite its magnitude, the cost of external works is not always factored into the estimated unit cost database used by some provinces for budget purposes, for instance in the detailed cost assumptions of the 2020-21 UAMP of Eastern Cape province (Department of Education, Province of Eastern Cape, 2019), making it difficult to plan a reliable budget for the school construction programme.

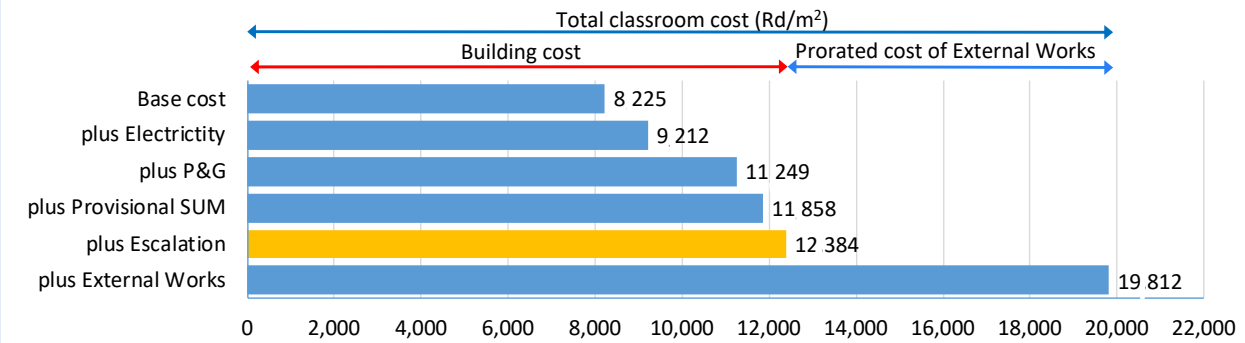


Figure 34: Detailed composition of the unit cost of classroom

Source: Author's graph with data from DBSA[30]

The regression analysis on CDC and DBSA projects implemented at the central level reveals an average of USD 125 660 (2020 prices) (ZAR 1.9 million) for every complete classroom delivered. Additional information from the considered contracts shows that delivering a classroom at the province is about 41 percent of the centralized cost, while a classroom delivered by the community costs about 60 percent of the provincial cost. The norms and standards for school facilities prescribes that a classroom should cover

[29] External works are described as: "All items outside the building footprint but inside the site boundary, encompassing wastewater and surface water drains, supply of utilities (e.g. gas, electricity and cabled services), footpaths, and access for vehicles including car parks and hard standings to be found in the vicinity of buildings." (BRE, 2020)

[30] Average cost-compositions form detailed cost of 10 contracts implemented by DBSA

60 square meters, this implying that construction of a classroom would need ZAR 31 700 per square meter at the central level, ZAR 13 000 per square meter at the province and ZAR 7 800 per square meter if the classroom were to be delivered by a community initiative (

Table 23).

Table 23: Unit cost of classrooms, by implementation modality

Implementation modality	USD/ Classroom	ZAR/ Classroom	ZAR / Square meter
Centralized	125 660	1 902 000	31 700
Provincial	51 500	780 000	13 000
Community	30 900	468 000	7 800

Sources. Authors' computations with data from CDC, DBSA, JGT, EC-DoE, ID-Gauteng and DPWRT Mpumalanga

The cost of infrastructure is high in South Africa, especially on construction and external works, and this may be prohibitive in meeting the needs of the country in pursuit of universal participation in learning. The next section will consider a raft of options that can be selected in addressing infrastructure needs in the country. That said, the country can also consider technological advancement to lower the cost of delivering infrastructure in the sector. Initiatives from the region show that significant costs can be cut by adopting technological modalities like 3 Dimension (3D) printing (see Box 9 for details on how 3D printing can revolutionize infrastructure development).

Box 7: Is 3D printed construction technology a game changer?

The world's first 3D-printed classroom was printed in 2021 by *14Trees* in Malawi[1] followed by others in Kenya and Zimbabwe. A 3D-printer for construction is a robot with an articulated printhead that pours lines of concrete, layer by layer, according to a 3D model in a computer (see Figure B7.1 and Figure B7.2 below). This construction technology is an "on-site prefabrication" because there is virtually no worker; wall construction is automated by a pre-programmed machine, and the material is processed on-site.

The material is a patented ready-made concrete mix, often proprietary to a cement producer (Masina, 2021).

Printing classroom walls can be fast (18 hours) and mason-free. However, some classic masonry work is still required to build the platformed floor and the robot's feet. In addition to the time savings, providers of 3D-printed classrooms claim 15-25 percent cost savings (excluding the cost of the printer).

1.1. General view of the 3D printer

1.2. The printhead in action

Figure B6.1: 3d printed classrooms in Malawi (2021)

Source: (14Trees, 2022)

3D-printed construction is the latest development in the history of prefabrication technology for construction. This history started at the end of the 19th century with American pioneers and developed in Europe during the 20th century along with the industrialization of all other sectors. At the beginning of the 21st century, although all other sectors of the economy have effectively industrialized, only the construction sector remains unindustrialized. There are still 3 million construction enterprises in the USA, and around half a million in any European country. The large majority (90 percent) are micro-, small- and medium- enterprises. The main reason for the construction sector's failure to industrialize is the higher competitiveness of small and medium construction enterprises (Theunynck, 2018)).

It is too early to forecast whether 3D printing will deliver better (by being faster and cheaper) than previous attempts at industrializing construction. However, the main objective of 3D printing technology is to lower labour costs by reducing the use of labour. This may make it unsuitable for South

Africa, where unemployment is a key social and economic issue. 3D printing is also dependent on access to printers, which is currently very limited, and their maintenance can be complex. Another unknown factor is whether there will be a reliable and cost-effective supply of the special patented concrete needed for 3D printing. With these unknowns, more analysis is needed before 3D printed classrooms can be recommended for South Africa.

Sources: (Masina, 2021) (Theunynck, 2018)

8 ESTIMATING THE COST OF UPGRADING AND EXPANDING BASIC EDUCATION TO MEET THE INFRASTRUCTURE DEMANDS FOR EDUCATION 2030

This section presents what the future of basic education is likely to look like, building on the present context discussed in Section 3, especially on enrolments and capacity of basic education and the objectives that the Government has committed itself to; factors that drive the need for additional infrastructure facilities in basic education, presented in Section 4; the cost drivers for infrastructure, elaborated in Section 5; the expenditure patterns on infrastructure and other school related operations highlighted in Section 6; and finally the unit costs for construction of school infrastructure as discussed in Section 7. Other elements that have been useful in shaping this section include the unit costs for delivering infrastructure projects at the three different approaches of implementation i.e. centralized, provincial and community approaches.

The report conceives the demand for additional spaces in basic education to be deliverable two components: (i) upgrading facilities in existing schools to bring them up to recommended or acceptable norms and standards, and (ii) expanding the network of schools in basic education, conditional on selected sector specific performance standards.

8.1 Upgrading of existing infrastructure

The first component in creating additional space in basic education will be the upgrading of existing infrastructure, which can transform some facilities, hitherto not in use, to a level which they can be used,

or increase their use. As seen from Section 4, the status of facilities in basic education schools shows that there is a lot of room for improvement.

Table 24, which highlights the list of facilities whose upgrade is considered necessary to conform to the desired norms and standards. According to administrative data from the DBE, only a handful of schools have computer rooms, libraries, laboratories, and servers, with this being prominent in the number of schools that will need these facilities. The subsector will need more than 15 600 computer rooms in primary, secondary and combined schools, nearly 17 000 libraries, 19 000 laboratories and almost 22 000 servers.

Table 24: Facilities that require upgrading in basic education

Facility	Primary	Secondary	Combined	Total need
Computer Room	10 630	3 232	1 746	15 608
Library	11 293	3 579	1 961	16 833
Laboratory	13 200	3 463	2 378	19 041
Server	13 578	5 393	2 989	21 960
VIP toilet seats needed	75 326	37 851	10 622	123 799
Water (<25%)				2 292
Electricity (<25%)				1 956
Mud/Clay/Wood	467	1 743	198	2 408
Broken floor	437	2 920	897	4 254
Broken Ceiling	272	1 688	1 124	3 084

Source: (DBE, 2021) and Author's computation

The sector will also need a substantial number of toilet seats, to raise the share of schools with at least a VIP toilet to 100%. Other areas include 2 300 schools that will need to have water supply fixed; and 2 000 schools that will need to have their access to electricity stabilized throughout the period schools will be in session. It will be necessary to stabilize the supply of each of these utilities in the affected schools, considering that both utilities are linked not only to improved learning environment, but they also create a conducive environment for school attendance. The upgrade would also be an opportunity to phase out some materials used in constructing existing facilities, which are conventionally considered weak and

attract high maintenance costs. Classrooms constructed from mud, clay, or wood, as well as those with broken floors and ceilings, would be replaced during the upgrade. In total 2 400 classrooms in mud would be replaced, and renovation in nearly 4 300 classrooms would see the floor fixed, and ceiling in almost 3 100 classrooms restored.

In terms of implementation, this component considers three possible options, which are founded on the assumption that the Government may not have adequate resources to address all the backlog. The authors have therefore considered three implementation options contemplating a situation where all the upgrade needs would be met and two others where the needs would be met only partially. In the first option (see Table 25), if all the needs identified in Table 24 were to be upgraded, the sector would need to spend ZAR 93.2 billion. The second option would address 100 percent of toilets needs, electricity, water, replacing of mud classrooms, floors, and ceilings; and 70 percent of the needs on computer rooms, libraries, laboratories, and servers, which is projected to cost the country ZAR 68 billion. The third and last would deliver 50 percent of the needs on computer rooms, libraries, laboratories, and servers; and 100 percent of the rest, which will cost the country ZAR 51 billion. Given the disparity in the quality of infrastructure in schools, the study recommends that the upgrade be carried out in the medium term .i.e. 3-5 years to ensure all learners have similar learning opportunities and that these opportunities are available without too much time lag. It is also important to note that the combinations in the three options are not cast in stone and that additional options can be generated depending on the perceived sensitivity of the needs of the selected facilities.

Table 25: Cost of upgrading facilities in basic education

Facility	Area covered (Adjusted to classroom – Sqm)	Coverage			Unit Cost per facility (ZAR)	Total cost of upgrade (Million ZAR)		
		Option 1	Option 2	Option 3		Option 1	Option 2	Option 3
Computer Room	99	100 %	70 %	50 %	1 287 100	20 100	14 100	10 000
Library	168	100 %	70 %	50 %	2 182 400	36 700	25 700	18 400

Facility	Area covered (Adjusted to classroom – Sqm)	Coverage			Unit Cost per facility (ZAR)	Total cost of upgrade (Million ZAR)		
		Option 1	Option 2	Option 3		Option 1	Option 2	Option 3
Laboratory	99	100 %	70 %	50 %	1 287 100	24 500	17 200	12 300
Server	10	100 %	70 %	50 %	130 000	2 900	2 000	1 400
Toilet seats	4	100 %	100 %	100 %	26 000	3 200	3 200	3 200
Water (<25%)	-	100 %	100 %	100 %	500 000	1 100	1 100	1 100
Electricity (<25%)	-	100 %	100 %	100 %	1 000 000	2 000	2 000	2 000
Mud/Clay/Wood	60	100 %	100 %	100 %	779 700	1 900	1 900	1 900
Broken floor	6	100 %	100 %	100 %	78 000	300	300	300
Broken Ceiling	12	100 %	100 %	100 %	155 900	500	500	500
Grand Total (Mn ZAR)						**93 200**	**68 000**	**51 100**

Source: Author's computation based on available unit cost data

8.2 Simulations to inform expansion of basic education

This second component of addressing the infrastructure needs employs simulation modelling to establish needs and costs of expanding basic education. Simulation models are planning tools that use available data to project future possibilities based on selected policy assumptions. The simulation model for this study gives the effects of selected policy options on outputs (enrolments, teachers, classrooms) and associated costs. The simulation model is built in Microsoft Excel that accompanies this report. Alongside the model, a navigation guide is provided in Annex 4 to help users manoeuvre through the model. The guide will help users in the manipulation of parameters (or policy options) if there is need to generate additional expansion scenarios. The simulation model is made flexible so that policymakers can change parameters (e.g. assumptions in terms of population growth, unit costs, norms and standards, SCR etc.), and be able to estimate how these changes would impact on the output and costs.

Given the status of basic education system discussed above, it is evident that there is a necessity for expansion to ensure more eligible children can attend school. This section presents expansion scenarios considered by the authors, discusses the policy choices driving the expansion, the demand that those choices are likely to create, as well as the cost associated with each set of policy choices.

There are three scenarios in the simulation model, including (i) a baseline scenario, (ii) a scenario with all the baseline parameters, except for improved access to school and learning experience, and is hereafter called the full access scenario, (iii) a scenario with all the parameters considered in the full access, as well as reduced repetition in primary and upper secondary, and is herein after referred to as the full access with efficiency scenario. As introduced in the methodology, the BtG assesses how endogenous factors would play out in different exogenous environments, and so the authors tested sensitivity of the full access with efficiency scenario on alternative population and economic growth profiles. The highlights of these scenarios are presented in Table 26, with specific modelling parameters and results of each scenario discussed in the subsequent sub sections.

Table 26: Policy assumptions driving the different scenarios

Option/Scenario	Objectives/Assumptions driving the option/scenarios
Scenario 1: Baseline	• Population growth profile without migration • Economy growing at 2.21% • All education indicators remain at baseline • Maintaining the share of recurrent non-salary costs at 8%
Scenario 2: Full Access	• Population growth profile without migration • Economy growing at 2.21% • Improving endogenous education indicators: Increasing Gross Enrolment Ratios at all levels of Education (100% in Grade R, primary, and lower secondary, 90% in upper secondary); Improving Student Teacher Ratios (Maximum of 34 in grade R and primary, and 31 in secondary); and improving class sizes (Maximum of 38 in grade R and primary, and 35 in secondary) • Maintaining the share of recurrent non-salary costs at 8%

Option/Scenario	Objectives/Assumptions driving the option/scenarios
Scenario 3: Full access with efficiency	• Population growth profile without migration, with sensitivity tests for alternative population growth profiles (World Bank based on Stats SA, urban and rural projection) • Economy growing at 2.21% (with sensitivity tests for alternative growth rates) • Improving endogenous education indicators: Increasing Gross Enrolment Ratios at all levels of Education (100% in Grade R, primary, and lower secondary, 90% in upper secondary); Improving Student Teacher Ratios (Maximum of 34 in grade R and primary, and 31 in secondary); and improving class sizes (Maximum of 38 in grade R and primary, and 35 in secondary); Reducing repetition in primary and senior secondary; creating incentives for private pre-primary education • Improving the share of recurrent non-salary costs from 8% to 10%

Source: Authors' framework

8.2.1 Scenario 1 – Baseline: Expansion driven by growth in the population of eligible children (– "Business as usual")

This scenario is primarily driven by the assumption that future expansion of Grade R-12 education will be driven by population growth, and that education specific parameters will remain more or less similar to the values recorded in 2020 (the baseline). Thus, the baseline scenario can be qualified as "business as usual". In 2020, 14.1 million children (or nearly one quarter of the country's population) were estimated to be eligible for basic education. This population is projected to grow by nearly 9 percent over the decade to 15.3 million. This means that by 2030, basic education sector would need to have created space for more than 1.2 million additional children entering Grade R, primary and secondary education if all of them are to be in school (see

Table 27).

Table 27: Evolution of school-age population (thousands), baseline scenario, 2020-2030

Year	Grade R	Primary	Secondary	Total
2020	1 169	7 975	4 955	14 099

Year	Grade R	Primary	Secondary	Total
2021	1 166	8 001	5 033	14 200
2022	1 162	8 028	5 113	14 303
2023	1 159	8 056	5 195	14 410
2024	1 156	8 086	5 278	14 520
2025	1 153	8 117	5 363	14 633
2026	1 150	8 149	5 449	14 748
2027	1 147	8 183	5 538	14 868
2028	1 144	8 218	5 628	14 990
2029	1 141	8 254	5 720	15 116
2030	1 139	8 360	5 814	15 313

Source: Authors' computations based on population from (World Bank, 2021)

Notwithstanding the overall growth in the number of children eligible for primary and secondary education, the population associated with Grade R is projected to decline 2.6 percent due to falling number of births – a phenomenon that has characterized African fertility rates in the last half a century. Children eligible for primary education will increase by 5%, while those eligible for secondary are projected to have the highest growth, increasing by more than 17 percent during the decade, and will inherently have highest demand for expansion compared to other levels of education. Apart from the change in population and the school-age population, all other education parameters including GER, share of learners in public school, student teacher ratios, average class size, share of recurrent non-salary expenditure will remain at their baseline levels.

Future enrolments under the baseline scenario

Even though education parameters are set to remain at their baseline levels under the baseline scenario, enrolments will increase due to the growth in the population of children and youth eligible for basic education. Based on the projected population and the baseline GER in respective levels of education (see Figure 6), the authors estimated that the total enrolment in basic education for both public and private schools will increase to 14.5 million in 2030, a 7 percent growth between 2020 and 2030. In public schools,

enrolments will reach 13.5 million learners, a net addition of more than 928 000 children and youth during the decade. The number of learners in public schools will evolve as shown in Table 28 for respective levels of education. Although enrolments in primary and secondary are projected to grow, pre-school enrolment will likely decline following the decline in the number of children eligible for this level of education. In each province, the present capacity of public pre-school is fixed so that any additional learner coming to pre-school would be benefit from the existing capacity of private schools, especially in Gauteng, KwaZulu Natal and Western Cape provinces.

Table 28: Future enrolment by level of education under the baseline scenario

	Public				All schools	percent public
	Grade R	Primary	Secondary	Sub total		
2020	760	7 293	4 479	12 532	13 543	92.5%
2021	757	7 312	4 547	12 616	13 629	92.6%
2022	754	7 332	4 614	12 699	13 718	92.6%
2023	751	7 353	4 682	12 785	13 810	92.6%
2024	748	7 375	4 752	12 874	13 904	92.6%
2025	745	7 398	4 823	12 965	14 002	92.6%
2026	742	7 422	4 895	13 059	14 102	92.6%
2027	739	7 447	4 969	13 155	14 204	92.6%
2028	736	7 474	5 044	13 254	14 310	92.6%
2029	734	7 501	5 121	13 356	14 419	92.6%
2030	731	7 530	5 199	13 460	14 530	92.6%

Notes: Enrolments presented in thousands

Source: Authors' computations based on *(DBE, 2020)*

Teachers required in public schools under the baseline scenario

The additional learners will trigger the need for additional teachers, who are to ensure that learning experience is sustained despite the expansion. Experiences from implementation of fee-free policies across Africa at the beginning of the millennium indicate that the influx of learners in schools was never met with commensurate resources, whether in terms of teachers, or infrastructure (Marishane, 2013);

(Essuman, 2018). Important indicators like STR were never controlled to ensure learning experience existing before the policy changes was sustained after the huge influx of learners. In this scenario, the STR is deliberately controlled at the current levels (33:1 in Grade R; 32:1 in primary; and 30:1 in secondary). Sticking to these ratios would mean that the government will need to hire additional teachers and increase the stock from 400 000 in 2020 to 431 300 by 2030; i.e., more than 31 000 additional teachers within the decade, including 7 200 teachers in primary and 24 800 teachers in secondary, evolving as shown in Table 29. In pre-school, the declining learner numbers and the fixed teacher ratios will see the size of teaching staff drop by nearly 900 teachers.

Table 29: Future teachers in public basic education schools in the baseline scenario

	Reception	Primary	Secondary	Total
2020	23 273	225 182	151 539	400 093
2021	23 176	225 757	153 875	402 906
2022	23 082	226 364	156 185	405 725
2023	22 990	227 003	158 540	408 624
2024	22 900	227 674	160 941	411 605
2025	22 812	228 379	163 388	414 667
2026	22 727	229 118	165 884	417 814
2027	22 644	229 891	168 429	421 047
2028	22 563	230 699	171 025	424 368
2029	22 485	231 544	173 672	427 779
2030	23 273	232 425	176 371	431 281

Source: Authors' computations based on (DBE, 2020)

Under the assumptions for this scenario, basic education will require 3 500 additional teachers annually, majority of whom will be needed in Gauteng and KwaZulu-Natal provinces. Notably, provinces like Eastern Cape and Free State, which have low learner to teacher ratios on average, will require no additional teachers overall at any time in the expansion period (see Table 30).

Table 30: Additional teachers in education, by province and year, baseline scenario

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gauteng	1 477	1 477	1 477	1 477	1 477	1 646	1 646	1 646	1 646	1 646
KwaZulu-Natal	906	906	906	906	906	960	960	960	960	960
Mpumalanga	107	107	107	107	107	124	124	124	124	124
North West	665	665	665	665	665	765	765	765	765	765
Western Cape	186	186	186	186	186	210	210	210	210	210
Total	**3 341**	**3 341**	**3 341**	**3 341**	**3 341**	**3 705**	**3 705**	**3 705**	**3 705**	**3 705**

Source: Authors' computations based on (DBE, 2020)

Classrooms required in public schools under the baseline scenario

Given the assumption to maintain the class sizes recorded in 2020, additional learners in basic education will need additional classrooms, which will increase from the 361 500 recorded in 2020 to 386 700 in 2030, translating to an additional 25 300 classrooms over the period. Majority of the additional classrooms (about 21 400) are projected to be required in secondary education schools, with only 4 800 projected to be needed in primary education schools. This scenario assumes that enrolment capacity of Grade R will remain the same, and that there will be no additional classrooms required nor any infrastructural development.

Table 31 highlights the evolution of classrooms between 2020 and 2030 for each level of education.

Table 31: Future classrooms in public basic education schools in the baseline scenario

	Grade R	Primary	Secondary	Total
2020	21 319	203 572	136 596	361 487
2021	21 210	203 925	138 625	363 761
2022	21 103	204 307	140 620	366 030
2023	20 999	204 716	142 652	368 367
2024	20 897	205 154	144 723	370 773

	Grade R	Primary	Secondary	Total
2020	21 319	203 572	136 596	361 487
2025	20 798	205 620	146 832	373 250
2026	20 701	206 116	148 982	375 799
2027	20 606	206 643	151 173	378 421
2028	20 513	207 199	153 405	381 118
2029	20 423	207 787	155 681	383 891
2030	20 335	208 407	158 000	386 742

Source: Authors' computations based on (DBE, 2020)

On average, the public will need to deliver more than 2 900 classrooms annually (see

Table 32), to meet the demand from the eligible children and youth. As seen earlier with teachers, the simulation shows that there will be no need for additional classrooms in Eastern Cape, Free State, Limpopo, and Northern Cape provinces.

Table 32: Additional classrooms in public basic education schools in the baseline scenario

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gauteng	1 160	1 160	1 160	1 160	1 160	1 293	1 293	1 293	1 293	1 293
KwaZulu-Natal	804	804	804	804	804	852	852	852	852	852
Mpumalanga	85	85	85	85	85	98	98	98	98	98
North West	569	569	569	569	569	654	654	654	654	654
Western Cape	165	165	165	165	165	187	187	187	187	187
Total	**2 782**	**2 782**	**2 782**	**2 782**	**2 782**	**3 084**	**3 084**	**3 084**	**3 084**	**3 084**

Source: Authors' computations based on (DBE, 2020)

Delivery of the additional classrooms is predicated on the existing guidelines on the size of public schools i.e., small, medium, and large schools, which come with 8, 15 and 30 classrooms respectively. The

additional classrooms estimated in Table 32 would therefore be delivered in terms of packages of schools, i.e., in terms of small, medium, and large schools. The authors assumed that 50 percent of the overall classroom demand would be for small schools – closer to where students live – 25 percent with medium, and another 25 percent with large schools (see

Table 33). For example, if there was need for 3 000 additional classrooms in a year, these classrooms would be delivered in a package of (i) 1 500 classrooms, accommodated in 188 small schools, this being the 50 percent of the total demand for classrooms; (ii) 750 classrooms, accommodated in 50 medium schools, each with 15 classrooms; and (iii) a final package of 750 classrooms, accommodated in 25 large schools, each with 30 classrooms.

Table 33: Translating the classroom demand to practical operations

Size of school	Number of classrooms	Share of classrooms
Small	8	50 %
Medium	15	25 %
Large	30	25 %

Source: Authors' computations based on (DBE, 2020)

In addition to the classrooms, schools need more than classrooms to be operational. The expected small, medium, and large schools would therefore be accompanied by selected facilities. For example, a small school with 8 classrooms will trigger the construction of an administration office, a computer room, a library, a multipurpose classroom, a sick room, principal's office, printing room, a science laboratory, staff kitchenette, staff room, strong room, eight regular toilets, and a toilet block for the disabled. Each of these facilities have standard constructed areas aligned to DBE's MNS. A standard classroom is expected to be 60 square meters, while a multipurpose hall is expected to be double the size of a classroom. The schedule of facilities and sizes relative to classrooms is presented in

Table 34.

Table 34: Additional facilities accompanying classrooms

Areas per Facility	Area (m^2)	Number of units		
		Small	Medium	Large
Classrooms	60	8	15	3-
Admin Office	20	1	1	1
Caretaker Room	12	-	1	1
Computer Room	60	1	1	1
Deputy Principal's Office	15	-	1	2
Food Garden	30	-	-	-
HOD Office	15	-	2	4
Library/Media Centre	60	1	1	1
Multimedia Centre	80	-	-	-
Multipurpose Classroom	60	1	1	1
Multipurpose Hall	120	-	1	1
Nutrition Centre	127	-	-	-
Dining Room	100	-	-	-
Food Storage	12	-	-	-
Kitchen	15	-	-	-
Pastoral Care Centre	30	-	-	-
Counselling Room	15	-	-	1
Sick Room	15	1	1	2
Principal's Office	20	1	1	1
Printing Room	15	1	1	1
Reception	15	-	-	1
Refuse Area	15	-	1	1
Science Laboratory	60	1	1	1
Security Room	4	-	-	-
Staff Kitchenette	12	1	1	1
Staff Room	60	1	1	1
Strong Room	10	1	1	1
Toilets	4	8	16	33
Disabled Toilets	4	1	2	2
Tuck shop	15	-	1	1

Source: Authors' computations based on (DBE, 2020)

Translating the classroom needs to schools under the baseline scenario, the government would need to construct more than 2 600 additional schools; i.e., 250 schools annually in the first half of the decade, and another 280 annually in the second half of the decade to fulfil the demand for additional space (see Table 35). Given the 50:25:25 ratio on the sharing of demand among small, medium, and large schools, the

government will need to construct 180 small schools annually in the first half of the decade, about 50 medium schools and about 25 large schools during the same period.

Table 35: Number of schools to be constructed under the baseline scenario by size

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Small schools	177	177	177	177	177	195	195	195	195	195
Medium schools	49	49	49	49	49	54	54	54	54	54
Large schools	25	25	25	25	25	28	28	28	28	28
Total	**251**	**251**	**251**	**251**	**251**	**277**	**277**	**277**	**277**	**277**

Source: Authors' computations based on (DBE, 2020)

Projected cost of expansion under the baseline scenario

Recruitment of additional teachers, sustaining administrative functions, and direct support to learners in schools will see recurrent expenditure increase by about ZAR 48.4 billion to ZAR 280.6 billion in 2030, translating to an increase of 21 percent relative to the recurrent expenditure recorded in 2020. The cumulative recurrent costs under the baseline conditions would total ZAR 2 341.1 billion, 46 percent of which would be directed to primary education schools.

Table 36 shows the breakdown of the recurrent costs, detailing how much is likely to be spent on administration on the one part and those that are likely to be spent at school level on the other, the latter case showing the distribution of the costs to the various levels of education. Notably, the recurrent spending will experience different increases in the various units. For instance, the projected cost on administration will increase by ZAR 9 billion (33 percent) when compared to the 2020 spending levels; Grade R spending expanding by ZAR 245 million (about 5 percent) – to accommodate increase in teacher salaries, given that there will be no additional teachers. Spending on primary will increase by nearly ZAR 15 billion (13 percent) while secondary is expected to increase by more than ZAR 24.4 billion (about 28 percent).

Table 36: Recurrent spending on the expanded education system in the baseline scenario

	Admin	Grade R	Primary	Secondary	Sub total
Baseline spending (2020)	27 204	4 521	111 752	88 693	232 171
Sector spending in 2030	36 267	4 767	126 421	113 109	280 565
Net additional from 2020	9 063	245	14 670	24 416	48 394
Cumulative spending (2022-2030)	291 728	41 975	1 082 281	925 100	2 341 084
Average spending 2022-30	32 414	4 664	120 253	102 789	260 120

Notes: Costs presented in Million ZAR

Source: Authors' computations based on (DBE, 2020)

The projected schools can be constructed using three implementation approaches, i.e., centralised, which would be overseen by the DBE; provincial, overseen by the PEDs/PPWs; or at the community level, overseen by SGBs. These different implementation levels have different unit costs per square meter, with a centralized approach costing ZAR 31 700 per square meter, ZAR 13 000 per square meter at the provincial level, and about ZAR 7 800 if implemented by the community. These unit costs are elaborated in Section 7 and Annex 3). Given the trend in the structure of past expenditure where only about 12 percent was executed at the central level, it is conceivable that the estimated capital costs will follow this pattern. This scenario accommodates the possibility of the share of capital costs executed at the central level rising to 20 percent, just about double the share of expenditure executed at the central level at baseline. Accordingly, the projected number of schools in Table 35 is likely to cost ZAR 75.6 billion, with ZAR 28.6.4 billion projected for execution at the central level and ZAR 47 billion in the provinces. Annually, the costs are projected to be average ZAR 3.2 billion at the central and ZAR 5.2 billion at the provinces, and relative to the projected recurrent costs, the cost of infrastructure expansion will be about 3.2 percent for both[31] levels of implementation (see Table 37).

Table 37: Capital spending on the expanded basic education under the baseline scenario

[31] The baseline scenario assumed that there will be no community approach in the construction of new schools.

	Total cost (2021-30)	Average annual cost		Percent of recurrent expenditure
		In Million ZAR	In Million USD	
Centralized (by DBE)	**28 632**	**3 181**	**210**	**1.2%**
Small	15 713	1 746	115	
Medium	7 499	833	55	
Large	5 420	602	40	
Provincial (by PEDs/PPWs)	**46 957**	**5 217**	**345**	**2.0%**
Small	25 769	2 863	189	
Medium	12 299	1 367	90	
Large	8 889	988	65	

Source: Authors' computations based on (DBE, 2020)

8.2.2 Scenario 2 – Full access: Growth in the population of eligible children and improving access to all levels of education as well as enhancing learning experience for teachers and students

This scenario builds on the baseline scenario, whose expansion was driven by population growth only. In the full access scenario, the population projection assumption is that there will be no significant migration between provinces. The economy will continue to grow at the baseline projection of 2.21 percent annually. In education, the policy choices will include increasing GER in grade R, primary and lower secondary to 100%, and this will mean that in provinces like Gauteng with a preschool GER of 71 percent the Government will have to put significant efforts to reach 100 percent. North West and Western Cape provinces with grade R GER of 93 percent and 92 percent respectively will have to put effort – even though not as much as Gauteng – to have all eligible learners in school. In primary, the efforts to increase coverage will be in Gauteng (97 percent), KwaZulu Natal (93 percent), Mpumalanga (96 percent), North West (89 percent) and Western Cape (85 percent). In these first two levels of education, the decade will allow for a gradual end to the catch up in provinces with GERs that are higher than 100 percent. The overage and underage will gradually reduce from the system and GERs in those provinces will converge to 100 percent. In junior secondary, the target of 100 percent GER by the end of the decade is anchored on the proposed creation of an incentive (an exit) at the end of lower secondary, which is likely to boost participation in

lower secondary education. This exit is founded on the understanding that students who would not be keen to continue the academic path may proceed to vocational training, having acquired a lower secondary certification. The optional exit after lower secondary would certainly trigger a decline in participation in upper secondary. The policy choice for access in upper secondary, as simulated by the authors, is to accommodate a decline in GER across all provinces, converging them to 90 percent. The second policy anchor is the improvement of teaching and learning experience through optimization of class sizes and student teacher ratios. This scenario sets the student teacher ratio in preschool and primary to a maximum of 34 and 31 for secondary. This means that in provinces with STRs higher than these maxima, recruitment of additional teachers will be triggered. For instance, the STR in Grade R for Limpopo would improve to 34 by the end of the decade, and similarly in primary. Given that the average STR in other provinces in these two levels are below the set maximum, the baseline ratios in such provinces were retained (see Table 38).

Table 38: Student teacher ratios in public basic education under the full access scenario

	Baseline			Projection		
	Grade R	**Primary**	**Secondary**	**Grade R**	**Primary**	**Secondary**
Eastern Cape	29.8	29.7	30.8	29.8	29.7	30.8
Free State	33.0	32.7	28.8	33.0	32.7	28.8
Gauteng	32.6	32.5	27.3	32.6	32.5	27.3
Kwa Zulu Natal	31.2	31.1	29.3	31.2	31.1	29.3
Limpopo	37.2	37.2	30.5	34.5	34.4	30.5
Mpumalanga	33.4	33.4	29.7	33.4	33.4	29.7
Northern Cape	30.8	30.8	28.1	30.8	30.8	28.1
North West	33.9	34.0	31.0	33.9	34.0	31.0
Western Cape	32.1	32.1	31.5	32.1	32.1	31.5
National	32.5	32.4	29.6	32.1	32.1	29.4

Source: Authors' computations based on (DBE, 2020)

Regarding class sizes, the scenario proposes that Grade R and primary be capped at 38 and secondary at 35, implying that any province with class sizes higher than these maxima will need to construct additional classrooms (delivered in school packages) to comply with these thresholds (see

Table 39).

Table 39: Projected average class size in public basic education under the full access scenario

	Baseline			Projection		
	Grade R	**Primary**	**Secondary**	**Grade R**	**Primary**	**Secondary**
Eastern Cape	28.5	28.4	29.4	28.5	28.4	29.4
Free State	34.6	34.4	30.3	34.6	34.4	30.3
Gauteng	41.5	41.4	34.7	37.7	37.8	34.7
Kwa Zulu Natal	35.2	35.0	33.1	35.2	35.0	33.1
Limpopo	36.6	36.6	30.0	36.6	36.6	30.0
Mpumalanga	42.3	42.4	37.7	37.7	37.8	34.8
Northern Cape	31.8	31.7	29.0	31.8	31.7	29.0
North West	39.6	39.7	36.2	37.7	37.8	34.8
Western Cape	36.1	36.1	35.4	36.1	36.1	34.8
National	35.7	35.8	32.8	35.2	35.2	32.8

Source: Authors' computations based on (DBE, 2020)

Future enrolments in public schools under the full access scenario

Based on the projected population, and the changing GER in respective levels of education, the authors estimated that the total enrolment in basic education would increase from 13.5 million in 2020 to 14.9 million in 2030, an estimated addition of 1.3 million additional children and youth. In public schools, the enrolments were estimated to reach 13.7 million by the end of the decade, translating to 1.2 million additional students (see Table 40). It is important to note, as in the baseline scenario, that the capacity of public Grade R will remain constant, with any additional learner coming to school beyond the existing

capacity expected to go to private schools. Also important to recall in the case of Grade R is that the population decline for children eligible for this level will be reflected in their enrolment, when combined with the fact that the GER in most provinces is expected to converge downwards towards 100 percent.

Table 40: Future enrolment in basic education under the full access scenario

	Public				All schools	percent public
	Grade R	Primary	Secondary	Sub total		
2020	760	7 293	4 479	12 532	13 543	92.5%
2021	758	7 336	4 543	12 637	13 654	92.5%
2022	756	7 381	4 607	12 743	13 770	92.5%
2023	754	7 427	4 672	12 853	13 890	92.5%
2024	752	7 475	4 740	12 967	14 014	92.5%
2025	751	7 525	4 809	13 085	14 143	92.5%
2026	750	7 577	4 880	13 207	14 276	92.5%
2027	749	7 632	4 953	13 334	14 414	92.5%
2028	748	7 688	5 029	13 465	14 557	92.5%
2029	748	7 746	5 106	13 600	14 705	92.5%
2030	747	7 807	5 186	13 740	14 858	92.5%

Source: Authors' computations based on (DBE, 2020)

Teachers required in public schools under full access scenario

In this scenario, the pressure for additional resources (teachers and classrooms) will be driven by the more than 1.2 million additional learners expected in the basic education system. Accordingly, the projected additional learners and the student teacher ratios discussed earlier, the number of teachers in public basic education schools would increase from 400 000 in 2020 to nearly 442 300 (an 11 percent increase), with 17 700 additional teachers expected in primary, and nearly 24 700 in secondary (see

Table 41). The decline in enrolments in Grade R will have an influence the need for additional teachers. The authors estimated that preschool would have negative demand for teachers. The spaces created could be used for balancing teachers across schools – schools whose teaching loads may have been missed due to the aggregation of indicators at the provincial level.

Table 41: Future teachers in public basic education under the full access scenario

	Grade R	Primary	Secondary	Total
2020	23 373	225 182	151 539	400 093
2021	23 332	226 692	153 772	403 796
2022	23 296	228 255	155 996	407 547
2023	23 266	229 872	158 283	411 421
2024	23 242	231 546	160 634	415 421
2025	23 223	233 276	163 052	419 552
2026	23 210	235 065	165 540	423 815
2027	23 202	236 915	168 100	428 217
2028	23 200	238 825	170 734	432 759
2029	23 203	240 799	173 445	437 447
2030	23 211	242 838	176 236	442 285

Source: Authors' computations based on (DBE, 2020)

Under these assumptions, the sector will need nearly 5 200 additional teachers annually to satisfy the education needs of the three levels of education, including 4 800 annually in the first five years and about 5 500 in the second half of the decade. Similar to the results of the first scenario, majority of the additional teacher needs will be concentrated in Gauteng, KwaZulu-Natal and Limpopo provinces. In addition, due to slow growth in population, coupled with fairly low teacher ratios, provinces like Eastern Cape and Free State will not need additional teachers during the expansion (see

Table 42). Conceivably though, these provinces will need replacement for teachers leaving the education system through natural attrition or other provisions for separations.

Table 42: Additional teachers in public basic education under the full access scenario, by province

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gauteng	2 213	2 213	2 213	2 213	2 213	2 563	2 563	2 563	2 563	2 563
KwaZulu-Natal	914	914	914	914	914	930	930	930	930	930

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Mpumalanga	116	116	116	116	116	124	124	124	124	124
Northern Cape	0	0	0	0	0	1	1	1	1	1
North West	991	991	991	991	991	1 183	1 183	1 183	1 183	1 183
Western Cape	596	596	596	596	596	673	673	673	673	673
Total	**4 830**	**4 830**	**4 830**	**4 830**	**4 830**	**5 474**	**5 474**	**5 474**	**5 474**	**5 474**

Source: Authors' computations based on *(DBE, 2020)*

Classrooms required in public schools under the full access scenario

The adjustments made in the average class sizes, especially in provinces whose class sizes were higher than the set maxima in respective levels of education will trigger classrooms to rise from 361 500 in 2020 to 401 400 in 2030, a net addition of 40 000 classrooms. In primary the additional learners will trigger a need for nearly 18 300 classrooms; and 21 700 in secondary (see

Table 43).

Table 43: Future classrooms in public basic education under the full access scenario

	Grade R	Primary	Secondary	Total
2020	21 319	203 572	136 596	361 487
2021	21 263	205 044	138 566	364 874
2022	21 218	206 588	140 519	368 325
2023	21 182	208 207	142 528	371 917
2024	21 156	209 903	144 593	375 653
2025	21 141	211 679	146 718	379 538
2026	21 136	213 536	148 904	383 576
2027	21 142	215 478	151 153	387 773
2028	21 158	217 507	153 468	392 133
2029	21 185	219 627	155 851	396 662

	Grade R	Primary	Secondary	Total
2020	21 319	203 572	136 596	361 487
2030	21 222	221 840	158 304	401 366

Source: Authors' computations based on (DBE, 2020)

On average, the public sector will need to deliver about 5 100 classrooms annually, to meet the demand from the eligible population. Majority of the classrooms will be concentrated in Gauteng, KwaZulu-Natal, Mpumalanga, North West and Western Cape. Gauteng and KwaZulu-Natal alone will account for 60 percent of the annual number of classrooms needed. Due to the low-class sizes in some provinces like Eastern Cape, Free State, Limpopo, and Northern Cape, there will be no trigger for additional classrooms (see

Table 44). Given the modelling approach for expansion – an aggregate approach – the inherent need for classrooms in overcrowded schools in the provinces which show no need for expansion can be considered as part of the upgrading.

Table 44: Additional classrooms in public basic education under the full access scenario, by province

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gauteng	2 083	2 083	2 083	2 083	2 083	2 461	2 461	2 461	2 461	2 461
KwaZulu-Natal	811	811	811	811	811	825	825	825	825	825
Mpumalanga	363	363	363	363	363	408	408	408	408	408
Northern Cape	0	0	0	0	0	1	1	1	1	1
North West	967	967	967	967	967	1 185	1 185	1 185	1 185	1 185
Western Cape	553	553	553	553	553	631	631	631	631	631
Total	**4 776**	**4 776**	**4 776**	**4 776**	**4 776**	**5 511**	**5 511**	**5 511**	**5 511**	**5 511**

Source: Authors' computations based on (DBE, 2020)

Delivered in the form of schools, the additional classrooms will trigger the construction of about 4 600 schools during the decade, with the government having to construct 430 schools annually in the first half of the decade, and about 500 annually in the second half, as highlighted in

Table 45.

Table 45: Schools to be constructed in public basic education under the full access scenario, by province

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Small schools	301	301	301	301	301	348	348	348	348	348
Medium schools	83	83	83	83	83	95	95	95	95	95
Large schools	43	43	43	43	43	49	49	49	49	49
Grand total	**427**	**427**	**427**	**427**	**427**	**492**	**492**	**492**	**492**	**492**

Source: Authors' computations based on (DBE, 2020)

Projected cost of expansion under full access scenario

Expansion of basic education under the parameters considered in the full access scenario would see the recurrent expenditure in basic education rise from ZAR 232.2 billion in 2020 to ZAR 286.2 billion in 2030, an overall increase of 23 percent, with the cumulative recurrent expenditure for the 2022-2030 period being ZAR 2 368.7 billion. The increase in spending will support the recruitment of teachers, administrative functions in the system and provide direct support to students through transfers. Administrative costs are expected to grow by an additional ZAR 9 billion over the period; about ZAR 390 million in Grade R; ZAR 20.3 billion in primary and ZAR 24.3 billion in secondary, with the costs evolving as shown in

Table 46.

Table 46: Recurrent spending on the expanded basic education under the full access scenario

	Admin	Grade R	Primary	Secondary	Sub total
Spending in 2020	27 204	4 521	111 752	88 693	232 171
Sector spending in 2030	36 267	4 911	132 030	113 003	286 212
Net additional from 2020	9 063	390	20 278	24 310	54 041
Cumulative spending (2022-2030)	291 728	42 682	1 110 772	923 516	2 368 697
Average spending, 2022-30	32 414	4 742	123 419	102 613	263 189

Source: Authors' computations based on (DBE, 2020)

Using the costs estimated to the three implementation approaches i.e., ZAR 31 700 per square meter for DBE implementation, ZAR 13 000 per square meter for provincial level execution, and ZAR 7 800 per square meter for community execution; and sharing the expansion on a 20:80 ratio between central and provinces implementation modalities[32], the projected number of schools in

Table 45 is likely to cost ZAR 131.7 billion, averaging ZAR 5.5 billion annually at the central and ZAR 9.1 billion for the provinces. Relative to the projected recurrent costs, the projected capital costs will be 3.9 percent for both implementation modalities (See Table 47).

Table 47: Capital spending on the expanded basic education under the full access scenario

	Total cost (2021-30)	Average expenditure		percent of recurrent expenditure
		In Million ZAR	In Million USD	
Centralized (by DBE)	**49 890**	**5 543**	**366**	**1.9%**
Small	27 485	3 054	202	
Medium	12 987	1 443	95	
Large	9 418	1 046	69	
Provincial (by PEDs/PPWs)	**81 820**	**9 091**	**601**	**3.2%**
Small	45 076	5 008	331	
Medium	21 299	2 367	156	
Large	15 445	1 716	113	

Source: Authors' computations based on (DBE, 2020)

8.2.3 Scenario 3 – Full access with efficiency: Driven by population growth, improved access levels, and improved internal efficiency

[32] The full access scenario, like the baseline scenario, assumed that only DBE and PDEs will be involved in the construction of new schools

Scenario 3, like its predecessor, builds on the baseline foundation of population growth, improving access in preschool, primary and lower secondary, accommodating an early exit after lower secondary, and anticipating the decline in participation in upper secondary. This scenario equally retains the policy anchors on improving classroom experience through the set maxima on student teacher ratios and class sizes. In addition to these, the main focus of this scenario is improving internal efficiency by reducing repetition, which is fairly high in basic education, especially in primary and upper secondary. In 2020, the share of repeaters was reported to be 15 percent in primary, 8 percent in lower secondary and 15 percent in senior secondary. Since enrolments include repeaters, high repetition rates would inflate the number of learners in the system, given the lag they have in exiting the level they are repeating. Abolishing or lowering repetition would reduce the number of learners but enhance efficiency in schooling. Under this scenario, the expansion assumed that repetition would improve to 10 percent in primary and senior secondary, while in junior secondary, the repetition rate would remain constant at 8 percent throughout the expansion period. It is important to note that the changes in repetition were applied to public schools only. The two previous scenarios assumed that the structure of recurrent spending would remain the same as in the baseline i.e., the non-salary recurrent expenditure would be 8 percent during the expansion period. This scenario assumed that efficiency would not just be built on student flow but also on the impact that schooling would have on learners. The authors hypothesized that increasing the share of non-salary recurrent costs from 8to 10 percent would allow schools to acquire necessary teaching and learning materials and equipment and thereby improve the efficiency in learning. This scenario also took a bold step to include community based construction, which as discussed in earlier sections, would be a more participatory approach with lower unit costs.

Future enrolments in the education system under full access with efficiency scenario

The authors estimated that the number of children and youth attending school would reach 14.9 million by the end of the decade, implying an additional 1.35 million when compared to the learners recorded in 2020 (see

Table 48). Given the application of improved internal efficiency on public schools alone, it is observed that the increment in public schools will be about 700 000 children and youth, compared to the 1.2 million

estimated in the full access scenario, demonstrating the inefficiency that repetition creates in an education system.

Table 48: Future enrolment in basic education under the full access with efficiency scenario

	Public				All schools	percent public
	Grade R	Primary	Secondary	Sub total		
2020	760	7 293	4 479	12 532	13 543	92.5%
2021	758	7 373	4 555	12 686	13 654	92.9%
2022	756	7 307	4 581	12 643	13 770	91.8%
2023	754	7 316	4 633	12 702	13 890	91.5%
2024	752	7 326	4 686	12 764	14 014	91.1%
2025	751	7 337	4 741	12 829	14 143	90.7%
2026	750	7 350	4 797	12 897	14 276	90.3%
2027	749	7 365	4 855	12 968	14 414	90.0%
2028	748	7 380	4 914	13 042	14 557	89.6%
2029	748	7 398	4 975	13 120	14 705	89.2%
2030	747	7 416	5 037	13 201	14 858	88.8%

Source: Authors' computations based on (DBE, 2020)

Alongside the evolution of learners in public schools, nearly 40 300 learners will come to Grade R and will be distributed in the provinces as shown in Table 49, an average of 4 000 learners annually. Only three provinces will have these additional learners. In the rest of the provinces, there will be no additional learners to private Grade R in private schools, due to the decline in population of five-year-olds as discussed earlier. This means that eligible children will be accommodated in the existing capacity of private and public schools.

Table 49: Additional enrolment in Grade R by province under the full access with efficiency scenario

In thousands	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gauteng	3 261	3 301	3 342	3 383	3 424	3 466	3 508	3 550	3 593	3 636
North West	278	280	282	284	285	287	289	291	293	294
Western Cape	300	300	300	300	300	300	299	299	299	299

In thousands	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total	**3 840**	**3 881**	**3 924**	**3 966**	**4 009**	**4 052**	**4 096**	**4 140**	**4 185**	**4 230**

Source: Authors' computations based on (DBE, 2020)

Teachers required in public schools under full access with efficiency scenario

Based on the projected population and the student teacher ratios, the number of teachers will evolve from 400 000 in 2020 to nearly 425 200 in 2030, a net addition of about 25 000 teachers as presented in Table 50. The teaching staff in primary is expected to rise by more than 5 500 and 19 600 in secondary. It is estimated that the declining participation in Grade R will see the teaching staff at this level be more than the need.

Table 50: Future teachers in public basic education under the full access with efficiency scenario

	Grade R	Primary	Secondary	Total
2020	23 373	225 182	151 539	400 093
2021	23 299	227 831	154 203	405 333
2022	23 234	225 972	155 125	404 331
2023	23 176	226 424	156 952	406 552
2024	23 125	226 915	158 826	408 867
2025	23 082	227 444	160 751	411 278
2026	23 047	228 013	162 726	413 786
2027	23 019	228 623	164 754	416 395
2028	22 997	229 272	166 835	419 105
2029	22 983	229 963	168 973	421 919
2030	22 975	230 696	171 168	424 839

Source: Authors' computations based on (DBE, 2020)

On average, basic education would require about 4 000 additional teachers annually, majority of whom would be needed in Gauteng, KwaZulu-Natal, North West and Western Cape provinces, driven by the higher increase in population of eligible learners as well as the fact that these provinces have lower than 100 percent GER and will have more incoming learners when the universal access policy is triggered.

Table 51: Additional teachers in public basic education under full access with efficiency scenario, by province

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gauteng	1 895	1 895	1 895	1 895	1 895	2 152	2 152	2 152	2 152	2 152
KwaZulu-Natal	515	515	515	515	515	491	491	491	491	491
North West	876	876	876	876	876	1 015	1 015	1 015	1 015	1 015
Western Cape	437	437	437	437	437	489	489	489	489	489
Total	**3 724**	**3 724**	**3 724**	**3 724**	**3 724**	**4 148**	**4 148**	**4 148**	**4 148**	**4 148**

Source: Authors' computations based on (DBE, 2020)

Classrooms required to accommodate additional learners under the full access with efficiency scenario

The adjustments made in the average class sizes, especially in provinces whose class sizes were higher than the set maxima in respective levels of education, together with improved internal efficiency – cutting down on unnecessary enrolments – would trigger classrooms to rise from 361 500 in 2020 to 385 700 in 2030, a net addition of 19 400 classrooms. In primary the additional learners would be 4 700 additional classrooms, while secondary would need 14 800 (See

Table 52).

Table 52: Future classrooms in public basic education under the full access with efficiency scenario

	Grade R	Primary	Secondary	Total
2020	21 319	203 572	136 596	361 487
2021	21 263	206 074	138 954	366 291
2022	21 218	204 523	139 735	365 475
2023	21 182	205 084	141 330	367 596
2024	21 156	205 705	142 968	369 830
2025	21 141	206 387	144 649	372 177
2026	21 136	207 130	146 376	374 642
2027	21 142	207 936	148 149	377 227

	Grade R	Primary	Secondary	Total
2020	21 319	203 572	136 596	361 487
2028	21 158	208 807	149 969	379 934
2029	21 185	209 744	151 840	382 768
2030	21 222	210 748	153 761	385 731

Source: Authors' computations based on (DBE, 2020)

On average, the public will need to deliver more than 4 100 classrooms annually, to meet the demand from the eligible population, their coming to school and the policy decisions discussed in previous sections of this report (see

Table 53).

Table 53: Additional classrooms in public basic education under the full access with efficiency scenario, by province

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gauteng	1 824	1 824	1 824	1 824	1 824	2 109	2 109	2 109	2 109	2 109
KwaZulu-Natal	478	478	478	478	478	456	456	456	456	456
Mpumalanga	253	253	253	253	253	281	281	281	281	281
North West	861	861	861	861	861	1 025	1 025	1 025	1 025	1 025
Western Cape	414	414	414	414	414	469	469	469	469	469
Total	**3 830**	**3 830**	**3 830**	**3 830**	**3 830**	**4 341**	**4 341**	**4 341**	**4 341**	**4 341**

Source: Authors' computations based on (DBE, 2020)

Delivered in packages of schools, the government will need to construct 220 schools annually in the first half of the decade, and another 250 annually in the second half of the decade to fulfil the demand for additional classrooms and associated facilities in basic education schools (see

Table 54).

Table 54: Schools to be constructed in public basic education under the full access with efficiency scenario

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Small schools	50	50	50	50	50	56	56	56	56	56
Medium schools	104	104	104	104	104	119	119	119	119	119
Large schools	66	66	66	66	66	75	75	75	75	75
Grand total	**220**	**220**	**220**	**220**	**220**	**250**	**250**	**250**	**250**	**250**

Source: Authors' computations based on (DBE, 2020)

Projected cost of expanding basic education under the full access with efficiency scenario

Expansion of basic education, under the policy considerations in this scenario, would trigger an evolution of recurrent costs from ZAR 232.2 billion in 2020 to ZAR 283.5 billion in 2030, a net additional spending of more than ZAR 51 billion, and translating to a 22 percent growth in recurrent spending. The Government would need to accommodate this increase, gradually throughout the expansion period. The cumulative recurrent expenditure for the 2022-2030 period would be ZAR 2 356 billion, nearly half (47 percent) estimated to be for primary education (see Table 55). The estimated recurrent costs would include the subsidy paid to private schools to incentivize the said schools to accommodate additional learners in Grade R, each learner receiving about ZAR 4 500 annually.

Table 55: Recurrent spending on the expanded basic education under the full access with efficiency scenario

	Admin	Grade R	Primary	Secondary	Sub total
Baseline spending (2020)	27 204	4 521	111 752	88 693	232 171
Sector spending in 2030	36 267	5 218	131 313	110 729	283 546
Net additional from 2020	9 063	697	19 561	22 035	51 376
Cumulative spending (2022-2030)	291 728	44 440	1 107 587	912 272	2 356 027
Average spending, 2022-30	32 414	4 920	123 065	101 364	261 781

Source: Authors' computations based on (DBE, 2020)

Applying the costs estimated for the construction of new schools, i.e., ZAR 31 700 per square meter under DBE implementation, ZAR 13 000 per square meter under provincial level execution, ZAR 7 800 per square meter under community execution; and sharing the expansion on a 10:85:5 ratio between central, provinces and communities, the projected number of schools in

Table 54 would cost ZAR 81 billion, with about ZAR 17.6 billion expected to be spent at the central level; ZAR 61.3 billion in the provinces; and ZAR 2.2 billion through communities. On average, expansion of infrastructure under this scenario would cost ZAR 1.96 billion at the central level; ZAR 6.8 billion at the provinces and about ZAR 240 million using communities. Relative to the projected recurrent costs, the projected capital costs under this scenario would average 3.1 percent annually. Table 56 presents the distribution of capital costs according to the implementation modalities as well as the size sizes of schools covered by these costs.

Table 56: Capital spending on the expanded basic education, full access with efficiency scenario

	Total cost (2022-2030)	**Average expenditure**		**percent of recurrent expenditure**
		In Million ZAR	**In Million USD**	
Centralized implementation	**17 591**	**1 955**	**129**	**0.7%**
Small	2 241	249	16	
Medium	8 135	904	60	
Large	7 216	802	53	
Provincial implementation	**61 306**	**6 812**	**450**	**2.4%**
Small	7 809	868	57	
Medium	28 351	3 150	208	
Large	25 147	2 794	185	
Community (by SGBs)	**2 164**	**240**	**16**	**0.1%**
Small	276	31	2	
Medium	1 001	111	7	
Large	888	99	7	

Source: Authors' computations based on (DBE, 2020)

Testing the sensitivity exogenous factors on the policy choices made within basic education

Up to this point, the three scenarios have been predicated on the assumption that the structure of the country's population would remain the same as observed in 2020, and that there will be no intra-country migration in the growth of the population. In practice, however, based on (World Bank, 2021), migration plays an important role in determining how many learners will potentially be in a given location, and this would certainly affect the supply of education in different locations. Consequently, the authors used alternative population projections to assess how the moving parts of the simulation would behave under different conditions. In the Urban population projection, there would be migration of population to urban areas – with the important result being that provinces with large cities and towns having more population in 2030, compared to others with fewer cities. In the Rural population projection, there would be influx of people in 'mostly-rural' provinces. Comparing the different population profiles, it is notable that the school age population would be higher in 2030 in the migration neutral projection, compared to the two other alternative profiles (see Table 57). This fact will certainly influence the number of learners who will come to basic education, and inherently the cost associated with their learning.

Table 57: Trend in population and enrolment under different migration policies

	Population				**Expected enrolments in the BAS-GER-CE-REP scenario in the context of**		
	Migration neutral	**Urban migration**	**Rural migration**		**Migration neutral**	**Urban migration**	**Rural migration**
2020	14 099	14 067	14 075		13 543	13 543	13 543
2021	14 200	14 129	14 149		13 654	13 617	13 631
2022	14 303	14 195	14 227		13 770	13 696	13 723
2023	14 410	14 265	14 309		13 890	13 780	13 820
2024	14 520	14 339	14 395		14 014	13 869	13 921
2025	14 633	14 418	14 484		14 143	13 964	14 027

	Population				Expected enrolments in the BAS-GER-CE-REP scenario in the context of		
	Migration neutral	Urban migration	Rural migration		Migration neutral	Urban migration	Rural migration
2026	14 749	14 500	14 578		14 276	14 063	14 137
2027	14 868	14 587	14 676		14 414	14 168	14 253
2028	14 990	14 678	14 778		14 557	14 278	14 373
2029	15 116	14 773	14 884		14 705	14 394	14 498
2030	15 313	14 966	15 081		14 858	14 516	14 629

Notes: Population is presented in thousands

Source: (World Bank, 2021)

The different needs from the different population projection scenarios is demonstrated by the differing needs of teachers, as seen in Table 58. Maintaining the same level of ambitions as far as education parameters are concerned, a change in population projection creates a large difference in the resources needed. For instance, the additional teachers needed in the migration neutral population projection context is 24 700, which is the highest among the three options. The Urban migration projection scenario has the least teacher needs at about 15 600 teachers for the three levels of education, a need that is 37 percent lower than the teacher needs in the migration neutral projection profile. Although the rural migration profile results in higher teacher needs compared to the urban migration case, the resulting need is still 22 percent lower than in the migration neutral scenario. Similar observations are made on the requirements for classrooms, where the additional classrooms needed in the migration neutral case is 38 percent higher than what would be needed in the urban population projection case, and 21 percent higher than in the rural migration case.

Table 58: Additional teachers and classrooms in public schools in the full access with efficiency scenario under different population projection profiles

Resources	Projection profile	Grade R	Primary	Secondary	Total
Teachers	Migration neutral	-398	5 515	19 629	24 746
	Urban migration	-633	-2 492	18 725	15 599

	Rural migration	-415	-137	19 811	19 258
Classrooms	Migration neutral	-41	4 674	14 807	19 440
	Urban migration	-178	-1 782	13 932	11 973
	Rural migration	18	279	15 011	15 308

Notes: The negatives represent surplus teachers in the respective levels of education, resulting from efficiency gains or declining student enrolments
Source: Authors' computations based on (DBE, 2020)

Another endogenous factor considered in this study is the economic growth, which affects the resources that are likely to be available for implementation of the selected policy choices. The alternative economic growth rates are applied in the subsequent sub section in assessing the resource gaps for this scenario, and the others as well.

8.3 Comparison of expansion scenarios

The policy assumptions/scenarios considered in the expansion component can be summarized as shown in Table 59, giving the main parameters that drive the simulation in each scenario. It is important to recall that these parameters are applied at the province level, even though a substantial number of results have been presented as aggregates.

Table 59: Parameters/assumptions made in the simulation model

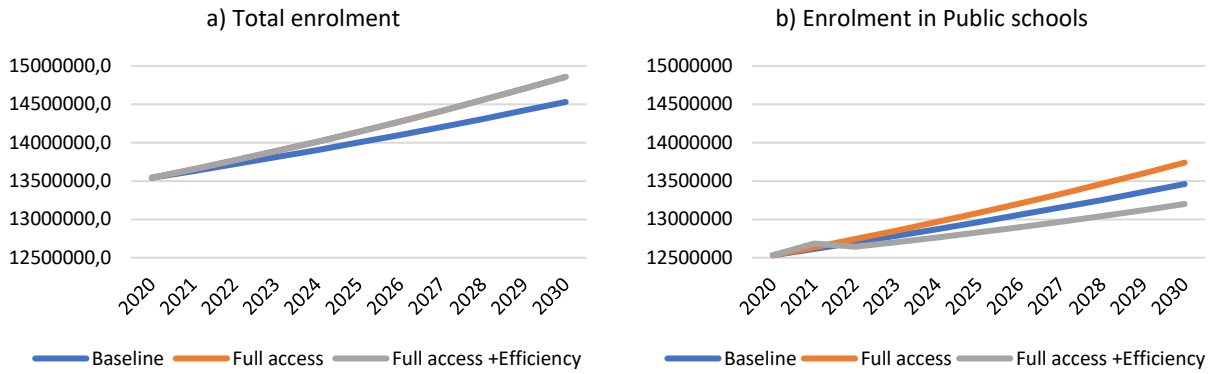
Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
Economy growing at an annual rate of 2.21%	No change from previous scenario	No change from previous scenario
Migration neutral population growth	No change from previous scenario	No change from previous scenario

Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
• National GER (baseline) • Grade R= 98% • Primary= 97% • Lower secondary= 102% • Upper secondary= 90% • Provincial disparities maintained	• GER Grade R & Primary set to 100% • GER for lower secondary set to 100% • Exit after lower secondary introduced • GER for upper secondary set to 90% (accommodates exist after lower secondary)	No change from previous scenario
STR and SCR • Grade R 33 & 36 • Primary= 32 & 36 • Secondary=30 & 33	• Maximum STR in Grade R & Primary set at 34; and 31 in secondary • Maximum SCR Grade R & Primary set at 38; 35 in secondary	No change from previous scenario
Repetition Rate • Primary= 15% • Lower Secondary=8% • Upper Secondary= 15%	No change from previous scenario	Repetition Rate • Primary= 10% • Repetition at lower secondary maintained as at baseline (8%) • Repetition in upper secondary to improve to 10%
Recurrent non-salary costs are 8% of total recurrent costs	Same as previous scenario	Recurrent non-salary increases from 8% of total recurrent costs to 10%
Construction of new schools to be carried by DBE (20%) and PDEs (80%)	Construction of new schools to be carried by DBE (20%) and PDEs (80%)	Construction of new schools to be carried by DBE (10%) and PDEs (85%), and communities (5%)

Source: Authors' compilations extracted from the simulation model

Results of the considered scenarios can be compared at three levels, i.e., the population projections stage; the number of learners who are likely to end up in basic education institutions during the expansion period; the teachers who will be needed to sustain teaching in the system; the number of classrooms that will be required for the additional learners; and most importantly, the cost of expansion – both recurrent and capital. In terms of total enrolment, it can be seen that see that scenario 2 and 3 will have a substantial advantage over the baseline scenario in accommodating school going children (see Figures 35a), while Figures 35b underscores the influence that repetition has on schooling. It is important to recall that all the education parameters are similar between the full access and full access with efficiency scenarios, except

for the repetition aspect which is introduced in the third scenario, and which creates a clearly different trajectory in terms of enrolments in public schools.



Figures 35: (A and B) Additional enrolment in basic education, by scenario

Notes: Scenario 2 (Full access) and 3 (Full access + Effciiency) have similar trajectories in the total enrolments graph

Source: Authorss computations from the simulation model

Due to the increase in access rates and improving teaching and learning in scenario 2 (full access), the number of teachers expected in this scenario is expected to be higher than in any other scenario. The teacher needs in the scenario 3 (full access with efficiency) is the least arising from the efficiency gains in reducing the repeating learners (see Figure 36). In classrooms, although only a few provinces are affected by the reduction of class sizes, where the maximum is violated, the effect of the reducing repetition is again seen in the fact that classroom needs is similar between the baseline and full access with efficiency scenarios (see Figure 37), which is another confirmation that the number of eligible children and youth, as well as management of their flow through an education system are important factors in determining infrastructure needs.

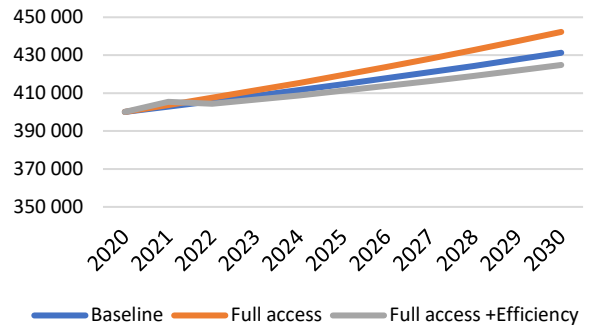


Figure 36: Additional teachers in public basic education schools, by scenario

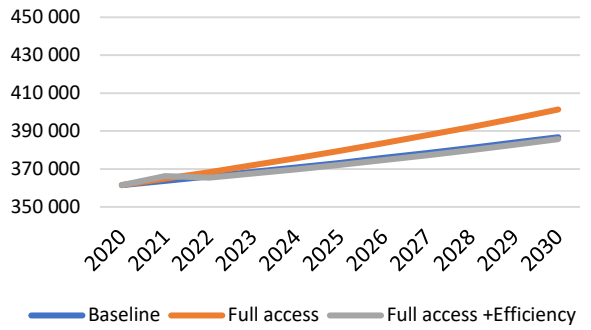


Figure 37: Additional classrooms in public basic education schools, by scenario

Source: Authorss computations from the simulation model

Based on assumptions discussed in each scenario, the Government will spend a total of ZAR 2 341 under scenario 1, ZAR 2 368.7 under scenario 2, and ZAR 2 356 billion under scenario 3 in recurrent terms between 2022 and 2030. These resources will be spent on sustenance of the existing and expanded system i.e., payment of salaries to teaching and non-teaching staff (in school and at various administration levels); hiring of new teachers (most of whom will be required in Gauteng and KwaZulu-Natal Provinces regardless of the scenario selected); facilitating the inspection of schools; providing subventions to school etc. As evident from Table 60, there are no significant differences in the projected recurrent costs. The cost estimated under scenario 3 assumptions are marginally lower than the ZAR 2 369 estimated for scenario 2 and marginally higher than the estimates for scenario 1. The average recurrent spending projected to range from a high of ZAR 260.2 billion annually during the expansion period in the baseline scenario to ZAR 263.2 billion in the full access scenario. Given the baseline recurrent spending of ZAR 232.2 billion, the Government will have to gradually stretch its commitment to basic education and reach ZAR 280.6 billion in the baseline scenario in 2030; ZAR 286.2 billion in the full access scenario; and ZAR 283.5 in the full access with efficiency scenario, all these indicating the efforts that the Government will need to make in expanding its commitment to fund education. These costs are based on the assumption that there will be no significant migration between the provinces and that the economy will grow at an annual average of 2.21%.

Table 60: Recurrent costs due to system expansion, 2022-30

Scenario	Spending focus	Admin	Grade R	Primary	Secondary	Sub total
Scenario 1: Baseline	Spending in 2020	27 204	4 521	111 752	88 693	232 171
	Spending in 2030	36 267	4 767	126 421	113 109	280 565
	Additional from 2020	9 063	245	14 670	24 416	48 394
	Cumulative (2022-2030)	**291 728**	**41 975**	**1 082 281**	**925 100**	**2 341 084**
	Average (2022-2030)	32 414	4 664	120 253	102 789	260 120
Scenario 2: Full access	Spending in 2020	27 204	4 521	111 752	88 693	232 171
	Spending in 2030	36 267	4 911	132 030	113 003	286 212
	Additional from 2020	9 063	390	20 278	24 310	54 041
	Cumulative (2022-2030)	**291 728**	**42 682**	**1 110 772**	**923 516**	**2 368 697**
	Average (2022-2030)	32 414	4 742	123 419	102 613	263 189
Scenario 2: Full access with efficiency	Spending in 2020	27 204	4 521	111 752	88 693	232 171
	Spending in 2030	36 267	5 218	131 313	110 729	283 546
	Additional from 2020	9 063	697	19 561	22 035	51 376
	Cumulative (2022-2030)	**291 728**	**44 440**	**1 107 587**	**912 272**	**2 356 027**
	Average (2022-2030)	32 414	4 920	123 065	101 364	261 781

Source: Authors' computations based on (DBE, 2020)

On capital costs, the authors estimated that the baseline scenario would costs ZAR 76 billion, rising to ZAR 132 billion in the full access scenario and ZAR 81 billion the full access with efficiency scenario (see Table 61). Comparison between the non-baseline scenarios shows that the full access with efficiency scenario would cost 62 percent less than the full access scenario, thanks to the efficiency introduced in the former

scenario, and whose effect has been clearly demonstrated through the simulation results, whether in the number of teachers to be recruited or in the classrooms, and by extension the schools to be constructed.

Table 61: Comparison of capital costs of expanding primary and secondary education

	Total for the expansion period (2022-2030)		Average (2022-2030)	
	In Mn ZAR	In Mn USD	In Mn ZAR	As percent of recurrent costs
Scenario 1: Baseline	**75 589**	**4 995**	**8 399**	
Centralized	28 632	1 892	3 181	1.2 %
Provincial	46 957	3 103	5 217	2.0 %
Scenario 2: Full access	**131 710**	**8 703**	**14 634**	
Centralized	49 890	3 297	5 543	1.9 %
Provincial	81 820	5 406	9 091	3.2 %
Scenario 3: Full access + efficiency	**81 061**	**5 356**	**9 007**	
Centralized	17 591	1 162	1 955	0.7 %
Provincial	61 306	4 051	6 812	2.4 %
Community	2 164	143	240	0.1 %

Source: Authors' computations based on (DBE, 2020)

When put together, the authors projected that the cost of expanding and upgrading basic education would be between ZAR 2 484.7 billion under the baseline scenario and ZAR 2 568.4 billion under the full access scenario (see Table 62). These costs are inclusive of recurrent and capital costs, with the share of capital costs ranging from 6 percent under the baseline scenario to about 8 percent under the full access scenario. The cost of upgrading existing infrastructure is constant across the three scenarios because the authors assumed that the Government would consider the second upgrading option (middle ground) in addressing the infrastructure backlog (addressing 100 percent of the toilet needs, electricity, water, replacing of mud classrooms, floors, and ceilings; and tackling 70 percent of the needs relating to computer rooms, libraries, laboratories, and servers). This option would cost ZAR 68 million, a cost that is not cast in stone as the Government may opt for a different upgrading option i.e., option 1 (ZAR 93.2

billion) or option 2 (ZAR 51.4 billion). Changing the upgrading option would change the overall capital costs and subsequently the total cost of expansion and upgrading of basic education.

Table 62: Funding needs for system expansion and upgrade of basic education

	Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
Recurrent	2 341 084	2 368 697	2 356 027
Capital	143 589	199 710	149 061
Expansion	75 589	131 710	81 061
Upgrade	68 000	68 000	68 000
Total projected costs	**2 484 674**	**2 568 407**	**2 505 088**
of which capital constitutes	5.8%	7.8%	6.0%

Source: Authors' estimation based on data from the National Treasury (Multiple years)

The feasibility of expansion of basic education, was tested by estimating the resources that are likely to be available to basic education during the expansion period. Given the limited information available for recurrent expenditure, the authors assessed the feasibility of infrastructure expansion only. To estimate the resources likely to be available in basic education, it is important to note that resources are based on extractions from the gross domestic product and as such dependent on the GDP growth. Assuming that the GDP would grow at an annual rate of 2.21% from ZAR 5.2 trillion in 2020 to reach ZAR 6.4 trillion by 2030, and that infrastructure funding levels in basic education remained similar to the 2020/21 levels of 0.2 percent of the GDP towards IEG, IDP and SBIG interventions, the cumulative resources likely to be available to basic education for infrastructure intervention would be ZAR 131.6 billion. Considering the projected capital costs and resources, the infrastructure interventions would have funding gaps ranging from ZAR 68.1 billion in the full access scenario (or 52% of the resources likely to be available for capital interventions) to ZAR 12 billion in the baseline scenario (or 13% of the resources likely to be available for capital) as shown in Table 63.

Table 63: Funding gap for the infrastructure interventions, by scenario

In Million ZAR	Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
Total capital costs	143 589	199 710	149 061
Expansion	75 589	131 710	81 061
Upgrade	68 000	68 000	68 000
Projected capital resources (based on 0.2% of GDP)	**131 566**	**131 566**	**131 566**
Funding gap	**12 023**	**68 144**	**17 495**
% Gap	-9.1%	-51.8%	-13.3%

Source: Authors' estimation based on data from the National Treasury (Multiple years)

Another way to look at the infrastructure funding gap is to test different economic growth profiles on a set of education policies. For instance, holding all the education inputs constant, and thereby the infrastructure costs, the authors were able to assess the funding gaps under different economic growth contexts. Of the three macroeconomic projections, the baseline was projected to grow at 2.21% annually, the first alternative at 1.98% while the second alternative at 1.78%. Estimating the resources associated with the GDPs behind the projected growth, the authors ended up with ZAR 129.8 billion and ZAR 128.2 billion respectively. Against the projected costs in each scenario, the funding gap ranges from ZAR 12 billion to ZAR 15.4 under the baseline scenario; from ZAR 68.1 billion to ZAR 71.5 under the full access scenario; and from ZAR 17.5 billion to ZAR 20.9 billion under the full access with efficiency scenario (see Table 64).

Table 64: Funding gap for the infrastructure interventions, by scenario under different economic conditions

In Million ZAR	Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
Total capital costs	143 589	199 710	149 061
Projected capital resources SC1	131 566	131 566	131 566

In Million ZAR	Scenario 1: Baseline	Scenario 2: Full access	Scenario 3: Full access with efficiency
Projected capital resources SC2	129 759	129 759	129 759
Projected capital resources SC3	128 209	128 209	128 209
Funding gap SC 1	(12 023)	(68 144)	(17 495)
Funding gap SC 2	(13 830)	(69 951)	(19 302)
Funding gap SC 3	(15 381)	(71 501)	(20 853)
% Gap SC1	-9.1%	-51.8%	-13.3%
% Gap SC2	-10.7%	-53.9%	-14.9%
% Gap SC3	-12.0%	-55.8%	-16.3%

Source: Authors' estimation based on data from the National Treasury (Multiple years)

9 CONCLUSION AND RECOMMENDATIONS

Overall, the study finds that the cost of addressing current deficits in infrastructure is substantial but this cost pales in comparison to future needs for additional classrooms and teachers. Just to address current backlogs related to toilets (i.e., make all toilets flush toilets), electricity, water, non-permanent classrooms made of mud/wood/clay, as well as broken floors and ceilings, will cost the Government of South Africa ZAR 9 billion, 40 percent of this cost is for upgrading/building toilets). If the cost of building laboratories, computer rooms and libraries in schools that do not have these facilities currently is added to this, the cost soars to ZAR 93 billion. Table 65 provides a summary. Aside from upgrading existing schools, there will be 1.2 million additional students entering the public education system in South Africa, even with a projected decline of 2.6 percent in Grade R, from 2020 to 2030. Majority of these additional students will be in secondary education, followed by primary education. Without any migration and with improvements in system efficiencies (i.e., full access with efficiency scenario), the capital costs of expanding primary and secondary education comes to about ZAR 9 billion (USD 595 million) on average per year (this includes ZAR 2 billion (USD 129 million) using the centralized implementation modality such as ASIDI/SAFE and ZAR

6.8 billion (USD 450 million) using the provincial construction modality, and ZAR 240 million (USD 16 million) using community modality.

Table 65: Summary of costs

Description	Costs	
	In Bn ZAR	**In Bn USD**
Address current infrastructure backlogs	9	0.5
Address current infrastructure backlogs and build laboratories	93.2	6.2
Expand primary and secondary education to accommodate additional students	81.1	5.4
Meet infrastructure demand towards SDG 4 targets	174.2	11.6

In order to meet the infrastructure demand (addressing the current deficits, and expanding schools for the anticipated admissions), towards the achievement of SDG 4 targets, i.e., ensuring that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and Goal-4 effective learning outcomes (Target 4.1) through building and upgrading education facilities that are child, disability, and gender sensitive and provide safe, nonviolent, inclusive, and effective learning environments for all (Target 4A), the government will require a total of ZAR 174.2 billion (ZAR 81.1 billion in expansion and ZAR 93.2 billion in upgrade). This does not include the costs of maintenance and other recurrent costs, which are embedded in the projected recurrent costs. It is important to note that recurrent costs cover salaries and other non-salary recurrent expenditure, including the acquisition of goods and services, operations and maintenance and subsidies to schools/institutions. Recurrent costs are projected to grow with the expansion and upgrade and as such assumed that this will cover the running and maintenance of facilities constructed from the capital costs. Our analysis estimates the additional recurrent costs associated with expansion to be approximately ZAR 51.3 billion for the 2022-30 period. This includes the hiring of a net additional 25 000 teachers.

Clearly, there is a need to consider how to reduce costs of construction in South Africa given the high costs of upgrading existing school facilities as well as the expansion to accommodate additional students and to remain on the path to meet the 2030 education goals. A few areas to consider include:

9.1 Review the minimum norms and standards for schools.

Given that the minimum norms and standards are a key driver of costs, the following issues should be reviewed:

9.1.1 Prioritizing the provision of the "Minimum" package of facilities rather than the "Optimum" package of facilities.

The tendency in South Africa has been to build schools that meet the optimum standards in terms of space and the types of facilities provided. For example, many new schools provide the "ideal" package such as a dining area or a school hall which are expensive and even classroom space is maximized rather than the minimum requirements which would clearly cost less. Given the significant needs of schools, the DBE may want to prioritize what facilities should be built in the first phase (the essential, minimum package) versus what facilities could be built in the second or third phase in the same school. Related to this, priority should be given to ensuring that existing schools meet the minimum standards related to flush toilets, access to water, electricity and elimination of inappropriate materials.

9.1.2 The digital connection of schools should become the norm.

This is a feasible next step given the progress South Africa has made in the provision of electricity to schools and the existing USAO requirements of the telecommunications licensing system in South Africa. There needs to be better monitoring of these USAOs by the Government of South Africa to ensure the most disadvantaged schools (Quintiles 1-3) are connected first and that the connection is high speed. The digital connection priority should start with the most disadvantaged schools offering secondary education and rapidly continue to primary schools. This will not only prepare schools for future crises and the need for remote learning but is also essential in promoting digital literacy in schools.

9.1.3 Shift from school-library buildings to classroom-libraries for primary school, and digital libraries for secondary schools.

Currently, 25 percent of public schools have a library, and the cost of building a library/media centre is three times the cost of building a classroom. Classroom libraries in primary school and virtual libraries for

secondary school are important alternatives to regular libraries and is a more sustainable alternative to the current gap of library-buildings:

- Classroom-libraries are more efficient than school-libraries to develop learners' reading skills and a love for reading in primary school. Books in a classroom makes it easier to access for students and are more likely to be used than central libraries that are often closed and difficult to navigate for younger children.
- Digital libraries particularly for secondary schools have several advantages: They can be accessed anywhere, anytime, and instantly (over the internet); they require less physical space in schools (usually a few computers connected to the internet); students can access potentially unlimited resources including open education resources and rich multi-media resources; digital resources do not deteriorate with use as compared to print materials; it is easier and cheaper to update digital materials and updates are instantly available; materials are easier to find through search functions as well as through sophisticated cataloguing systems; teachers and students can also contribute materials to the digital library; and digital libraries are indispensable to remote learning, building resilient education systems and for schools of the future where learners can learn anywhere and at any time. While there may be some challenges related to copyright issues, challenges with connectivity, teacher capacity and skills to use digital resources, the advantages of digital libraries over traditional libraries are clear.

9.2 Change the implementation modality mix for school construction

The unit cost analysis shows that decentralizing school construction to provinces is cheaper than centralized school construction as per the unit cost analysis. While there can be different modalities of construction in any country, as is the case in South Africa, the international trend in school construction has leaned towards increased decentralization to the local level. In South Africa, provincial school construction is dominant accounting for 71 percent of the funding towards overall school construction and maintenance. But there is an opportunity to decentralize even further to the community level through the engagement of SGBs:

9.2.1 There are opportunities for better value for money through community engagement

This option could be piloted in one or two provinces – or in parts of some provinces – prior to being rolled out if the outcomes are positive. Based on international knowledge, this approach is likely to be more cost-effective than the provincial level construction modality; and increases communities' ownership and interest in the school construction process. Building the capacity of communities/SGBs to manage this process will take time and resources, but the benefits accrued in terms of sustainability, community ownership are probably higher. These costs and benefits should be carefully reviewed during the implementation of the pilot. There are a handful of examples of community/SGB based school construction that the pilot could build on

9.2.2 Focus on small construction works rather than large ones.

Moving from the current implementation strategy, which tends to package large construction works that are business opportunities for large contractors, towards small construction packages would open opportunities for small contractors. This approach is in line with the recommendation above to focus on addressing the school facilities deficit in existing schools which are typically "small works"; e.g., latrine blocks, additional classrooms, replacement of some sub-standard or over-aged classrooms, admin-block, staff-room, etc. Small works tendered through local competitive bidding processes can also increase competition between small contractors, of which there are several in the construction industry in South Africa, resulting in lower costs. It will also strengthen the small- and medium-sized segment of the construction industry, which is a positive externality of this type of programme, as evidenced in many counties.

9.3 Build better data monitoring and dissemination systems for school construction to improve accountability and transparency.

There is a need to improve the data collection system in the following areas, to allow for regular and relevant analysis of the costs, effectiveness, and efficiency of school construction:

9.3.1 Ensure that NEIMS data systems are regularly updated and linked to EMIS.

One critical challenge in this study was not being able to match the student enrolment data by school with the infrastructure data by school. There were several missing schools and while the enrolment data was from 2020, the infrastructure data was from 2018. Ensuring these datasets are complete, consistent, updated in a timely manner is crucial to drive evidence-based policy analysis and decision-making. Particularly the NEIMS needs to be updated with data on new schools and schools that have been closed, as well as the number of other facilities that have been built each year. While the provincial UAMPs provides information on needs, the status of construction and future plans, it is not an effective tool for national level monitoring purposes since they are very detailed and non-standardized.

9.3.2 Develop a systematic process to collect data on costs of construction in the country.

To increase transparency and accountability in the school construction system, Implementing Agents (IAs) should be required to submit to DBE specific data on the programmes they implement, including designs, costs and outputs on an annual basis. This includes cost differences due to variations in bulk services required per site which could be attributed to differences in terrain. For example, larger sites would require longer electric/sewage/water pipelines, resulting in increased costs. This information was hard to come by for the study making the calculation of unit costs of construction challenging. DBE should be strengthened to be able to collect all the above-mentioned data, ensure its completeness, conduct annual analysis on the construction gap, and comparative analysis on the unit costs of the different construction programmes. Data should also be collected from municipalities through PEDs on their contribution to the provision of services (water, sanitation, and electricity) in schools. The analysis of this data should be communicated with the public to improve the overall transparency of the school construction system.

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ANNEXURES

Annex 1: Data sources used to analyse the infrastructure financing gap

- Data on existing school infrastructure:
  - Harmonized data from NEIMS 2018
  - Provincial UAMPS for various years
  - Data obtained directly from provincial depts. of education
- Data on enrolments:
  - EMIS for several years
  - GHS 2019 and 2020
- Current DBE norms and standards:
  - Regulations relating to minimum uniform norms and standards for public school infrastructure
  - Guidelines relating to planning for public school infrastructure
- Data on unit costs of construction:
  - Completion costs of infrastructure projects from implementing agents of the DBE's ASIDI
  - Provincial departments of education
  - Data from construction firms that have completed schools
- Population projections from (StatsSA, 2020) and (World Bank, 2021)

Annex 2: Estimation of number of classrooms

Most of the parameters applied in this study's analysis of the expansion of basic education have used 2020 as their baseline. It is also important for the understanding of the steps in estimating the number of classrooms that expansion of basic education is predicated on infrastructure needs, whose entry point is classrooms, i.e., future expansion of basic education is linked to the need of classrooms. It was therefore important to establish the number of classrooms in each and every school.

The starting point of the estimation was the 2013 NEIMS database, which had details of classrooms for each school in it. This database was merged with the 2020 dataset, which had enrolments, resulting in an array of more than 22 000 schools with enrolments and classrooms. The first assumption for these schools was the non-growth in classrooms, i.e., that the schools did not have too much expansion and as such increase in the number of classrooms between 2013 and 2020 is negligible and the increase if any is ignored.

The second was to scrutinize the schools to assess the validity of the classrooms in them. Indeed nearly 900 had learners in them but without classrooms, an odd occurrence for these many schools. Classrooms in affected schools was therefore estimated based on the average learners in a classroom for each of the levels of education using the function highlighted below

$$Classrooms \ = \alpha X_{preprimary} + \beta X_{primary} + \gamma X_{secondary} + \mu$$

Where: α, β and ϒ are coefficients of the average class size in respective levels of education; μ is a constant of the linear function; and Xs are enrolments in respective levels of education.

$$Classrooms \ = 0.004 * Enrol_{preprimary} + 0.017 * Enrol_{primary} + 0.019 * Enrol_{secondary} + 6.917$$

Annex 3: Estimating the unit cost of classrooms

Estimating the cost of a classroom was carried out to validate an existing cost of classrooms, around USD 118 900. To validate this cost, a database of 130 infrastructure contracts executed over a number of years was obtained from the DBE, with the contracts providing the cost of constituent facilities like classrooms, administration blocks, libraries, toilets etc., while some of the contracts had only the total sum of contract without details on facilities. The first step in the estimation was to adjust the costs of the contracts using GDP deflator to 2020 prices, since the contracts were from different years. 2020 had also been selected as the baseline for the simulation of expansion, and other expansion parameters had a base of 2020.

With the costs adjusted to 2020 prices, a multiple linear regression model was run on four selected variables, i.e., the overall value of available contracts, the cost of classrooms, cost of administration blocks and libraries, with the overall cost of contracts being the dependent variable, and the other three explanatory variables. Other facilities in the available contracts were not considered as they rendered the model misspecified (in most cases weakening the explanatory power of the model). As shown in Table 79, the model used in estimating the cost of facilities is strong, with the independent cost variables explaining nearly 60% of the variance observed in the overall cost of contracts (see the adjusted R-Squared).

Table 66: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.772[a]	.596	.587	1448748.2170

Source: Authors' computations based on contracts from CDC, DBSA

Testing for robustness of the model, results show significant influence of the independent cost of the three facilities on the overall value of the contracts considered (see Table 80). The test confirms that the preferred model is significantly better than the residual model, essentially clearing it for application in the estimation of the final cost of the facilities in question.

Table 67: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	3.904E+14	3	1.301E+14	62.008	.000[b]
	Residual	2.645E+14	126	2.099E+12		
	Total	6.549E+14	129			

Source: Authors' computations based on contracts from CDC, DBSA

The final model can be represented by the equation:

$$CC = \propto + \beta_1 C_{Classroom} + \beta_2 C_{Admin} + \beta_3 C_{Library}$$

Where:

CC= Contract cost; α = Constant coefficient; $\beta_1 =$ Coefficient for cost of classrooms; $\beta_2 =$ Coefficient for cost of administration block; and $\beta_3 =$ Coefficient for cost of libraries (see Table 81). From the model, it can be discerned that classrooms and admin blocks are both independently significant in the model, with the cost of libraries not being statistically significant independently but adds to the overall significance of the model. Other facilities like toilets, whose independent inclusion in the model rendered the model misspecified have been accommodated in the constant coefficient. From the results, the average cost of a classroom is taken from the classroom coefficient, estimating the cost of a classroom to USD 125 660, which is 6% from the existing cost of USD 118 900.

Table 68: Model coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	732 291.823	203 710.393		3.595	.000
	Classroom	125 660.988	14 503.191	.573	8.664	.000
	Admin block	206,013.861	63 358.997	.224	3.252	.001
	Library	338 764.439	196 384.826	.118	1.725	.087

Source: Authors' computations based on contracts from CDC, DBSA

Annex 4: Background to simulation models and navigation of the model for the expansion of basic education

Simulation models

Simulation models can be considered as planning tools that project future possibilities of systems, based on random or deliberate assumptions. The projected future could be in any of the sectors of the economy, including education. The 2030 education agenda, for instance, is built on the assumption of universal access to quality and inclusive education i.e., that all children eligible for education would access school regardless of their background, and that education offered to them would of universally accepted quality. The assumption that all eligible children would access school, alone can be used to trigger potential cost of having the children in school. If we knew the cost of schooling a child in the present time, we could use that cost to estimate how much it would cost to school all eligible children, assuming that all other factors could be held constant. A simulation model can be used to project such a future, the number of children who will potentially be in school and the associated needs that they would trigger, if their stay in school were to count. We refer to the tool as simulation because the imagined future state can be manipulated (simulated) until the desired balance in terms of inputs and results is achieved. Although any aspect of a system expansion can be forecasted, we limit the function of a simulation model in this note to a financial tool that projects the likely population of students and support structure (staff and infrastructure) and the associated cost, which includes the cost of evolution of the system towards the desired future, and most importantly, the cost of sustaining the system once the desired future state is attained.

Financial simulation models can be categorized as either basic or advanced, depending on the approach used in computing the projected costs. In the first case, the total present expenditure on the system being projected and the total beneficiaries can be used to compute the average spending per beneficiary. This unit spending can be held constant throughout the simulated future such that future costs will be varying on the number of expected beneficiaries. The second case, the advanced category of models, involves disaggregation, with a high level of detail in terms of the expenditure items and the beneficiaries. Advanced models will decompose various costs associated with training an individual in a given level of education i.e., annual cost towards instructors, cost towards operation of an institution; cost towards the

use of libraries and workshops; costs towards maintenance of assets; costs towards mobility of faculty etc. On the beneficiaries side, advanced models would be interested in learners in a given pathway or discipline of learning, as opposed to basic models which would consider the overall volume of learners in school. The difference between the two options lies in the details of the cost parameters involved. Although a detailed simulation model would result in higher precision of future results and costs, it is important to note that the level of detail is dependent on data availability. In choosing between the application of basic and advanced simulation models, it is always advisable to have a good balance between detail and communication such that the model has adequate detail for transparency in the projected results and costs but also aggregated enough to make the model easy to interpret by stakeholders.

Purpose and limitations of simulation models

Simulation models should be viewed as decision support tools, particularly helpful in assessing the cost and impact of different future policy options. Simulation models allow for the development or creation of multiple future scenarios, whose potential results are displayed side to side, so that decisions on them can be taken. For instance, a simulation model will present the cost of universalization of basic education (100 percent of eligible children coming to school and staying in school until a prescribed exit, meaning 100 percent completion) alongside another scenario which moves the Gross Intake Rate (GIR) only a little higher (we assume in the second case that access to school is not universal.) Decision would have to be made on these two scenarios. In some cases there can be three or more scenarios to be considered. A superior scenario would have to be picked among the presented scenarios. The simulation model would have aided those with the power to choose to pick an option that is ambitious enough but also cost sensitive to the environment. Simulation models can be developed for an entire education system, or for sub systems, depending on the need. In the former case, simulation models can ensure harmonious and coherent development of the different sub-sectors. This kind of model will demonstrate how the expansion of one of the sub sectors is likely to affect another. A full model will for instance demonstrate how increasing participation in lower levels of an education system is likely to increase future participation in higher levels, as one would be able to see the student flow from one sub system to another.

Logic of simulation models and decision parameters

Simulation models are founded on three fundamental logical steps, as illustrated in Figure 37. The first step involves identification of beneficiaries or the demand for schooling. The expected population of students in the future must be imagined. Starting from the total population of a country, simulation models can segment the population into ages that are relevant for each sub education system. For instance, in South Africa, children aged 6-12 would be eligible for primary; 13-18 for secondary; and 18-24 for TVET and higher education. The segmented population can be considered as the gross demand for education and training services in the country.

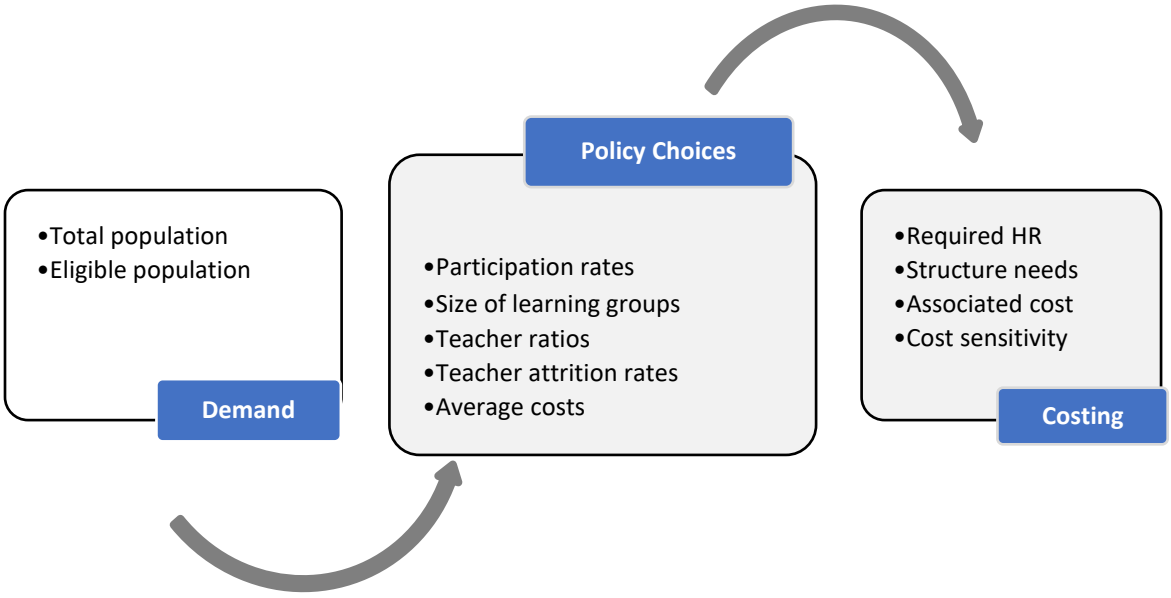


Figure 38: Common logic of simulation models

The second step involves the decision on key policy choices, including school participation rates, which would translate gross demand to the number of learners that will potentially be in school. For example, the Gross Intake Rate at the beginning of primary can be used to compute how many learners of school entry age are likely to enrol in school. In the case of TVET and higher education, which have no definitive age range, crude participation rates like the number of students per certain count of population can be used to estimate and/or project how many students, out of the projected population are likely to be in

higher education institutions. Other policy parameters that may be considered in this second step include how to organize the expected students into learning groups. The size of learning groups will determine how many structures are to be added on to the existing ones to accommodate the increased population of learners. Teacher ratios will determine how many additional teachers will be required to sustain the expected number of students. The average costs for these different elements will be key in computing the costs of different elements not only in the present but also in the future. The final step entails computing the volume of needs and their associated costs. In this last stage, simulation models mostly provide estimates of the human resources required to drive the expansion and sustaining it; the physical infrastructure that will comfortably accommodate the increased population. Apart from the costs associated with the expansion, simulation models provide insights on the sensitivity of the costs. For instance, the costs relative to known benchmarks; the financing gap based on the costs and resources expected to be available in the sector in future.

Structure of simulation models and data needs

Simulation models built for projecting education systems are often developed as blocks of the sub sectors. It is common to find simulation models built in blocks of pre-school, primary, secondary, TVET, university education and teacher training. Most models separate these blocks by recurrent and development needs since each sub sector has different needs in either category. Simulation models can be full targeting an entire education system or may focus on a particular sub sector. The advantage of a full model is that the effects of policy decisions taken in one sub sector to another can be clear. A sub sector specific model will often obscure the effects to other sub sectors, especially on the balance of costs. Simulation models exist in different forms, ranging from MS Excel to sophisticated application based models. The simulation model behind the expansion of basic education and TVET is built on the highly accessible MS Excel, which means nearly every stakeholder who has access to MS Excel can access and manipulate the model.

Apart from the operational definition we gave to simulation models in the opening section, simulation models can be considered as processors which process data from the sector and only displays results. In this context, a simulation model is as good as the data provided for processing. Supplying reliable data into a simulation model would result in reliable projections just as much as unreliable data would result

in inaccurate projections. It is for this reason that baseline data, used as the launchpad for future projections, should be reliable. In addition, simulation models should be accompanied with strong analytical background that can support the policy orientation of the parameters used in the model. For instance, having a strong analysis of enrolment patterns in basic education, will inform whether jumping from a GIR of 70% to 100% would be feasible in the considered context. A strong diagnostic can help in regulating the ambitions set in the model so as to have a balanced future vision.

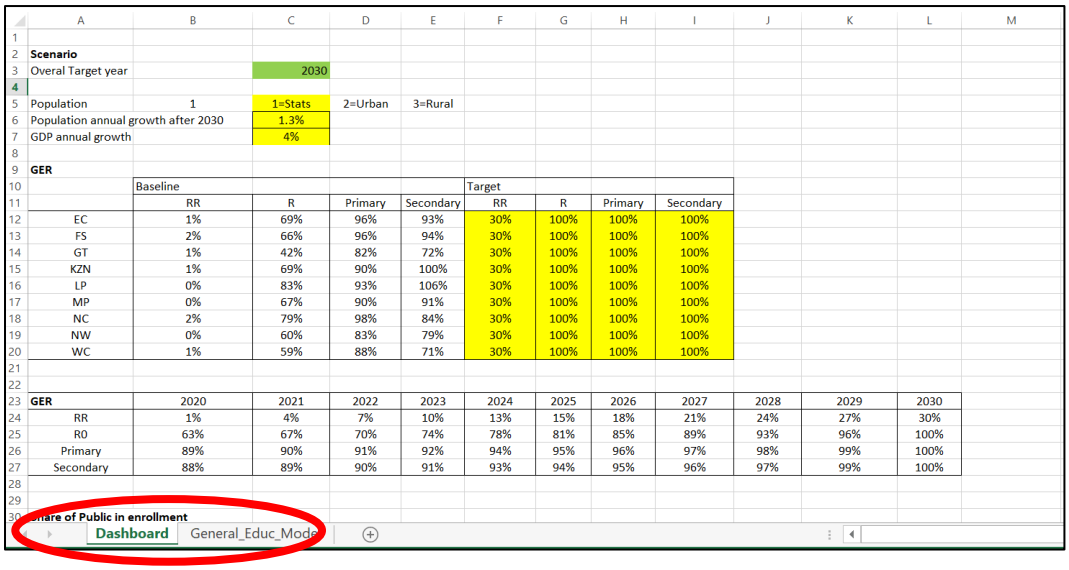
Navigating simulation models

As a processor, a simulation is developed with two functional handles i.e. an engine and a dashboard. The engine of a simulation model, like in most machines, can appear sophisticated to people who are not technicians. This does not mean that the engine is inaccessible. The dashboard will always appear less sophisticated, and maybe easier to access. Dashboards often contain only useful buttons that can be used to give instructions to an engine. In a similar manner, the dashboard in a simulation model works the same. In the dashboard of a simulation model, only relevant parameters are made visible to users. One can manipulate the said parameters, which are parsed to the engine, and results are sent back to the user. Being decision tools, simulation models are mostly useful to policy makers, who often do not have adequate time to look at the complete engine (the full model, or the more sophisticated view). Instead, they have time to look at the essential parts of the model, and this is where the dashboard comes in handy, as will be demonstrated shortly. A dashboard allows users to manipulate key parameters driving the engine and view results of their choices at the same time. It is important to note that while the engine of the model (or the full model) is accessible by any user, the dashboard is more recommended to navigate models through the dashboard. Let us turn to navigation of the basic education simulation model through the two approaches.

Navigating simulation models from the dashboard

Dashboards often contain parameters that are known to its users, making them easier to navigate, whether one is at a policy or technical level. Typically, the engine and dashboard of a simulation model developed in MS Excel will appear in adjacent Worksheets of an MS Excel Workbook as illustrated in Figure 38. Apparent from the Dashboard Worksheet, the parameters in display are common to most education

planners. Population, which was discussed to be the entry point in simulation models is high on the list of parameters. We have the population growth rate, and the growth in the gross domestic product, which are important policy parameters. The dashboard also highlights the gross enrolment rate in each of the provinces for the four levels of basic education (RR, R, primary and secondary). It is important to note that the table with gross enrolment rates shows the baseline as well as targets. A user would have to supply a target GER in the yellow cells, which would then be parsed to the engine (General_Educ_Model.) In most simulation models, most of the policy choices would be supplied through coloured cells (in the case of this model, the yellow cells.) For instance the population growth can be changed to a slower or faster growth by changing the contents of cell C6. Either choices will affect future population, and consequently the potential future demand for education, and ultimately the response to the demand.



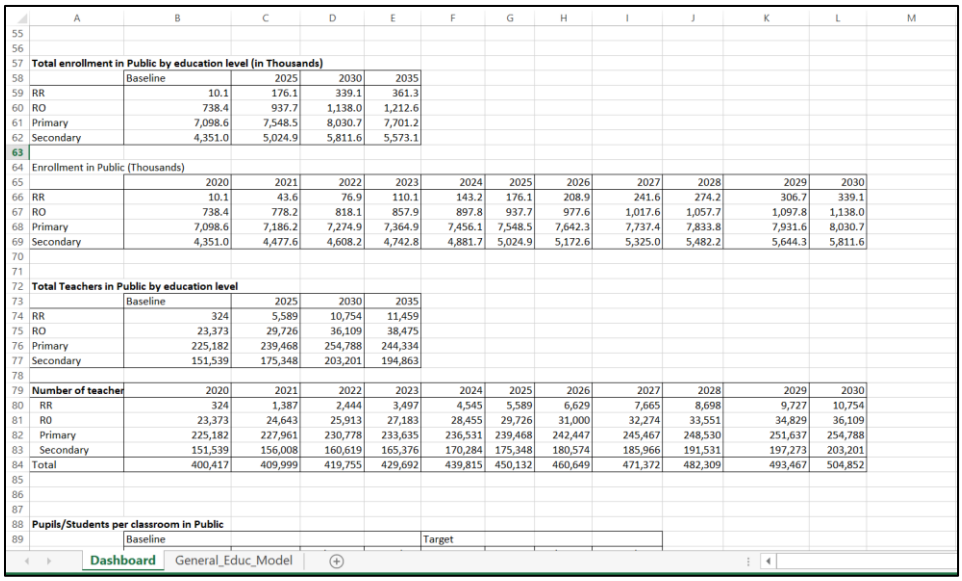
	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2	**Scenario**												
3	Overal Target year		2030										
4													
5	Population	1	1=Stats	2=Urban	3=Rural								
6	Population annual growth after 2030		1.3%										
7	GDP annual growth		4%										
8													
9	**GER**												
10		Baseline				Target							
11		RR	R	Primary	Secondary	RR	R	Primary	Secondary				
12	EC	1%	69%	96%	93%	30%	100%	100%	100%				
13	FS	2%	66%	96%	94%	30%	100%	100%	100%				
14	GT	1%	42%	82%	72%	30%	100%	100%	100%				
15	KZN	1%	69%	90%	100%	30%	100%	100%	100%				
16	LP	0%	83%	93%	106%	30%	100%	100%	100%				
17	MP	0%	67%	90%	91%	30%	100%	100%	100%				
18	NC	2%	79%	98%	84%	30%	100%	100%	100%				
19	NW	0%	60%	83%	79%	30%	100%	100%	100%				
20	WC	1%	59%	88%	71%	30%	100%	100%	100%				
21													
22													
23	**GER**	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
24	RR	1%	4%	7%	10%	13%	15%	18%	21%	24%	27%	30%	
25	R0	63%	67%	70%	74%	78%	81%	85%	89%	93%	96%	100%	
26	Primary	89%	90%	91%	92%	94%	95%	96%	97%	98%	99%	100%	
27	Secondary	88%	89%	90%	91%	93%	94%	95%	96%	97%	99%	100%	
28													
29													
30	**Share of Public in enrollment**												

Dashboard | General_Educ_Model

Figure 39: An example of dashboard of simulation model

Once all possible policy choices have been made i.e., by supplying the desired targets corresponding to the selected indicators/parameters, the implication of the choices can be viewed in the same sheet. Figure 39 highlights the results of the selected levels of parameters, showing likely enrolment in basic education, and the teachers who will potentially be in the system, based on the selected parameters on population, sharing of enrolment between public and private schools, and the norms and standards guiding distribution of teachers to schools (Pupil Teacher Ratios.) For instance, cell rage A57:E62 (Figure 39) shows

that enrolments will grow from 4.4 million in 2020 to 5.6 million by 2035, with cell range A65:L69 showing annual evolution of the same results. Similarly, the number of teachers likely to be in basic education is highlighted in cell range A73:E77 for five-year intervals, while the annual evolution is given in cell range A78:L84. At all times, users should remember that the results displayed in the dashboard are based on the multiple targets applied to the model. This means that different results can be achieved by changing policy targets. Should the indicative results be high, the policy targets can be lowered and vice versa to achieve the desired balance discussed before.

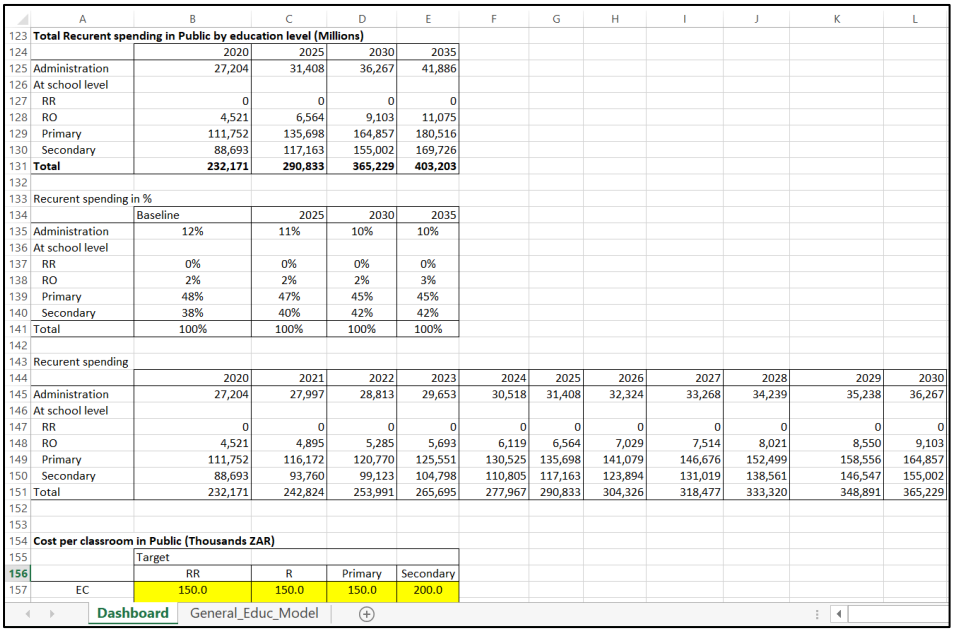


	A	B	C	D	E	F	G	H	I	J	K	L	M
55													
56													
57	**Total enrollment in Public by education level (in Thousands)**												
58		Baseline	2025	2030	2035								
59	RR	10.1	176.1	339.1	361.3								
60	RO	738.4	937.7	1,138.0	1,212.6								
61	Primary	7,098.6	7,548.5	8,030.7	7,701.2								
62	Secondary	4,351.0	5,024.9	5,811.6	5,573.1								
63													
64	Enrollment in Public (Thousands)												
65		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
66	RR	10.1	43.6	76.9	110.1	143.2	176.1	208.9	241.6	274.2	306.7	339.1	
67	RO	738.4	778.2	818.1	857.9	897.8	937.7	977.6	1,017.6	1,057.7	1,097.8	1,138.0	
68	Primary	7,098.6	7,186.2	7,274.9	7,364.9	7,456.1	7,548.5	7,642.3	7,737.4	7,833.8	7,931.6	8,030.7	
69	Secondary	4,351.0	4,477.6	4,608.2	4,742.8	4,881.7	5,024.9	5,172.6	5,325.0	5,482.2	5,644.3	5,811.6	
70													
71													
72	**Total Teachers in Public by education level**												
73		Baseline	2025	2030	2035								
74	RR	324	5,589	10,754	11,459								
75	RO	23,373	29,726	36,109	38,475								
76	Primary	225,182	239,468	254,788	244,334								
77	Secondary	151,539	175,348	203,201	194,863								
78													
79	**Number of teacher**	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
80	RR	324	1,387	2,444	3,497	4,545	5,589	6,629	7,665	8,698	9,727	10,754	
81	R0	23,373	24,643	25,913	27,183	28,455	29,726	31,000	32,274	33,551	34,829	36,109	
82	Primary	225,182	227,961	230,778	233,635	236,531	239,468	242,447	245,467	248,530	251,637	254,788	
83	Secondary	151,539	156,008	160,619	165,376	170,284	175,348	180,574	185,966	191,531	197,273	203,201	
84	Total	400,417	409,999	419,755	429,692	439,815	450,132	460,649	471,372	482,309	493,467	504,852	
85													
86													
87													
88	**Pupils/Students per classroom in Public**												
89		Baseline				Target							

Dashboard | General_Educ_Model

Figure 40: Results from selected policy choices in the basic education model

The costs of additional teachers and the infrastructure for accommodating the increased population of learners can be viewed in the same Dashboard Worksheet. Cell range A124:E132 presents the total recurrent expenditure between 2020 and 2035 in intervals of 5 years. The annual recurrent costs between 2020 and 2030 are presented in cell range A144:L151. Although truncated in Figure 40, the cost of classrooms can be seen in the same window. Alongside these results, the Dashboard typically shows the resources that are likely to be available to the sector, and in this case basic education, to help with decision on whether the resulting cost can be accommodated in the projected fiscal space.



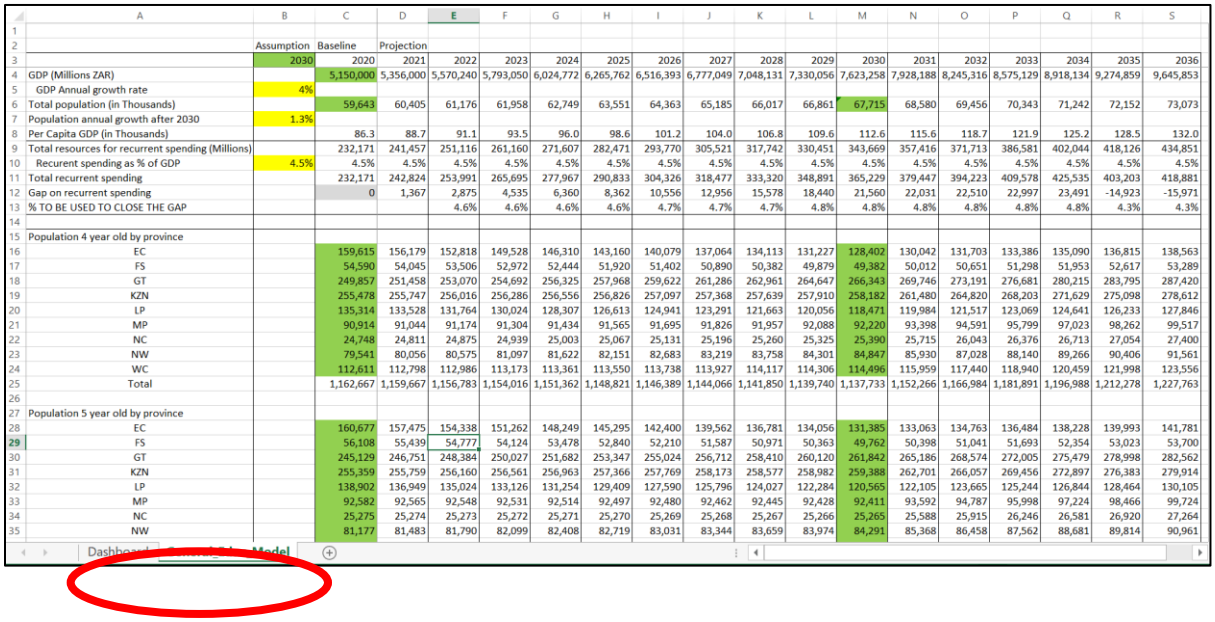
	A	B	C	D	E	F	G	H	I	J	K	L
123	**Total Recurent spending in Public by education level (Millions)**											
124		2020	2025	2030	2035							
125	Administration	27,204	31,408	36,267	41,886							
126	At school level											
127	RR	0	0	0	0							
128	RO	4,521	6,564	9,103	11,075							
129	Primary	111,752	135,698	164,857	180,516							
130	Secondary	88,693	117,163	155,002	169,726							
131	**Total**	**232,171**	**290,833**	**365,229**	**403,203**							
132												
133	Recurent spending in %											
134		Baseline	2025	2030	2035							
135	Administration	12%	11%	10%	10%							
136	At school level											
137	RR	0%	0%	0%	0%							
138	RO	2%	2%	2%	3%							
139	Primary	48%	47%	45%	45%							
140	Secondary	38%	40%	42%	42%							
141	Total	100%	100%	100%	100%							
142												
143	Recurent spending											
144		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
145	Administration	27,204	27,997	28,813	29,653	30,518	31,408	32,324	33,268	34,239	35,238	36,267
146	At school level											
147	RR	0	0	0	0	0	0	0	0	0	0	0
148	RO	4,521	4,895	5,285	5,693	6,119	6,564	7,029	7,514	8,021	8,550	9,103
149	Primary	111,752	116,172	120,770	125,551	130,525	135,698	141,079	146,676	152,499	158,556	164,857
150	Secondary	88,693	93,760	99,123	104,798	110,805	117,163	123,894	131,019	138,561	146,547	155,002
151	Total	232,171	242,824	253,991	265,695	277,967	290,833	304,326	318,477	333,320	348,891	365,229
152												
153												
154	**Cost per classroom in Public (Thousands ZAR)**											
155		Target										
156		RR	R	Primary	Secondary							
157	EC	150.0	150.0	150.0	200.0							

Dashboard | General_Educ_Model

Figure 41: Possible cost of sustaining the needs of basic education

Navigating simulation models from the engine

The second option of accessing the simulation model is to consider the full model or the engine (see Figure 41). The model can be read in columns as follows: Column A of the model highlights the parameter applied; column C, the baseline or the starting point; column B, the policy target or policy assumptions, which underline the sector vision for that parameter; and columns D-S, the annualized evolution of policy targets, inputs and costs. Apart from the columns, the model can be appreciated in blocks of rows, which include macroeconomic parameters (gross domestic product, population, population growth, spending on education etc.), organization of learning and student flow in RR, R, primary and secondary; and the associated spending on each of the levels etc. which are elaborated in the subsequent sub sections.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1																			
2		Assumption	Baseline	Projection															
3		2030	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
4	GDP (Millions ZAR)		5,150,000	5,356,000	5,570,240	5,793,050	6,024,772	6,265,762	6,516,393	6,777,049	7,048,131	7,330,056	7,623,258	7,928,188	8,245,316	8,575,129	8,918,134	9,274,859	9,645,853
5	GDP Annual growth rate	4%																	
6	Total population (in Thousands)		59,643	60,405	61,176	61,958	62,749	63,551	64,363	65,185	66,017	66,861	67,715	68,580	69,456	70,343	71,242	72,152	73,073
7	Population annual growth after 2030	1.3%																	
8	Per Capita GDP (in Thousands)		86.3	88.7	91.1	93.5	96.0	98.6	101.2	104.0	106.8	109.6	112.6	115.6	118.7	121.9	125.2	128.5	132.0
9	Total resources for recurrent spending (Millions)		232,171	241,457	251,116	261,160	271,607	282,471	293,770	305,521	317,742	330,451	343,669	357,416	371,713	386,581	402,044	418,126	434,851
10	Recurent spending as % of GDP	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
11	Total recurrent spending		232,171	242,824	253,991	265,695	277,967	290,833	304,326	318,477	333,320	348,891	365,229	379,447	394,223	409,578	425,535	403,203	418,881
12	Gap on recurrent spending		0	1,367	2,875	4,535	6,360	8,362	10,556	12,956	15,578	18,440	21,560	22,031	22,510	22,997	23,491	-14,923	-15,971
13	% TO BE USED TO CLOSE THE GAP				4.6%	4.6%	4.6%	4.6%	4.7%	4.7%	4.7%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.3%	4.3%
14																			
15	Population 4 year old by province																		
16	EC		159,615	156,179	152,818	149,528	146,310	143,160	140,079	137,064	134,113	131,227	128,402	130,042	131,703	133,386	135,090	136,815	138,563
17	FS		54,590	54,045	53,506	52,972	52,444	51,920	51,402	50,890	50,382	49,879	49,382	50,012	50,651	51,298	51,953	52,617	53,289
18	GT		249,857	251,458	253,070	254,692	256,325	257,968	259,622	261,286	262,961	264,647	266,343	269,746	273,191	276,681	280,215	283,795	287,420
19	KZN		255,478	255,747	256,016	256,286	256,556	256,826	257,097	257,368	257,639	257,910	258,182	261,480	264,820	268,203	271,629	275,098	278,612
20	LP		135,314	133,528	131,764	130,024	128,307	126,613	124,941	123,291	121,663	120,056	118,471	119,984	121,517	123,069	124,641	126,233	127,846
21	MP		90,914	91,044	91,174	91,304	91,434	91,565	91,695	91,826	91,957	92,088	92,220	93,398	94,591	95,799	97,023	98,262	99,517
22	NC		24,748	24,811	24,875	24,939	25,003	25,067	25,131	25,196	25,260	25,325	25,390	25,715	26,043	26,376	26,713	27,054	27,400
23	NW		79,541	80,056	80,575	81,097	81,622	82,151	82,683	83,219	83,758	84,301	84,847	85,930	87,028	88,140	89,266	90,406	91,561
24	WC		112,611	112,798	112,986	113,173	113,361	113,550	113,738	113,927	114,117	114,306	114,496	115,959	117,440	118,940	120,459	121,998	123,556
25	Total		1,162,667	1,159,667	1,156,783	1,154,016	1,151,362	1,148,821	1,146,389	1,144,066	1,141,850	1,139,740	1,137,733	1,152,266	1,166,984	1,181,891	1,196,988	1,212,278	1,227,763
26																			
27	Population 5 year old by province																		
28	EC		160,677	157,475	154,338	151,262	148,249	145,295	142,400	139,562	136,781	134,056	131,385	133,063	134,763	136,484	138,228	139,993	141,781
29	FS		56,108	55,439	54,777	54,124	53,478	52,840	52,210	51,587	50,971	50,363	49,762	50,398	51,041	51,693	52,354	53,023	53,700
30	GT		245,129	246,751	248,384	250,027	251,682	253,347	255,024	256,712	258,410	260,120	261,842	265,186	268,574	272,005	275,479	278,998	282,562
31	KZN		255,359	255,759	256,160	256,561	256,963	257,366	257,769	258,173	258,577	258,982	259,388	262,701	266,057	269,456	272,897	276,383	279,914
32	LP		138,902	136,949	135,024	133,126	131,254	129,409	127,590	125,796	124,027	122,284	120,565	122,105	123,665	125,244	126,844	128,464	130,105
33	MP		92,582	92,565	92,548	92,531	92,514	92,497	92,480	92,462	92,445	92,428	92,411	93,592	94,787	95,998	97,224	98,466	99,724
34	NC		25,275	25,274	25,273	25,272	25,271	25,270	25,269	25,268	25,267	25,266	25,265	25,588	25,915	26,246	26,581	26,920	27,264
35	NW		81,177	81,483	81,790	82,099	82,408	82,719	83,031	83,344	83,659	83,974	84,291	85,368	86,458	87,562	88,681	89,814	90,961

Dashboard | Model

Figure 42: View of the full simulation model for basic education

The full model is a consolidation of blocks/sub models linked by formulas that operate on sector specific parameters and targets. These blocks include:

1. **The macroeconomic parameters block** which presents and projects the growth of the economy and the expenditure on education, with expression of these spending relative to the GDP (a common benchmark in education expenditure). Using this benchmark and future size of the economy, this block projects the resources that are likely to be available to the sector. This block facilitates comparison of costs and resources to determine whether the development scenario is viable or not.
2. **A population block** which projects the eligible school-aged children based on the existing population from the National Statistics Agency and the trends in population growth. This block is the foundation of the expansion, without which future student enrolment may not be reliably projected.
3. **Student enrolment and student flow parameters block** which determines the entry of students to the various levels of education; how they are shared between private and public schools; how they progress to various grades (or repeat);
4. **Enrolment and teachers blocks** which simulate the interaction between teachers and learners based on the PTR parameter, thereby determining how many teachers are likely to be needed in basic

education, given the number of learners in public education streams for the four levels of education (RR, R, primary and secondary); and

5. **Infrastructure block** which simulates the number of facilities required to sustain the number of additional students expected to join and remain in the system as guided by the enrolments block. The facilities are determined not only by the number of students expected to be in the system but also by the norms of usage of the facilities. For instance, there could be a standard class size; there could be a standard ratio in the usage of sanitation facilities; there could be standard ratios in the usage of science laboratories etc.

Setting policy targets and viewing costs of expansion

To set policy targets in the full model, one should remember that only green-shaded and yellow-shaded cells can be edited. The green shaded cells can be edited to supply the baseline figures corresponding to a parameter in question (in column C) while the yellow-shaded cells can be edited to supply the policy target or vision (in Column B.) Typically, future costs associated with these policy targets are provided at the end of each block. For instance, at the end of the RR block, the model provides the summary of annual costs that are associated with admitting a given percentage of children to school; directing a given share of these learners to public schools; organizing these learners according to some desired class sizes, and instructing them based on some desired PTRs. The only limitation of the full model is the fact that there is more than enough information available in a single view, which certainly undermines comparison of scenarios. In contrast, the dashboard has limited information, which allows room for useful visuals, which can aid in decision making.

Annex 5: Population Estimate

Table 69: Scenarios of population increase between 2020 and 2030 by Stats SA and update by World Bank

Province	Population Census	Stats SA projection for 2030						Stats SA projections updated by World Bank for 2030					
		Past population growth			Baseline scenario			Urban scenario			Rural scenario		
	2011	2020	Growth 2011-2020		2030	2020 to 2030		2030	2020 to 2030		2030	2020 to 2030	
Eastern Cape	6 555 444	6 750 832	195 388	3 %	6 666 950	(83 882)	-1 %	7 232 273	481 440	7 %	7 395 747	644 914	10 %
Free State	2 745 155	2 928 066	182 911	7 %	3 044 300	116 234	4 %	3 299 535	371 468	13 %	3 249 785	321 718	11 %
Gauteng	12 271 226	15 483 870	3 212 644	26 %	19 168 436	3 684 566	24 %	20 254 375	4 770 505	31 %	19 579 909	4 096 039	26 %
KwaZulu-Natal	10 263 829	11 532 602	1 268 773	12 %	12 865 550	1 332 948	12 %	13 726 176	2 193 575	19 %	14 272 784	2 740 182	24 %
Limpopo	5 402 393	5 856 308	453 916	8 %	6 203 542	347 234	6 %	5 578 571	(277 737)	-5 %	5 740 833	(115 476)	-2 %
Mpumalanga	4 039 512	4 684 59	644 947	16 %	5 327 623	643 164	14 %	4 465 325	(219 134)	-5 %	4 517 696	(166 763)	-4 %
Northern Cape	1 145 394	1 293 148	147 754	13 %	1 427 408	134 260	10 %	1 206 908	(86 240)	-7 %	1 187 535	(105 613)	-8 %
North West	3 509 733	4 107 035	597 302	17 %	4 769 356	662 321	16 %	3 869 242	(237 793)	-6 %	3 922 458	(184 577)	-4 %
Western Cape	5 821 810	7 006 713	1 184 903	20 %	8 241 664	1 234 951	18 %	8 082 423	1 075 711	15 %	7 848 082	841 370	12 %
South Africa	51 754 496	59 643 032	7 888 536	15 %	67 714 828	8 071 796	14 %	67 714 828	8 071 796	14 %	67 714 828	8 071 796	14 %

Annex 6: ICT and education in schools in South Africa

South Africa has made strides to deploy technology in schools. EdTech in South Africa has a long history but was given impetus by the White Paper on e-Education 2004 which called for the use of technology to improve teaching and learning (Republic of South Africa, 2004). It wasn't until 2015 that a digital library project was launched by DBE through a public-private partnership (DBE, n.d.). The DBE also launched an Education Cloud which was a central portal hosting digital resources called the DBE Cloud.

The high ambitions of the White Paper have not been achieved by the DBE in 2020 (at which point all schools were supposed to have EdTech) acknowledging that "The implementation of ICT in education is far below the goal of the White Paper 7 on e-Education (2004)" (DBE, 2020). While the richer provinces were able to mobilize funding for EdTech, many of the poorer Provinces and schools relied on the USAO required as part of telecommunications licensing regime starting in 2004. Under the USAO, telecom license holders (Vodacom, MTN, Cell C, Neotel/Liquid Telecom) were required to provide a combined total of 5 250 public schools with Internet connectivity and ICT equipment as part of their obligations (Republic of South Africa, 2014). The ICT equipment includes student devices, a teacher device, a local area network to inter-connect the devices, software and secure storage and charging facilities.

Under USAO, 6858 schools (representing almost 30 percent of public schools) have been connected as of 2020 (Independent Communcations Authority of South Africa , 2021) and the connectivity has been accompanied by ICT equipment. The DBE estimates that 70 percent of all schools are now connected to the internet of which only 8 percent have "high speed connectivity" while the rest have "low speed connectivity" (DBE, 2020). It is estimated that 40 percent of all public schools now have EdTech deployed in the school, mostly in the form of computer labs (SApeoplenews, 2020). However, it is not clear if those schools with labs are using digital libraries.

In 2019, the South African Government reaffirmed its commitment to EdTech and the provision of digital learning resources: "Over the next six years, we will provide every school child in South Africa with digital workbooks and textbooks on a tablet device. We will start with those schools that have been historically most disadvantaged and are located in the poorest communities, including multigrade, multiphase, farm and rural schools. Already, 90 percent of textbooks in high enrolment subjects across all grades and all workbooks have been digitized."- President Cyril Ramaphosa (South African Government , 2019). This

new programme focuses on digital LTSM delivered through ICTs and therefore could form the cornerstone for a national digital library programme.

Annex 7: Minimum Norms and Standards

The MNS are adjusted to nine sizes of school. Schools are categorized into 3 main categories: *micro-schools*, *primary schools*, and *secondary schools*. Each category is further subdivided into 3 sub-categories: *small*, *medium* and *large schools*, and the MNS provides the minimum package of facility for each of the nine sub-categories. However, there are two main differences between the *Regulations relating to minimum uniform norms and standards for public school infrastructure* (MNS), 2013, and the *Guidelines relating to planning for public school infrastructure,* 2012.

- The *Regulations relating to minimum uniform norms and standards* include norms and standards for *micro Schools* (up to 125 learners), while the *Guidelines relating to planning for public school infrastructure* do not mention micro schools.
- The *Regulations relating to minimum uniform norms and standards* present only a minimum size for each type of classroom (for example, 48m^2 for a classroom), while the *Guidelines relating to planning for public school infrastructure* provide guidance on the area of each room along with "*minimum*" and "*optimum*" functionality of the area. For instance, the classroom area is 48m^2 for the minimum and 60 m^2 for the optimum.

Table A7.1 provides the minimum and optimum areas of the main rooms from the Guidelines.

Table A7.1: Minimum and optimum Standard areas of the Minimum package of education areas

Minimum Education Area	Minimum area (m2)	Optimum area (m2)
Class-room	48	60
Grade R classroom	60	80
Multi-purpose room	60	80
Science Labora-tory	60	80
School library/ Media center	60	120
Multi-media center	80	120
Storage per class-room	12	15
Toilet	1.2	1.8
Principal office	15	20
Admini-stration office	15	20
Strong room	6	10
Staff room	48	60
Kitche-nette	12	20

Source. Authors' table with data from DBE 2012.

The 2013 *Regulations relating to minimum uniform norms and standards* (DBE 2013) provides detailed norms and standards for micro schools of less than 125 learners, organized in small, medium and large categories, with 1-2, 2-4 and 4-6 classrooms. Table A7.2 combines the minimum list of areas with the minimum area for each of the items in the list for the Micro Schools. The standard "Educational package" is composed of 3 types of rooms: classrooms, Gr. R classroom and multipurpose room. The standard "Administration package" is composed of 4-5 rooms. In addition, guidance on a "Covered dining area," is included although it is not part of the minimum packages of the two upper groups of schools (primary and secondary).

Table A7.2: Minimum education norms and standards for micro schools (below 125 learners)

SMALL MICRO SCHOOL Less than 25 learners		Nb	unit area	1 clrm	2 clrm
Grade R classroom		1	60	60	60
Classrooms		1-2	48	48	96
Mulipurpose room [1]		1	60	60	60
Admi-nistra-tion areas	Principal's office	1	20	20	20
	Admin office [2]	1	20	20	20
	Strong room	1	10	10	10
	Staff Kitchenette	1	12	12	12
Covered dining area		1	100	100	100
Parking bays					
Toilets as per enrollment		4-5	1.2	4.8	6
Nutrition center [3]					
Recreation and physical edu.					
Total constructed areas				335	384
Ratio all areas / clrm areas [4]				**3.1**	**2.5**

MEDIUM MICRO SCHOOL 26 to 65 learners		Nb	2 clrm	4 clrm
Grade R classroom		1	60	60
Classrooms		2-4	96	192
Mulipurpose room [1]		1	60	60
Admi-nistra-tion areas	Principal's office	1	20	20
	Admin office	1	20	20
	Strong room	1	10	10
	Staff room	1	60	60
	Staff Kitchenette	1	12	12
Covered dining area		1	100	100
Parking bays				
Toilets as per enrollment		5	4.8	6
Nutrition center if needed				
Recreation and physical edu.				
Total constructed areas			383	480
Ratio all areas / clrm areas [4]			**2.5**	**1.9**

LARGE MICRO SCHOOL 66 to 125 learners		Nb	4 clrm	6 clrm
Grade R classroom		1	60	60
Classrooms		4-6	192	288
Mulipurpose room [1]		1	60	60
Admi-nistra-tion areas	Principal's office	1	20	20
	Admin office	1	15	15
	Strong room	1	6	6
	Staff room	1	60	60
	Staff Kitchenette	1	12	12
Covered dining area		1	100	100
Parking bays				
Toilets as per enrollment		5-7	6	8.4
Nutrition center if needed				
Recreation and physical edu.				
Total constructed areas			471	569
Ratio all areas / clrm areas [4]			**1.9**	**1.6**

Note: [1] Library/Computer/Science Laboratory; [2] also Staff room; [3] where National School Nutrition Program is implemented; [4] classroom area also includes Grade R classroom. Source: Authors' table with data from *Regulations relating to minimum uniform norms and standards* for schools (DBE 2013)

There is an important *economy of scale* in terms of ratio of classroom area compared to the total constructed area, when moving from a 1-classroom school (below 13 learners) to the 2-classroom school (below 25 learners) and up to the 6-classoorm school (65 to 125 learners). The total constructed areas represent 3 times the classrooms' area (including the Grade R classroom) in the school of one classroom, and this ratio declines to 2.4, 1.8, and 1.6 respectively for schools of 2, 4 and 6 classrooms. Question for consideration with regard to cost-efficiency for equitable quality education in micro schools include:

- For small micro schools of 1 or 2 classrooms (plus a Grade R classroom each), enrolling respectively less than 12-13 learners or 13-25 learners respectively, is an additional multipurpose room necessary?
- For all micro schools of 2-4 classroom, is a covered dining area of 100 m^2 necessary? Such area is not in the MNS package of other types of schools.
- For medium micro schools, is an area of 60m^2 necessary for the staff room? It is rarely found in existing schools.

A review of the MNS package of facilities for micro schools may consider these questions with a view to substantially improve the ratio between learning areas and total areas and, thus, ensure a more efficient use of capital funding for micro schools.

The main difference between the norms and standards for primary schools and micro schools is in the size of the administration area, which expands from 5 rooms in the medium and large micro schools, up to 7, 10 and 14 rooms in the small, medium and large primary schools.

Table A7.3: Minimum Uniform Norms and Standards of Primary schools (between 125 and 930 learners)

SMALL PRIMARY SCHOOL 125 to 320 learners		Nb	5 clrm	8 clrm
Grade R classroom		1	60	60
Classrooms		5-8	240	384
Multimedia center [1]		1	80	80
Science laboratory		1	60	60
Mulipurpose classroom		1	60	60
Administration areas	Principal's office	1	20	20
	Admin office	1	20	20
	Staff room	1	60	60
	Sick room	1	15	15
	Staff kitchenette	1	12	12
	HOD office	1	15	15
	Printing room	1	15	15
Parking bays				
Toilets as per enrollment		7-15	8	18
Nutrition center [2]				
Recreation & physical ed.				
Total constructed areas			**665**	**819**
Ratio all areas / clrm areas [3]			**2.2**	**1.8**

MEDIUM PRIMARY SCHOOL 321 to 620 learners		Nb	9 clrm	15 clrm
Grade R classroom		2-3	120	180
Classrooms		9-15	432	720
Multimedia center [1]		1	80	80
Science laboratory		1	60	60
Mulipurpose classroom		1	60	60
Administration areas	Principal's office	1	20	20
	Deputy principal offi	1	15	15
	Admin office	1	20	20
	Strong room	1	15	15
	Staff room	1	60	60
	Sick room	1	15	15
	Staff kitchenette	1	12	12
	HOD offices	2	30	60
	Printing room	1	15	15
Parking bays				
Toilets as per enrollment		15-19	18	23
Nutrition center [2]				
Recreation & physical ed.				
Total constructed areas			**972**	**1355**
Ratio all areas / clrm areas [3]			**1.8**	**1.5**

LARGE PRIMARY SCHOOL 621 to 930 learners		Nb	16 clrm	23 clrm
Grade R classroom		3	180	180
Classrooms		16-23	768	1104
Library		1	80	80
Computer room		1	60	60
Science laboratory		1	60	60
Mulipurpose classroom		1	60	60
Administration areas	Principal's office	1	20	20
	Deputy principal o	1	15	15
	Admin office	1	20	20
	Reception area	1	15	15
	Storage area/adm	1	15	15
	Strong room	1	15	15
	Staff room	1	60	60
	Counseling room	1	15	15
	Sick room	1	15	15
	Staff kitchenette	1	12	12
	HOD offices	3	45	45
	Printing room	1	15	15
Parking bays				
Toilets as per enrollment		26-30	31	36
Nutrition center [2]				
Recreation & physical ed.				
Total constructed areas			**1501**	**1842**
Ratio all areas / clrm areas [3]			**1.6**	**1.4**

Note: [1] Library/Computer/Science Laboratory; [2] Where National School Nutrition Program is implemented; [3] classroom area includes Classrooms and Grade R classroom. Source: Authors' table with data from DBE 2013

There is a substantial *economy of scale* in terms of ratio of classroom area compared to the total constructed area when moving from small to large primary schools, specifically this ratio decreases from 2.2 to 1.4. However, such a decrease is approximately of the same order of magnitude as this of Micro schools. Considerations with regard to cost-efficiency for equitable quality education in primary schools include:

- Review of how the norms for primary schools align with the norms for micro schools. A strict reading of the norms for primary school tends to preclude the existence of a micro school in primary education. Such a reading is reinforced by that micro schools are not included in DBE's *Guidelines relating to planning for public school infrastructure*.
- *Science Laboratories* in primary schools are expensive to build and manage, and few teachers have the ability to use them properly. Likewise, evidence has shown that experimental science can be property taught without a traditional laboratory.

- Extensive evidence has shown that reading skills and affinity for read are more efficiently developed through a classroom library as opposed to a school library given that books are readily available to learners in their classrooms. Classroom libraries can save the capital costs of a library facility and instead redirects the focus on reading materials.

The minimum norms and standards are very similar between primary and secondary schools for the three categories of schools: small, medium and large. The main difference is the absence of the *Grade R classroom* in secondary schools and the distinction between *Library* and *Computer room* in secondary schools as opposed to *Multimedia Center* in primary schools. For each of the 3 size-categories, the order of magnitude of the constructed areas are very close between primary and secondary schools, as well as the ratio between classroom areas and total constructed areas. This observation is also valid with respect to the range of economies of scale of such a ratio. Table A7.4 provides the details of the minimum norms and standards.

Table A7.4: Minimum education Norms and Standards of Secondary/ schools (between 200 and 1000 learners)

SMALL SECONDARY SCH. 200 to 400 learners		Nb	6 clrm	10 clrm
Classrooms		6-10	288	480
Library		1	80	80
Computer room		1	60	60
Science laboratory		1	60	60
Mulipurpose classroom		1	60	60
Administration areas	Principal's office	1	20	20
	Admin office	1	20	20
	Strong room	1	10	10
	Staff room	1	60	60
	Sick room	1	15	15
	Staff kitchenette	1	12	12
	HOD office	1	15	15
	Printing room	1	15	15
Parking bays				
Toilets as per enrollment		13-15	16	18
Nutrition center [2]				
Recreation & physical ed.				
Total constructed areas			**731**	**925**
Ratio all areas / clrm areas [3]			**2.5**	**1.9**

MEDIUM SECONDARY SCH. 401 to 600 learners		Nb	11 clrm	15 clrm
Classrooms		11-15	528	720
Library		1	80	80
Computer room		1	60	60
Science laboratory		1	60	60
Mulipurpose classroom		1	60	60
Administration areas	Principal's office	1	20	20
	Deputy principal off.	1	15	15
	Admin office	1	20	20
	Strong room	1	15	15
	Staff room	1	60	60
	Sick room	1	15	15
	Staff kitchenette	1	12	12
	HOD offices	2	30	30
	Printing room	1	15	15
Parking bays				
Toilets as per enrollment		15-19	18	23
Nutrition center [2]				
Recreation & physical ed.				
Total constructed areas			**1008**	**1205**
Ratio all areas / clrm areas [3]			**1.9**	**1.7**

LARGE SECONDARY SCH. 601 to 1000 learners		Nb	16 clrm	23 clrm
Classrooms		16-25	768	1104
Library		1	80	80
Computer room		1	60	60
Science laboratory		1	60	60
Mulipurpose classroom		1	60	60
Administration areas	Principal's office	1	20	20
	Deputy principal o	2	30	30
	Admin office	1	20	20
	Reception area	1	15	15
	Storage	1	15	15
	Strong room	1	15	15
	Staff room	1	60	60
	Counseling room	1	15	15
	Sick room	2	30	30
	Staff kitchenette	1	12	12
	HOD offices	4	60	60
	Printing room	1	15	15
Parking bays				
Toilets as per enrollment		19-30	23	36
Nutrition center [2]				
Recreation & physical ed.				
Total constructed areas			**1358**	**1707**
Ratio all areas / clrm areas [3]			**1.8**	**1.5**

Source: Authors' table with data from DBE 2013.