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# Projections of Educators by Age and Average Cost to 2070

Final Report

Martin Gustafsson (23 June 2023)

Teacher Demographic Dividend.

RESEP

Research on Socio-Economic Policy

# Projections of educators by age and average cost to 2070

*Final report*
*Martin Gustafsson*

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**Summary**

This report explains the design and projections of a teacher supply and demand model for South Africa. While the report addresses a number of policy issues, it pays special attention to two. One is the **number of new teachers universities will need to graduate** over the coming two decades, given a context of a wave of retirements among older educators over the next ten years. Secondly, the report deals with the possibility of a **'demographic dividend'**, or lower-than-expected salary costs resulting from a decline in the average age of educators as a wave of younger teachers enter the system. This dividend can facilitate a larger public educator workforce, something made necessary by ongoing increases in enrolments.

Much of the report discusses the background to the projections. The reader wishing to go straight to **a summary of findings** can read this summary and then turn immediately to **section 7.2**, which is relatively easy to read on its own, and which provides details relating to six scenarios.

Though the model described here could be developed further, it can be considered the final model of the Teacher Demographic Dividend project. An earlier pre-final version was published in December 2022. Differences between the December 2022 report and the current version are summarised in a box following this summary.

In some respects, the current report builds on earlier work done for the Department of Higher Education and Training (DHET). That earlier work, released early in 2022, warned of an imminent shortage of teachers if universities did not increase the output of teacher graduates. One limitation of that previous work is that it did not differentiate between newly graduated teachers and older teachers re-joining the profession. It moreover used breakdowns by age in a very limited fashion, and did not examine financial impacts at all. The current report, which reaches broadly similar conclusions to the DHET report, seeks to address these methodological limitations.

The model uses the number of **educators by age, notch, and type** in a base year as a central input. There are two types of educators: **level 1 teachers and senior educators** (also referred to as 'non-teachers'). The Excel tool uses VBA code, but is relatively straightforward and easily editable by the user. It produces statistics for fifty future years. In each year, five processes, each subject to changeable assumptions, can occur: **attrition**; **promotion**; **annual notch progression**; **on-the-job qualification**; and **joining**. The second-last process is new relative to the previous version of the model.

In the current version of the model, the distinction between joiners who are first-time joiners and those who are not is now better anchored in empirical analysis. This is important as **joiners should each be counted just once** for the purposes of estimating the demand for graduates from universities. Moreover, pre-qualified joiners are now permitted in the joining process, and

are then moved to a higher notch on obtaining their qualification some years later (the second-last of the five processes). This has some financial implications.

There is not much in the way of existing and publicly available tools and reports to guide this kind of work, but what was sourced was useful, and is discussed in the report.

As a validation exercise, the model was used to **retrospectively project developments between 2011 and 2021**, using 2011 as the base year, to see how well the model predicts the actual 2021 situation. This check led to some enhancements of the model and decisions around how to deal with attrition and joining assumptions. This retrospective check was only run with respect to educator numbers by age, not unit costs, given complexities created by the switch from a 1.0% annual notch progression to 1.5%, a process whose phasing in began in 2019.

For projections beyond 2022 it was important to have an appropriate set of 2022 base year statistics. The report explains how 2022 Persal payroll data were processed, and decisions around which employees to include and which to exclude from the modelling.

Section 5.1 explains a vital phenomenon for understanding the demand for teachers in the coming decades: **an *unexpected* and sharp increase in the school-age population**. This increase has already begun, and partly as a consequence of this enrolment in the public plus independent schooling system has risen by over a million between 2010 and 2021. Projections of the school-age population point to an increase of a further one million or so learners between 2021 and 2030 (see Figure 7). This is clear in both the UN's population projections and those of the local Thembisa Project. A part of the problem is that an increase in the child population was not anticipated a decade or so ago, when the National Development Plan was drawn up. Instead, a continual *decline* was expected, with older projections pointing to a decline in the school-age population of around half a million between 2020 and 2030. Much planning in South Africa has been premised on an expected decline in the child population. Planning, including teacher planning, must still adjust to the reality of very different demographic projections.

Section 5.2 presents projected educator counts to 2072, according to various scenarios. One scenario envisages no change to the size of the educator workforce, despite the abovementioned child population growth. Another middle-of-the-road scenario increases the stock of publicly employed educators in line with population growth, meaning the **learner-educator (LE) ratio would not worsen relative to 2021**. This scenario moreover allows for an **improvement in 'survival' to Grade 12** to continue along its recent trajectory, and incorporates some savings from reduced grade repetition. (The scenario is referred to as 'Population + Grade 12' in Table 9 and Table 10.) The scenario envisages 84% of youths reaching (not necessarily successfully completing) Grade 12 by 2030 – in recent years the figure has stood at 78%. For all these conditions to be met, the publicly paid educator workforce, which has in recent years been around 400,000 people, would need to be increased by around 25,000 people by 2030.

The middle-of-the-road scenario translates to a relatively small **increase in the availability of new teacher graduates from universities, from around 31,000 in 2021 to around 33,000 in 2030**. The assumption is used that **four in five graduates enter public employment as teachers** soon after graduating. Around one in seven grades 1 to 12 educators currently working in schools are privately employed, either in a public or an independent school. This stock of teachers must obviously be replenished. Furthermore, some teacher graduates have in the past ended up not working in a South African school, for instance because they find employment elsewhere in the South African labour market, or leave the country. The analysis takes into account the in-migration of foreigners who become publicly employed teachers in South Africa. This phenomenon has in recent years been tiny. (See section 5.3.).

**The abovementioned workforce expansion scenario is conservative insofar as it does not aim to reverse a deterioration in the learner-educator seen in the 2011 to 2021 period**. The ratio has risen from 27.4 to 29.8 between 2011 and 2021, which in large part explains a worsening class size problem in the sector, especially among historically disadvantaged schools. This trend has come about because the educator workforce has not grown, while the number of learners has. A more ambitious scenario (referred to as 'Population + Grade 12 + LE' in the report) envisages returning the LE ratio to its 2011 level by 2030. This scenario would require the educator workforce to grow by 63,000 and for the output of new graduates from universities to reach around 40,000 by 2030. If factors such as a healthy economy with more job options in 2030 are envisaged, higher attrition among younger educators could push the annual demand for new graduates by 2030 as high as 46,000. Past patterns suggest that when the economy fares well, and additional opportunities for young teachers exist in the labour market, attrition rates among these teachers rise substantially, meaning the training system would have to compensate for this.

It should be noted that even in this more ambitious scenario **South Africa's LE ratio would remain a little higher than what is typically seen in middle income countries**. The 2011 reference point is in other words not in any sense an ideal one.

The ratio of four in five graduates becoming publicly employed teachers is based on historical patterns. A clear problem since around 2017 is that an increasing proportion of graduates have *not* entered public employment as teachers. The data suggest that by 2020, only around 60% of graduates were joining the public system. This is due to two factors: **universities have been relatively successful at increasing the output of teacher graduates**, in response to government targets, yet **budget constraints in the schooling system**, combined with **a change in the rules governing teachers' annual increments** introduced in 2019, have made it difficult for provincial education departments to absorb enough new graduates, even though the LE ratio was deteriorating. This situation is unlikely to continue, especially as the retirements wave will force employers to ramp up the intake of young graduates in order to maintain the size of the workforce at at least past levels, but also due to some easing of the per educator cost problem through the 'teacher demographic dividend'. Yet the recent situation points to a need to **align spending on initial teacher education at universities and spending on personnel in the schooling system** in better ways. This should be done within a holistic plan that considers how many teachers the schooling system can afford to employ. The current report provides important guidance relating to what is financially viable in this regard over the next decade.

Like the earlier DHET analysis, the projections of the current report point to the **demand for graduates *dropping* somewhat beyond 2030**, though the extent of this is sensitive to various assumptions (Figure 25). This means that some of the expansion in the required training capacity of universities might need to be scaled down after 2030.

The **average cost of an educator is projected to remain virtually unchanged, in real terms**, with there being an overall increase of 0.8%, or just 0.10% a year, between 2022 and 2030. Behind this is **a 2.0% overall increase for teachers** and **a 2.2% *decline* for senior educators** across the entire period – these translate to annual changes of 0.2% and -0.3% respectively. It is clear that a small increase in the unit cost of teachers is offset by a small decline in the unit cost of senior educators. The assumption is that **all educators would receive an annual notch progression of 1.5%**, and only CPI-linked cost-of-living adjustments. The fact that the overall unit cost trend to 2030 is found to be virtually flat, while educators receive 1.5% increases per year in their purchasing power, through notch progression, is in part possible because **the declining age of educators offsets the effects of the notch progression** (though the logic of this dictates that even with no decline in the average age, annual increases at the aggregate level would be well below 1.5%). The figures provided here emerge from a scenario where the total number of educators does not increase after 2022. If the most expansive scenario is taken, then slight declines in the overall educator unit cost are seen, given the larger proportion of young teachers.

Before work on the project began, it had been assumed that there would be a real saving arising from the decline in the average educator age, given that younger educators cost less. Those assumptions were based on rough calculations and not the detailed modelling which is now possible, and which is able to estimate the impacts of different magnitudes of annual notch progression, and how a changing age profile affects promotions. What is now clear is that **a substantial real decline in the average unit cost in the foreseeable future is unlikely**. Instead, what can be expected are unit costs which remain almost constant over time, as explained above.

In a sense, however, there is a teacher demographic dividend. Had the 'less favourable' educator age structure seen in 2011 existed in 2022, the real annual increase would have been 0.4% a year, and not the expected 0.10% referred to above. This implies that the educator wage bill in 2030 will be **R6.4bn lower due to a 'more favourable' age structure** – it will be R193.5bn and not R199.8bn (all in 2022 Rand terms). This is one way of quantifying the demographic dividend. However, its impact is not large enough to result in a substantial real *decline* in the average unit cost. Had there not been a shift from an annual notch progression of 1.0% to 1.5%, the situation would have been different. If the period 2022 to 2030 is modelled with a notch progression of just 1.0%, then there is an *decline* in the real cost of an educator of 0.26% a year, as opposed to the tiny increase of 0.10% a year seen with the presence of the 1.5% progression. This translates to a wage bill which is R5.3bn lower in 2030 in 2022 Rand values.

There is a further dividend, not a demographic one, which is available if **cost-of-living adjustments are aligned with CPI**. If this strategy is followed, and there is no workforce growth, the total cost of the educator workforce over GDP is likely to decline from the current 2.9% to 2.6% in 2030, and 2.2% by 2040. This assumes a fairly pessimistic GDP growth trajectory of 1.8% from 2023 onwards. Given the way the budgeting system works, it is extremely unlikely that such large declines in the ratio of education personnel spending to GDP would be realised. As far back as 2007, spending on educators by provinces over GDP was 3.0%, close to the current level. If very large declines in this ratio are not permitted, and if cost-of-living increases for educators are pegged to CPI, then there is considerable scope for expanding the workforce to deal with learner-educator ratio pressures. This window of opportunity would allow for the educator workforce to grow gradually. In fact, a not unrealistic assumption of 1.8% annual GDP growth over the next decade would permit the funding of the additional 63,000 teachers referred to above, which would be necessary to take the LE ratio back to the 2011 level. **Spending on educators, and the schooling system as a whole, relative to GDP, needs to become a central feature of the education policy debates**.

In 2021, additions to the stock of qualified educators within the public system were 93% due to entering joiners, but 7% due to teachers already in the system who were **completing their qualifications while on the job**, and obtained the qualification in 2021. The phenomenon of pre-qualified teachers has been on the decline, but this could rise in future to address under-supply problems. Modelling of this reveals that delaying the attainment of the entry-level notch applicable to a fully qualified teachers has a negligible impact on total expenditure. Pre-qualified joiners can help to secure a sufficient supply of young teachers, but are not really a cost-saving measure.

There is a strong interest in breakdowns of teacher demand **by province and specialisation in terms of language, non-language subject and phase**. The specialisation breakdown needs better input data on how teachers with different specialisations differ in their age structure, if the modelling is to move beyond the rudimentary modelling of specialisations of the earlier DHET report. It seems at least some of the required data will become available. What has been done as a separate analytical exercise is to run the Excel model with data from subsets of the educator workforce. A report on province-specific issues is being released in tandem with the current report.

**Key differences relative to December 2022 version of the report**

- There were a few changes to the Excel model itself. There is now a more empirically informed calculation of which joiners are *first*-time joiners (see details in section 5.2). Moreover, the model now permits pre-qualified joiners to join the workforce at a notch below the usual entry-level notch for qualified teachers. The pre-qualified joiners would become qualified after some years on the job, and would move up to the official entry-level notch (in section 6.1, also 6.2). There was also some minor 'cleaning up' of the Excel VBA code to ensure that only positive integer numbers reflect educator counts at the level of every cell of the five-dimensional educator table, and that the sum of this matches user inputs, where applicable. What complicates matters here, is that parts of the processing *do* use fractions of educators, while other parts use just counts of *whole* educators. This cleaning of the coding is one reason why many statistics, such as unit costs, display tiny differences relative to the statistics of the December report.

- The historical base year for scenarios is now 2022 (previously it was 2021). This means the first projected future year is 2023. The use of a new base year is a further factor that would bring about tiny differences in statistics such as future unit costs.

- There is now a new method, employed outside the main Excel model, to translate first-time joiners to graduate demand. What is now taken into account is the impact of a reserve pool of graduates built up in recent years, while the production of graduates exceeded the capacity of the public system to absorb new educators. See section 5.3.

- A new section examines existing projections of economic growth which could inform the educator scenarios – see section 7.1.

- There is now a more comprehensive and logical presentation of key scenarios emerging from the modelling – see section 7.2.

## Contents



## 1 Introduction

This report explains projections of numbers of educators by age, and their average unit costs, up to 2072. The work falls within a larger project known as the Teacher Demographic Dividend project, begun in 2021. How the projections were calculated and are presented is informed by the aims of the project, which is largely to identify risks and opportunities associated with the movement of a large age peak of educators through retirement in around 2030. While this phenomenon will result in a peaking of retirements around 2030, an increase in retirements as the system moves towards 2030 has already commenced.

Workstream 1 of the project is headed 'Developing a demand and supply model'. Research questions relating to this workstream appearing in the original project plan are as follows:

- Questions relating to **past work**: What can be learnt from past attempts at modelling teacher supply and demand in South Africa? For instance, how exactly was the severe under-supply crisis anticipated to arise out of the HIV/AIDS pandemic avoided (Crouch, 2001)?

- Questions relating to **modelling methods**: What format should a model take in order for it to be both sufficiently comprehensive and sufficiently accessible and adaptable? What variations with respect to salary scales, promotions, employee benefits, non-retirement attrition, future learner enrolments and the utilisation of teacher time should be considered? What are the impacts of earlier/later retirement ages? (For example the increase in early retirements during COVID-19).

- Questions relating to **future costs**: What might be the financial and educational implications or likely scenarios for tackling the teacher supply issues? What are the key assumptions driving likely declines in the projected wage bill? What are the short, medium and long-term implications of an immediate rise in the number of semi-qualified teachers expected to complete their qualifications while working (this being a solution already implemented in more remote parts of the schooling system)?

- Questions relating to **educators not paid by the state**: What do current trends suggest will be the role of independent schools, and privately paid teachers in public schools (the so-called 'SGB teachers'), in the coming years?

The project, run from Stellenbosch University, involves stakeholders from inside and outside government. The work presented in the current report relies strongly on collaboration with the national Department of Basic Education (DBE).

This is the second and final publicly available version of this report. The first version was released in December 2022. The focus here remains on elements of the above four over-arching questions which were identified by various stakeholders as being urgent for the project as a whole, as well as other priority matters not referred to in the above four bullets.

Methodological issues of relevance to the current analysis arising from previous modelling work are discussed in section 2. Section 3 discusses the design of the model used for the current report. Section 4 discusses the input data used to generate the projections, and a retrospective validation done on the model. Section 5 discusses the headcounts and section 6 the costs emerging from the various scenarios, and their implications for policy, including policy on how many teacher graduates universities need to produce. Section 6.3 explores the meaning and magnitude of the 'demographic dividend'.

A point on terminology should be made. This report refers to 'projections' and not 'forecasts'. The two are closely related, though forecasts are generally understood as pictures of the *likely* future, based on historical trends and what is known about changes to impact factors in future. Projections, on the other hand, may also include *unlikely* future scenarios, driven by relatively unlikely factors, where the aim is to demonstrate the design of the projection model, or point out risks or opportunities[1].

# 2 Methodological issues in past work

## 2.1 Projected future teachers and their costs

Given that a 2012 UNICEF-funded model is adapted for the new modelling of this report, and given the direct relevance of modelling behind a 2020 Department of Higher Education and Training (DHET) report, the UNICEF-funded and DHET work is discussed in considerable detail in section 3. This section thus provides a short overview of other work, including work using South African data.

The review of past work is in part informed by the need to find ways of undertaking three tasks. Firstly, the current South African context, with its age peak approaching retirement, requires careful modelling by single age. Secondly, modelling educator unit costs in a context of rapidly changing age profiles and the sensitivity of unit costs to age, is necessary. Thirdly, as this report will make clear, there is considerable 'churning' into and out of the publicly paid workforce, meaning entry and exiting is often not a once-in-lifetime event. How to model this optimally is a key issue.

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[1] See for instance 'Financial forecasts and projections' of the American Institute of Certified Public Accountants (AICPA) at
https://us.aicpa.org/content/dam/aicpa/research/standards/auditattest/downloadabledocuments/at-00301.pdf.

Williams (1979) provides generic guidance in a report published by UNESCO's International Institute for Educational Planning (IIEP). Unfortunately, nothing more recent of its kind seems to exist. An update could have provided guidance on how to use technologies such as modern spreadsheet applications, particularly Excel, to do the work. While Williams (1979) provides a useful set of concepts and equations, the three critical tasks of modelling by age, unit costs and churning are not covered in any depth.

There are few teacher supply and demand models used by education authorities which are available in the public domain. The 2020 DHET report makes reference to a few other reports, from beyond South Africa, which offer the results of some modelling. In preparing the current report, a search of other existing models was undertaken. Only one model with the tools required to implement it was found: the model of the Department for Education in England[2].

The England model is able to make use of considerable background data on why educators leave the system and who is joining the system. This allows the model, for instance, to accommodate shifts in the willingness to take up early retirement.

The background information on joiners in the England model is rich, and clearly beneficial for the modelling. Joiners are broken down into three groups. Firstly, there are joiners who qualified as teachers in the previous year. Secondly, there are 're-entrants' who have worked in the system in the past. These re-entrants are people who drive the phenomenon of churning. It is not made explicit how far back the historical data needed for this goes, but it seems to be extensive. Thirdly, there are all other joiners, essentially educators who have not recently qualified, and who did not work in the system previously. This could include immigrant teachers, or teachers who qualified some time back but worked in the private sector. Obtaining this background information on joiners assumes good data availability, and relatively easy processes for merging databases. For example, data on who qualifies as a teacher in a training institution would need to be merged with the employed teacher database. In South Africa, achieving this level of data integration would require considerable investments, and a closer technical engagement between the DBE and DHET.

Gender breakdowns are used throughout the England modelling, which is valuable for a number of reasons. For instance, it is clear that men and woman have displayed different attrition rates in the past.

In one respect, the England model is limited. It is not designed to examine the effect of major demographic transitions of the kind seen currently in South Africa, with its bulge of older teachers retiring over the coming decade. The England model uses five-year age bins, not single ages, and assumes that joiners always display the same age breakdown as the existing workforce. Moreover, the England model does not deal with unit costs.

Crouch (2001) specified a teacher supply and demand model, in large part as a response to the educator morbidity and mortality expected to arise from the HIV/AIDS pandemic. This model is relatively simple but comprehensive, using just high-level aggregates and inputs. It does not break down educators by age, and does not deal with unit costs or churning. Ramrathan (2003) focusses on the numbers of one South African province and underscores how sensitive models such as that presented by Crouch (2001) are to the assumptions made.

## 2.2 Lessons from projections in the health sector

It appears that globally more rigorous work on workforce supply and demand has occurred in the health sector, compared to the schooling sector. The health equivalent of education's Williams (1979) is Hall and Mejía (1978), published by the World Health Organization. Indeed,

[2] England: Department for Education, 2015.

the 1970s saw a keen interest in the production of planning manuals in several public sectors. More recently, Roberfroid *et al* (2009) have reviewed existing models projecting the workforce in the health sector across several developed countries. They apply retrospective analysis to existing models to test their reliability. This involves running the models using historical data and comparing model outcomes to what actually occurred. Retrospective analysis is clearly an important way of examining how reliable a model is, and is used in section 4 below.

Willis *et al* (2018) provide an account of work done by government in England to plan for the health sector workforce through the use of system dynamics. System dynamics is an analytical approach that assists in understanding systems, for instance natural ecosystems, industrial processes or the labour market. Typically, system dynamics is done using specialised software which organises the system in terms of stocks and flows over time. The software pays special attention to graphical representation of the system and its dynamics. As is clear from Willis *et al* (2018), a fully-fledged systems dynamic approach entails considerable investment in human and institutional capacity, as the method easily leads to high levels of complexity and may require years of work by a team of skilled analysts. However, it seems possible to learn from system dynamics while conducting more rudimentary modelling. In many ways, this is what the modelling presented in this work does.

# 3 Model design

## 3.1 The original UNICEF-funded model and how it was adapted

What is referred to here as the UNICEF-funded model is an Excel tool that formed part of a broad UNICEF-funded study examining the financing of schooling in South Africa. The original Excel tool is described in one of the reports emerging from the study (Gustafsson, 2012b).

The UNICEF-funded model was in many ways appropriate for the needs reflected in the questions put forward in section 1 above. In particular, this model modelled the future educator workforce by single age, and produced future unit costs. Yet in some respects the model needed adaptation to meet the needs of the current project. Moreover, repeated use of the model with new data revealed aspects of the coding which had to be corrected[3] or adapted to avoid run-time errors.

The original UNICEF-funded model allowed the user to insert basic enrolment drivers. These elements were removed as they were too basic to add much value to the model. Instead, the model now requires the user to insert future educator totals needed. Whatever drives that, must be calculated outside the model. This means that with respect to the modelling of demand, the model focusses on the demand for *joiners* per year, and does not model the demand for the *total stock of educators* in a future year. As will be seen in section 5.1 below, how future educator numbers are calculated, outside the model, is relatively straightforward. It could be made far more complex if comprehensive modelling of enrolments were done. This is complex largely because of grade repetition. The educator projections would benefit from such work, but full-scale enrolment modelling is generally done as a separate standalone model[4].

Returning to the UNICEF-funded model, certain reporting features that allowed for unit costs to be reported against GDP per capita were removed, in part because they were inflexible. Future costs relative to GDP are reported on in the current report, but the calculations for this occurred outside the model. In enhancing the model for the current analysis, it seemed optimal

[3] Some corrections related to the way rounding to the closest integer occurred. Parts of the model used fractions of educators, but outputs to the form of counts of whole educators, which had to be internally consistent.
[4] See Department of Basic Education (2017) for past work on modelling future enrolments.

to invest in those aspects of the model which are, firstly, complex and clearly require programming and, secondly, which address key questions of interest.

Figure 1 below describes the workings of the model. Illustrative values are those that would apply for the scenario 'Population + Grade 12' described in section 5. This means that the time period covered is 2023 to 2072. This report provides a summary of the model's design. Further details would be reflected in the first sheet of the Excel file, and the VBA code, which is easily accessible in the Excel file[5]. An alternative way of describing the model is presented in Table 1, which indicates when educators move between 'cells' of the five-dimensional educator table.

The model requires two major input tables, found in the Excel sheets *Educators* and *Notches* – the former is represented in the top-right of Figure 1, the latter near the bottom-right. *Educators* has a row for every combination of single age, educator type, and notch. For each row, the number of educators with these characteristics in the base year, 2022 in this case, appears. Ages are in the range 21 to 65. Educator type is 1 for a level 1 teacher, and 0 for a senior educator above this level. For the 2023 to 2072 projections, there are 491 notches. The table *Notches* has a row for every notch, with the notch code and 2022 monetary notch value in each row.

Beyond the base year, 2022, there are 50 future years for which projected values are calculated. There are five processes implemented for each future year: attrition; promotion; progression; on-the-job qualification; and joining. The promotion, on-the-job qualification and progression processes affect the unit costs in the model.

The **attrition process** uses year- and age-specific attrition rates. The source for this is a small table in first sheet of the tool (*Main*) giving the attrition rate per age for the base year, but also for some future year. Attrition rates will change linearly towards this future year, and beyond this will remain constant. A key element of the model is a five-dimensional educator table, the dimensions being age, educator type, notch, year and whether qualified (the fifth dimension is not found in the *Educators* input sheet reflecting the base year, meaning that for the base year everyone is considered qualified). The five-dimensional table, which consists of 44,190 cells in just one year, exists in the computer's memory only, and is continuously updated while projections are being calculated. For the year 2023, the five-dimensional table is populated with the 2022 data from *Educators*. Educators aged 21 to 64 are moved to 2023 in the five-dimensional table, with age being incremented by one, and with a subtraction for leavers, in line with the age-specific attrition rates. Rounding occurs, so that no fractions of educators ever appear in the five-dimensional table. Educators aged 65 in 2022 are all assumed to retire, and not be present in 2023.

In the **promotion process**, two rounds of promotion occur. In the first round, promoted senior educators are moved into higher notches. In the second round, level 1 teachers are promoted to senior educators. The promotion process was easily the most complex of the four processes in the original UNICEF-funded model, yet it was the most problematic process insofar as its results did not seem reliable. The process was thus completely redesigned, and anchored more firmly in historical patterns of promotion. The number of senior educators who must move up to a higher notch, and the extent of their notch gains, are driven by two columns of data, each with 101 values. The minimum and maximum notch values in the sheet *Notches* are taken, and between these values 99 values are calculated such that the difference between one value and the next is always the same. The 99 values are unlikely to match notch values exactly. The reason for using the 101 values and not the 491 notch values is to avoid having the model design dependent on a specific notch structure. In the first column of input values, the probability of being promoted from one senior position to another is given. This is based on historical data (see section 6.1). The second column gives the 'promotion bonus', or the percentage gain in the

[5] Reference is to the Excel file *TSD model 3.1 2023 06 23 To 2072.xlsm*. The *Developer* tab must be visible, which in turns leads to the *Visual Basic* button.

notch value expected for someone at that particular original notch level. The coding in the model finds a correspondence between the 99 values and actual notch values. This correspondence is then used to place promoted senior educators in new notches. The destination notch is the one that will produce a notch gain which is as close as possible to the 'promotion bonus' specified in the input data.

In the second round of promotions, level 1 teachers are promoted into senior positions. The first step here is to calculate how many promotion posts are available in the current year, as the model user can allow the total number of senior educators to vary over time. The user selects a future year for setting targets, and then specifies the number of teachers and senior educators for this future year. Targets per year up to the specified year are set linearly. The teacher-to-senior promotion process has its own two 101-row columns of input values using the same logic as that applicable to the senior-to-senior promotions. Here, however, if the inputted 'percentage bonus' is not sufficient to take the teacher to the minimum notch for senior educators, which is notch 209, then the teacher is automatically taken to notch 209.

*Figure 1: Design of the Excel model*

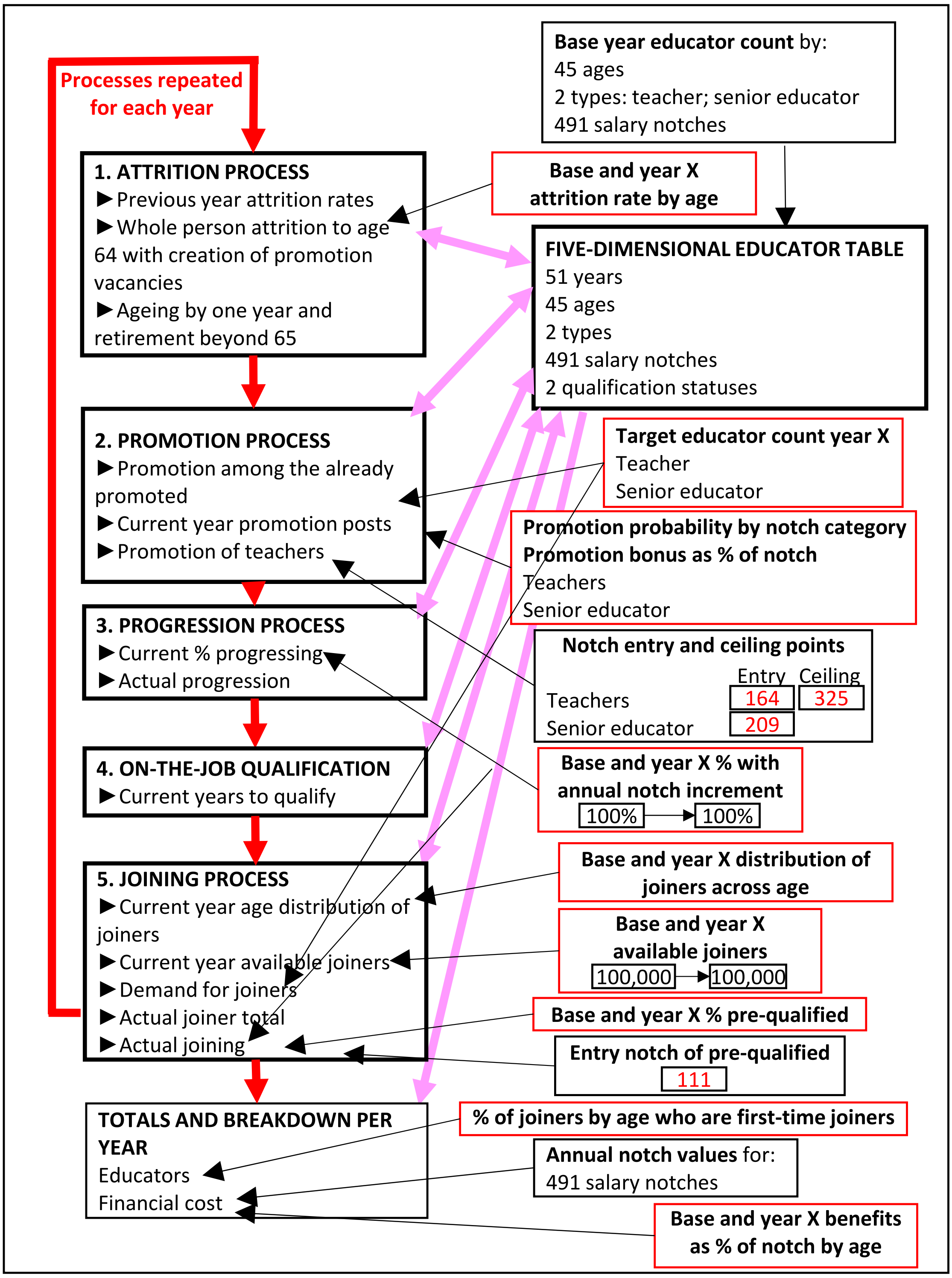

***Table 1: How the model processes redistribute educators across dimensions***

| | Years | Ages | Types | Notches | Quali-fication status | Other move-ments |
|---|---|---|---|---|---|---|
| 1. Attrition | | Always changes (ageing) | | | | Educators leave |
| 2. Promotion | | | Can change | Can change | | |
| 3. Progression | | | | Nearly always changes | | |
| 4. On-the-job qualification | | | | Can change | Can change | |
| 5. Joining | | | | | | Educators join |
| New year | Always changes | | | | | |

*Note: 'New year' is a separate process, run after 'Joining', which simply replicates the educator counts as they stand at the end of one year, in the next year.*

In the **progression process**, educators move up salary notches in line with parameters set by the user. In nearly all the scenarios discussed in this report, the parameters are simple: 100% of educators move up three 0.5% notches every year, producing an overall increment of around 1.5%, unless they have reached the maximum notches for the two types of educators: notches 325 and 491. The exception is a scenario where the impact of having a 1.0% annual notch progression was tested.

Teachers who were below the entry notch for qualified teachers, notch 164, in the base year, are moved up notches in line with the general progression rules. The assumption is thus that teachers who are possibly under-qualified in the base year do qualify to reach notch 164 after some time, and to move beyond this notch, though the speed of this movement is determined by the general progression rules, not by the on-the-job qualification inputs of the user.

In the **on-the-job qualification process**, teachers who in a previous year were considered not to have completed their teaching qualification (see the next process), are assumed to become qualified while on the job, for instance through distance education. This means they become considered qualified with respect to the fifth dimension, and are moved to the entry level notch for qualified teachers, notch 164. The key user input for this process is the number of years taken by pre-qualified joiners to obtain their qualification. The model remembers how many newly joined and pre-qualified teachers should be qualified in each future year, while keeping into account the fact that some would leave, through attrition, before they qualify.

In the **joining process**, the first step is to establish the distribution across ages of joiners for the specific year. This is based on user inputs. The number of teachers available to join the system is taken into account as a ceiling for actual joiners. If this number is set very high, for instance at 100,000, then the supply constraint is effectively removed. Next the number of joiners needed is calculated. With no changes in the total number of educators, the number of joiners needed would be the same as the number of leavers. Joiners are always level 1 teachers, never promoted teachers. Joiners are brought into the five-dimensional table, either at the official entry level notch for teachers[6], which is notch 164, or at some lower notch, specified by the user, in the case of the pre-qualified. Whether they are qualified or pre-qualified is specified in the fifth dimension. The number of joiners who are pre-qualified is determined by a percentage of

[6] A 2018 policy change makes it realistic to place even older joiners, which are likely to be re-joiners, at the teacher entry level notch (see section 6.1).

joiners assumed to apply up to some specified future year. Only joiners aged 30 and below are permitted to be pre-qualified, meaning the percentage is applied only to young joiners.

The five processes described thus far are run 50 times, for 50 years. Thereafter, headcount and financial statistics which have been stored by the model are deposited into output tables in the Excel file broken down into three groups: statistics by year, age and notch. Financial statistics are influenced by user parameters around annual cost-of-living adjustments and the percentage of the notch value, or basic salary, that is accounted for by benefits. This latter percentage is different for each age. If benefits and cost-of-living adjustments are set at zero, the model will calculate constant monetary values that represent just the basic salary.

An important distinction made in the output tables is that between first-time joiners and other joiners, based on age-specific percentages provided by the user. First-time joiners are an important category as estimates of new graduates needed per year should be based on this. However, the distinction between first-time and other joiners is made only in the output tables, not within the five processes of the model, as that is not needed within these processes.

In the sheet *Log* of the Excel file details such as the numbers of educators moved in and out of the system, across notches, at different points in the projection processes, are recorded.

In the rest of this report, the model described above is referred to as simply ‘the Excel model’, and not the UNICEF-funded model, in part because the changes done to the original UNICEF-funded model change it fairly substantially.

## 3.2 How the new model differs from the DHET 2020 calculations

There several key differences between the model described in section 3.1 and that used for a 2020 report to the Department of Higher Education and Training (DHET)[7]. The latter is much simpler than the model used here, largely as it does not disaggregate anything by age. This means that a single attrition rate is used for each year, though this is disaggregated by the primary and secondary levels. Moreover, it is not possible to see the age distribution of joiners, meaning it is not possible to see which joiners are more likely to be newly graduated teachers. The rise in the number of required joiners referred to in the DHET report is therefore not strictly the number of new graduates required, as some could come from other sources, including a reserve stock of teachers among older adults who have not taught for some years, or have been teaching in the private sector, or come from abroad.

The DHET model uses future enrolments and a learner-educator (LE) ratio as a driver of the future total demand for teachers. But it does this in a very basic manner. The new Excel model, on the other hand, assumes that this work occurs outside of the model, and therefore requires a future total number of teachers to be entered.

A key advantage of the DHET model is that it breaks the future total demand and joiners down by home language for Foundation Phase teachers and by subject specialisation for grades 10 to 12. But the approach is basic, as it assumes that annual leavers and the total pool of teachers have the same distribution of specialisations. For instance, the fact that mathematics teachers may be older or younger than average is not taken into account. Joiners disaggregated by specialisation is important for universities that train teachers. This could be fairly easily incorporated into the new model in a very basic manner, though a more refined age-specific approach is likely to be difficult, given how weak the potential input data are on the specialisations of existing individual teachers. Specifically, there is no database from the last ten years or so with all key details for every schools-based educator, including age, what specialisations lie behind the teacher’s qualifications, and what subjects and grades are *actually*

[7] Department of Higher Education and Training, 2020.

taught by the teacher. There are currently attempts to pull together provincial data drawing from the SA-SAMS school management system used by over 90% of schools, and this may produce the required database[8].

### 3.3 Modelling opportunities and risks

The Excel model from which the current report draws, and which currently has some 1000 lines of VBA code, is relatively simple. However, it could become considerably more complex, depending on the level of effort that can be made available, what additional source data become available, and the needs of policymakers. What are some of the opportunities and risks lying ahead?

The opportunities are fairly clear. While the future is inherently unpredictable, modelling the future well can help to reduce some uncertainties, and contribute towards better strategies. The modelling can bring to the fore the strengths and gaps in the existing historical data. Conversations around how to construct a model provides opportunities for learning how a complex system actually works, and can dispel certain myths.

Modelling the future provides opportunities for collaboration across different specialisations. Crookes and De Wit (2014) have argued that there is value in bridging the approaches, and ideologies, of the economists and system dynamics specialists. Economists have traditionally relied on models such as those dealing with a computable general equilibrium (CGE) to understand the future, while systems dynamic specialists (see section 2.2 above) tend not to be economists. Put differently, the insights of economists around how systems have worked in the past could be applied more extensively to the design of models used in system dynamics.

It is worth clarifying how projections based on system dynamics differ from time series analysis techniques often used by economists. Time series is statistical in the sense that it seeks correlations over time, often based on some form of regression. It then uses parameters based on past trends to forecast into the future. Relatively few variables are used, and the thinking is often to subsume details within certain indicators, without attempting to make details explicit. System dynamics, on the other hand, makes many details explicit, through a multitude of stocks and flows. One typical weakness in system dynamics is that as high-level indicator variables are not extensively used, ‘invisible’ dynamics relating to human behaviour may not be taken into account.

The Excel model used for this report is arguably a basic system dynamics model. The advantage with Excel is that the software is widely available, making it relatively easy for a range of users to adapt the model, especially if some basic VBA skills are learnt. Optimally, however, system dynamics is implemented using software specifically designed for this purpose, such as Vensim. This software tends to be costly – the Vensim software costs around USD 1,200.

Turning to risks, an ‘illusion of accuracy’ easily arises[9]. Put differently, consumers of the model outputs may not appreciate the difference between *precision* and *accuracy*. Outputs of the Excel model discussed below are precise insofar as they are exact. However, this is illusory insofar as there is considerable uncertainty around the assumptions underlying the modelling. In particular, unexpected attrition patterns would change outputs substantively. It is unknown whether there will be substantive changes to the system of ranks and notches underpinning the whole salary system.

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[8] South African School Administration and Management System. The analysis of this data will be released as part of the Teacher Demographic Dividend project.
[9] See for instance Hennesy’s short article titled ‘From spreadsheets to system dynamics models’ at https://thesystemsthinker.com/from-spreadsheets-to-system-dynamics-models.

A further illusion is the 'illusion of reduced complexity'. A model will only deal with a limited number of factors, and will often not include political factors, or disruptive factors relating to health crises and natural disasters. The orderliness embodied by the model can lead to the illusion that it is more comprehensive than it in fact is.

A further risk relates to confusing 'detail complexity' with 'dynamic complexity'. An example can illustrate this. It would be relatively easy to break down all the stocks, or 'boxes', in the Excel teacher supply and demand model by gender. This would create more *detail* complexity. But this on its own would not make the model deal properly with gender. For gender to be dealt with properly, the way the *flows*, or inter-relationships across stocks, work differently for men and women would need to be taken into account. For instance, differentiated attrition rates and preferences in applying for a promotion would ideally need to be considered. This is the *dynamic* complexity. The mistake should be avoided of bringing in only the detail complexity, while ignoring the dynamic complexity.

Making a model more complex obviously has costs in terms of development time, and a loss in transparency. The risk of errors in the model also rises. The 'law of parsimony' when it comes to models states that one should not add complexity to a model if this does not help to answer key questions[10]. It is important to point out to any audience that models are typically not mini-worlds that capture everything in, say, a schooling system. It is not unusual to come across this expectation. Such an understanding would represent an exaggerated view of what can possibly be modelled. Any model must be evaluated relative to a few central questions it is designed to answer.

## 4 A retrospective validation of the Excel model

Good practice in refining a projection model is to use the model to predict patterns in past years, and then to compare projections to what actually occurred. Through a process explained below, the model produced in 2012 was used with 2011 input data, to produce projected values to 2021. The 2021 figures were then compared to the actual data of 2021 to assess how accurately the model performed the projections.

### 4.1 2022 input data

The process of extracting the necessary information from a month's payroll data will be discussed with respect to 2022 here, as this is the point of departure for projections to 2072 in the current report. The same methods were applied to 2021 Persal data (details appear in the previous version of this report), and to 2011 (section 4.2 below).

The following four tables provide details on excluded educators and breakdowns of the included. The data source is a November 2022 Persal payroll download, November being a month when typically a high proportion of available posts are filled. As shown in Table 2, there were 410,463 educators in the 2022 data, identified through their rank code (codes in the range of 60000 to 69999 indicate educators). From these, 103 educators were excluded as their ages were outside the 21 to 65 range the model is designed to deal with. Three-quarters of these 123 educators were above age 65. The number of excluded 'examination revisers' was 548. These educators all carried a notch value of zero and had no other employment in the basic education system at the time. These employees are not significant in terms of the modelling that is needed. Lastly, 6,597 ECD practitioners were excluded. All these 6,597 educators received spending classified as '0518 -EARLY CHILD DEV PRAC'. The breakdown of the 6,597 by province is provided in Table 3, which illustrates the fact that only some provinces pay ECD practitioners through Persal. Why are ECD practitioners excluded? This exclusion occurs largely because ECD practitioners are currently not required to have a university qualification, and the

[10] Batty and Torrens, 2001.

modelling is to a large degree intended to inform universities to what degree the output of teacher graduates will have to increase in the coming years. Moreover, ECD practitioners are rather different in terms of their cost to the system. The mean cost per month to the employer of the 6,597 practitioners is R8,432, or R101,186 per year. As will be seen below, this is less than a quarter of the cost of other educators.

After the three exclusions, the remaining educators are 403,245. These would include teachers, but also educators in 'promotion posts', in particular posts of schools-based heads of department, deputy principals, principals, and certain more education-focussed officials based in offices.

***Table 2: Exclusion of non-core educators in 2022***

| | |
|---|---|
| Educators (according to rank) before exclusions | 410,463 |
| **Exclusions** | |
| Outside 21 to 65 age range | 103 |
| Examination revisers with no other employment | 548 |
| ECD practitioners | 6,567 |
| Educators after exclusions | 403,245 |

***Table 3: ECD practitioners excluded by province***

| | Practitioners excluded |
|---|---|
| EC | 0 |
| FS | 826 |
| GP | 0 |
| KN | 5,003 |
| LP | 0 |
| MP | 0 |
| NC | 736 |
| NW | 2 |
| WC | 0 |
| SA | 6,567 |

Table 4 below provides breakdowns of the 403,245 educators by category relating to their salary notch type. A key task was to provide a notch value *on one notch scale* for the model. 394,193 of the 403,245 educators, so 98% of educators, have a notch on the standard OSD[11] scale, details of which appear in Government Notice 2952 of 2023. There are 432 notches on this standard scale. The average spending column in the table draws from the Persal expenditure file and refers to the average monthly spending per educator in November 2022. The average notch value 'before' is the *annual* salary notch value. This is less than the average spending multiplied by twelve as the notch represents just the basic salary, and not benefits.

There were 1,833 senior educators carrying notch values appearing in the 'inclusive' OSD category – this is the sum of the 1,616 and 217 in the table. The 'inclusive' scale also appears in the aforementioned policy. The 1,616 refers to educators with an 'inclusive' notch value at or below the maximum value in the standard table, namely 1,098,408 Rand. The 217 figure refers to those with a notch value above this level. For the 1,616, the closest notch value in the standard table was found, and this became the new notch value for each person. This explains why the 'before' and 'after' notch means are slightly different in the second row of Table 4. For the 217 educators, the 'inclusive' notch was retained, and added onto the standard scale, extending this from 432 notches to 491 notches. The additional 59 notches thus added were contiguous notches from the 'inclusive' table.

[11] OSD refers to Occupation Specific Dispensation.

*Table 4: Details behind the November 2022 educator input data*

| | Educators aged 21 to 65 | Average spending | Average notch before | Average notch after (if different) | Educators below entry notch of 292,764 |
|---|---|---|---|---|---|
| With standard notch values | 394,193 | 47,945 | 348,452 | | 25,715 |
| With low 'inclusive' notch values | 1,616 | 104,984 | 944,266 | 942,890 | |
| With high 'inclusive' notch values | 217 | 126,643 | 1,191,315 | | |
| With non-OSD notch values | 4,479 | 51,670 | 371,058 | 371,592 | 2,191 |
| With zero notch value | 2,740 | 11,416 | | 135,646 | 2,708 |
| Sub-total without zero notch | 400,505 | 48,009 | 351,566 | 351,566 | 27,906 |
| Total | 403,245 | 48,260 | | 350,099 | 30,614 |

The new notch table used for the model was thus the standard table up to 1,098,408 Rand, with inclusive values added beyond that. The range for the new notch table constructed for the purposes of the model was R128,838 to R1,467,768. The gap between these two values, across the 491 notches, provides a notch-on-notch increment of 0.497%, almost the 0.5% that is widely understood to be the gap between notches. Annual notch progressions for employees involve moving up *three* notches, meaning the progression, without any accompanying cost-of-living adjustment, comes almost exactly to a 1.5% annual increase.

For 4,479 educators with notch values not found in either of the OSD notch scales, the closest notch value in the newly constructed notch table was used. There were 2,740 educators with a zero notch value. 92% of these educators had nature of appointment number 32, which means 'abnormal appointment'. Notch values were imputed for the 2,740, drawing from the coefficients of a regression of notch on total spending per employee, where a non-zero notch value existed[12]. The value in the notch table closest to the imputed notch value was then used.

The final column of Table 4 indicates how many educators had a notch value which was below the entry level notch applicable to newly appointed educators. This entry level is R292,764. That this is the entry level can easily be confirmed by looking at the concentration of joiners between 2021 and 2022 at this notch level. The fact that 30,614 educators should be below this level is important for the modelling and policy discussions. One way of dealing with a future under-supply of teachers is to hire teachers with incomplete qualifications, and to allow them to complete their qualifications while working. The 30,614 seen in the table are likely to be under-qualified educators, and in 2022 they constituted 8% of educators in the system. Indeed, if REQV values are brought into the analysis, 95% of educators with a notch value of at least the official entry level have the minimum for a new and young teacher of REQV 14, while this is true for only 6% of those with a notch value below the entry level[13]. Importantly, the under-qualified are not younger educators: the under-qualified are a bit older than the qualified on average. Moreover, the average age of the 30,614 on below-entry notches is about the same as that of other educators[14].

What are the chances that many of the 30,614 on notches below the entry level are ECD practitioners, even though they are not marked as such on Persal[15]? An examination of the total

[12] Total spending is what the employer spent in November 2022. The median of this spending value per notch value was calculated, and then notch was regressed on the median values.

[13] REQV stands for Relative Education Qualification Value. To illustrate, REQV 13 is a Matric plus three years of post-Matric training, REQV 14 is a Matric plus four years of post-Matric training, and so on.

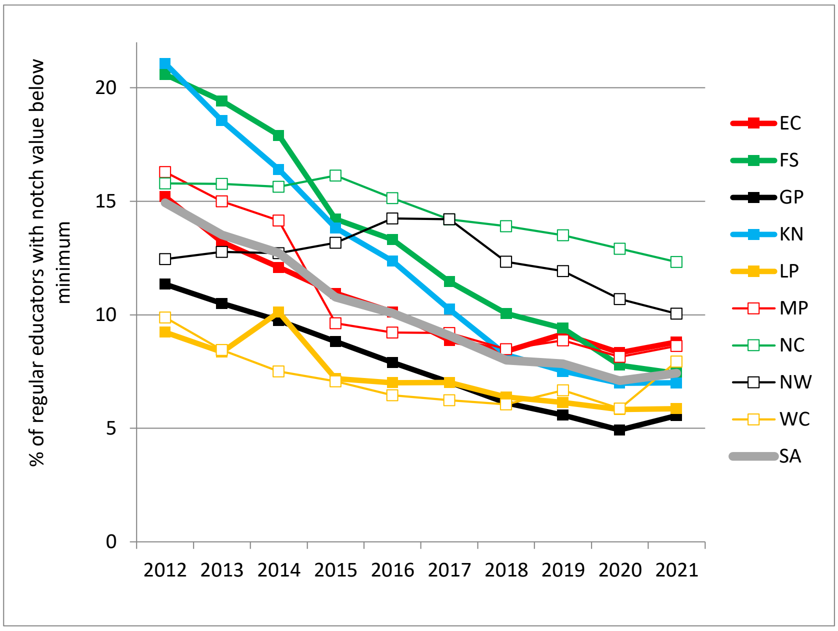
[14] See further details in the previous version of this report.

[15] Apart from the check using expenditure item referred to above, a check of the rank description was also used. Many educators did have rank descriptions indicating they were ECD practitioners, but they were also clearly ECD practitioners according to the expenditure item.

cost to the employer was run to see how many of the 30,614 were paid as little as the ECD practitioners reflected in Table 3, around R8,000 a month. It seemed possible that around one thousand of the 30,614 were in fact ECD educators, given how low their earnings were. These individuals were concentrated in Western Cape, Gauteng and Free State. Judging from the number of *learners* enrolled in Grade R in 2021, one might expect around 21,000 ECD practitioners overall. There are thus around 14,000 practitioners not accounted for in the payroll data – 21,000 minus the 7,000 of Table 3. Given that ECD practitioners in public schools, regardless of their mode of salary payment, are widely known to be paid exceptionally low salaries, it seems clear that there is no major unaccounted for presence of ECD practitioners in the Persal data. It thus seems there is no substantial risk in assuming that the great majority of the 30,614 on below-entry notches are *not* ECD practitioners.

Figure 2 below illustrates the fact that around 8% of educators nationally were below the entry-level notch in 2021[16], with levels being noticeably higher in North West and Northern Cape. The graph also illustrates that this percentage has declined substantially over time. It was twice as high in 2012. If the analysis is restricted to educators aged 30 or below joining the workforce in that year, the trend is also a downward one. This is important for the modelling and the broader Teacher Demographic Dividend project. The implication is that the entry of under-qualified young teachers, possibly UNISA[17] distance education students with an incomplete qualification, has been on the decline. If this were to increase to deal with an under-supply crisis, then the historical trend would be *reversed.*

***Figure 2: Educators whose notch is below the entry level***




A key breakdown of the 403,245 educators used for the model is that between level 1 teachers and senior educators, referred to as 'teachers' and 'non-teachers' in the Excel model. In the model, non-teachers are any educators not classified as teachers according to the rank code of the Persal data. This breakdown, average age and average notch are shown in Table 5.

[16] The 2021 national value in the graph is 7%. The graph is taken from a separate report where a slightly different method was followed.
[17] University of South Africa.

*Table 5: Teachers and senior educators in the final 2022 data*

| Category | Employees | Average age | Average notch |
|---|---|---|---|
| Teachers | 315,464 | 43.4 | 316,967 |
| Senior educators | 87,781 | 51.5 | 469,169 |
| Total | 403,245 | 45.1 | 350,099 |

## 4.2 2011 input data

Persal data from October 2011 were processed in the same manner as the November 2022 data. Details on exclusions appear in Table 6 below. One category of educators which had to be excluded in 2011 was college lecturers. In 2021 (and 2022) colleges were no longer a provincial responsibility and hence there were no lecturers paid through provincial departments.

*Table 6: Exclusion of non-core educators in 2011*

| Educators (according to rank) before exclusions | 431,909 |
|---|---|
| **Exclusions** | |
| Outside 21 to 65 age range | 546 |
| Examination revisers with no other employment | 666 |
| ECD practitioners | 6,822 |
| College lecturers | 4,017 |
| Outside 21 to 65 age range | 419,858 |

The 2011 equivalent of the earlier Table 4 is the following table. In 2011 there were far fewer notches, and the gap between notches was around 1.0%. The total number of notches was 257, of which 42 were derived from the 'inclusive' table.

*Table 7: Details behind the October 2011 input data*

| | Educators aged 21 to 65 | Average spending | Average notch before | Average notch after (if different) | Educators below entry notch of 162,354 |
|---|---|---|---|---|---|
| With standard notch values | 400,169 | 22,422 | 196,709 | | 66,212 |
| With low 'inclusive' notch values | 2,138 | 51,933 | 531,608 | 531,007 | |
| With high 'inclusive' notch values | 379 | 62,265 | 648,705 | | |
| With non-OSD notch values | 3,362 | 16,637 | 111,537 | 124,695 | 2,565 |
| With zero notch value | 13,810 | 5,032 | | 77,491 | 13,587 |
| Sub-total without zero notch | 406,048 | 22,567 | 198,189 | 198,294 | 68,777 |
| Total | 419,858 | 21,990 | | 194,321 | 82,364 |

The breakdown across the two levels of educators considered in the model is given below.

*Table 8: Teachers and senior educators in the final 2011 data*

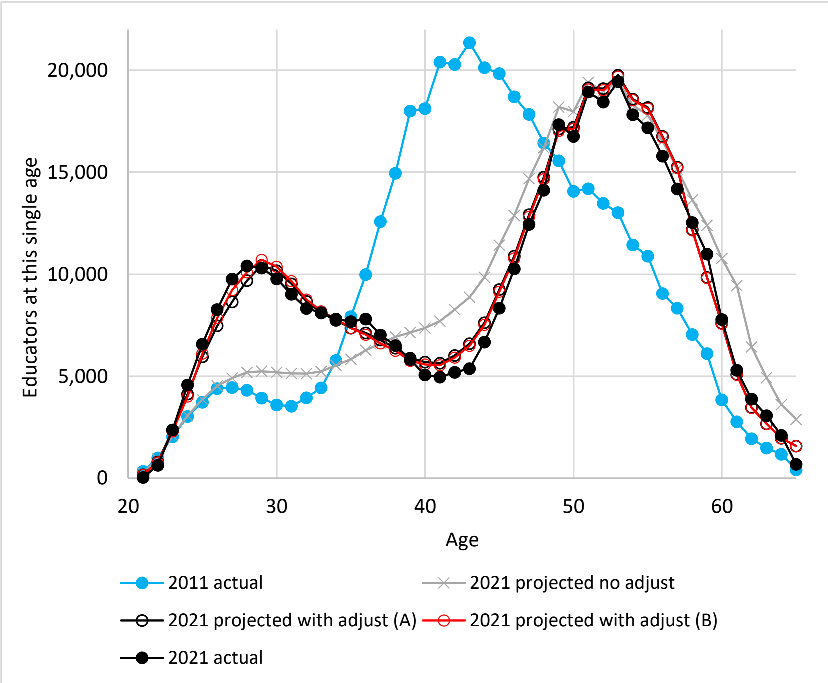
| Category | Employees | Average age |
|---|---|---|
| Teachers | 323,631 | 43.2 |
| Senior educators | 96,227 | 48.5 |
| Total | 419,858 | 44.4 |

## 4.3 A retrospective 2011 to 2021 projection

Figure 3 below illustrates the actual age distributions of educators in 2011 and 2021. Clearly, between the two years the age peak had shifted to the right, from age 43 to 54. The 2021 actual curve points to a few obvious realities, assuming the maximum age for employed educators, or the maximum retirement age, remains 65. By 2030, at least 19% of the 2021 workforce will have left, as they are age 56 or older in 2021, and the compulsory retirement age, or the maximum age at which educators can stay at work, is 65. And a whole 42% of the 2021 workforce would be of age 65 and above in 2035 and would therefore almost certainly have left the workforce.

Original age-specific input values for the attrition rate and joiner age distribution calculated over a decade ago were inserted into the model. The base year was set at 2011, and outputs for the year 2021 were requested through the facility in the model that allows interim years to be selected. The result was the 2021 age distribution referred to as ‘2021 projected no adjust’ in Figure 3. Clearly this age distribution deviates considerably from the actual 2021 distribution. The 2021 projection displays too few educators below age 38, and too many above that age, though the projected peak at age 53 matches reality almost perfectly.

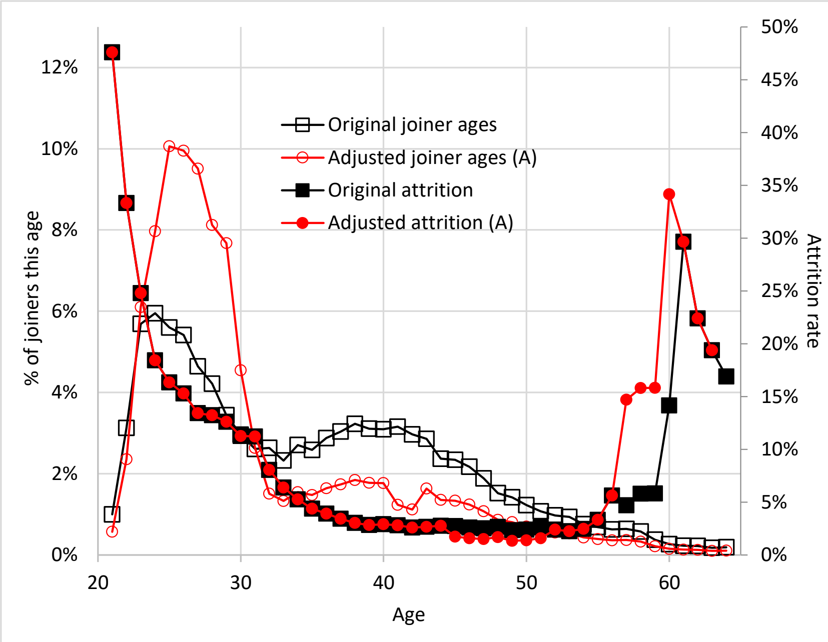
***Figure 3: Educators by age in 2011 and 2021***




For ‘2021 projected no adjust’ future targets for the joining and attrition inputs were set at the level of the base year, meaning attrition and joiner age distribution patterns were assumed not to change. The total number of educators was set to decrease linearly from 419,859 to 405,469. Lastly, no supply constraint was assumed: there would always be enough joiners to meet the demand.

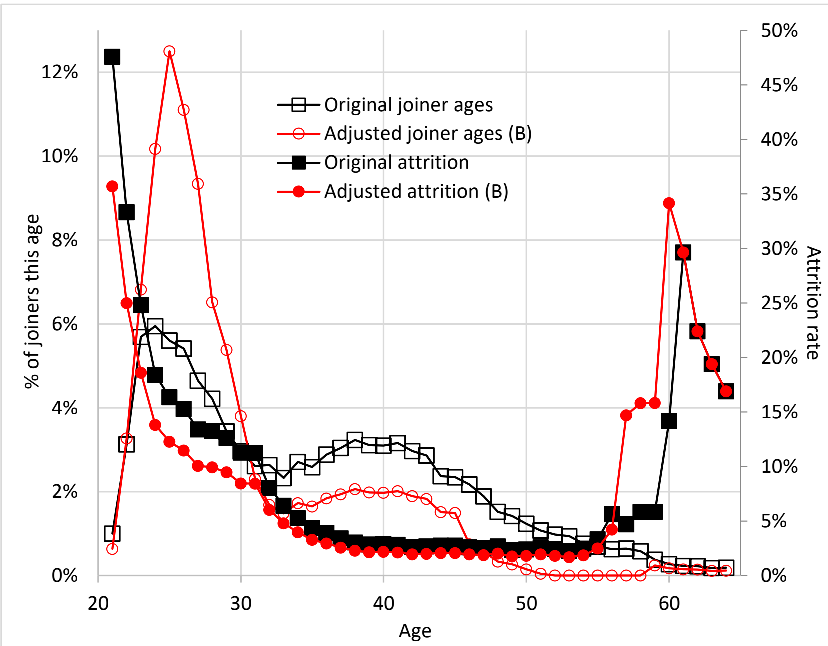
The attrition and joiner inputs used for the initial retrospective are illustrated by black curves in Figure 4 (and repeated in Figure 5). These inputs are based on an analysis of the 2010 and 2011 Persal data. The analysis pointed to high levels of attrition below around age 35 and above around age 60. Between these two ages around 3% of educators left between 2010 and 2011. The joiner analysis revealed two peaks of joiners: at age 24 and around age 40. Clearly, these patterns were not successful at reproducing the actual 2021 age distribution, something which can be seen from Figure 3.

***Figure 4: Attrition and joiner inputs for retrospective***




Adjusting both the attrition and joiner inputs in a manual trial-and-error manner permitted the actual 2021 age distribution to be reproduced rather well – see '2021 projected with adjust' A and B in Figure 3. The important thing to note, however, is that *different* sets of attrition and joiner patterns were able to produce roughly similar and accurate age distributions. Two sets of attrition and joiner values underlie A and B: A appears in Figure 4 above and B in Figure 5 below.

***Figure 5: Attrition and joiner inputs for low-attrition retrospective***




With regard to attrition, adjustment A is closer to the original patterns than adjustment B. The key differences between the original patterns and adjustment A are (1) that attrition had to be adjusted upward for ages 57 to 60, in order to reduce the excess of older educators seen in '2021 projected no adjust' and (2) that the proportion of joiners who are age 30 and below had to be increased. Note that because attrition was raised, the overall *number* of joiners would also increase.

Attrition rates are both politically sensitive and easily confusing, because of the phenomenon of churning, whereby educators leave the system and then return. If just two years of payroll data are used, attrition rates appear relatively high. The attrition rates shown in Figure 4, which are based on an analysis of 2010 and 2011 data, produce an overall attrition for ages 21 to 64 of 4.6% – in terms of the model this would be non-retirement attrition, as all retirement is assumed to occur at age 65 (though high 'pre-retirement' attrition can be simulated at the ages just below 65, effectively producing early retirement)[18].

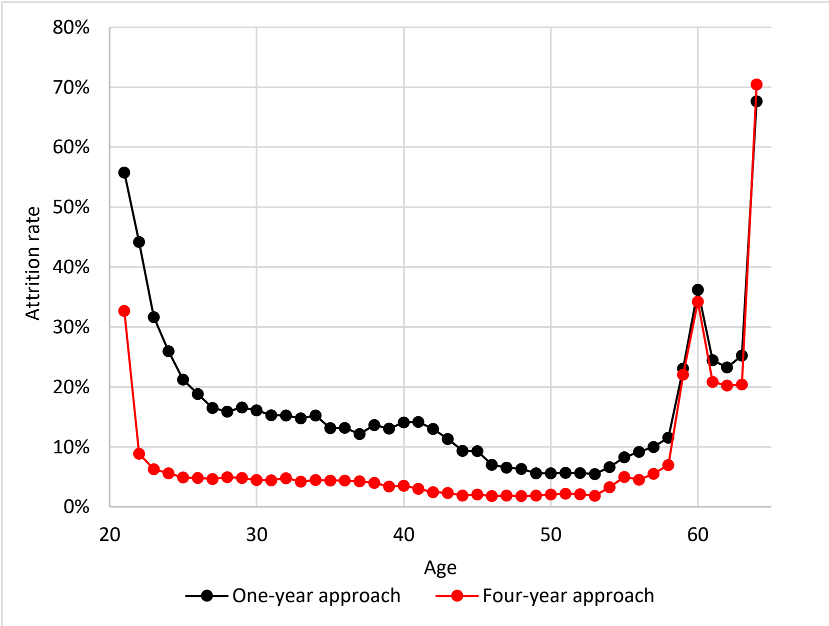
An attrition rate of 4.6% can appear worryingly high, and could suggest that a high proportion of teachers are unhappy about their careers. However, what should be taken into account is that the attrition rate more than halves if four years of data are considered. What this means is that if a leaver is considered someone who is present in a year, but then absent in each of the following three years, then attrition emerges as lower. The conceptual problem is that many think of the attrition rate as reflecting the number of educators who are lost to the system each year. The reality is that many are not lost, as they may return a couple of years later. This is the phenomenon of churning.

Figure 6 below illustrates how different using two years of data, in this case 2020 and 2021, versus using four years of data, 2018 to 2021, is. The one-year approach seen in the graph translates to a 12.2% attrition rate for ages 21 to 64, while the figure for the four-year approach is 5.5%. The former is more than twice the latter. The abovementioned 4.6% is much lower than the 12.2%, which points to the fact that attrition has risen over time in the context of far more educators in their late fifties and sixties – see Figure 3 – for whom attrition rates are high. Importantly, the gap between the one-year and four-year approaches in Figure 6 is larger for educators below around age 43. These educators are far more likely to 'churn'. This in turn is linked to the fact that younger teachers are more likely not to have obtained permanent tenure yet and to be employed on a temporary basis. The percentage of educators employed on a temporary basis has been around 12% since at least 2017[19].

[18] There are two key reasons why actual retirement is not dealt with in the current report. Firstly, retirement details are captured in separate Persal files, and not those merged and normalised for the current analysis. A preliminary analysis of these separate files revealed that the descriptors of retirement are complex, and not that easy to interpret. The second reason is that for the purposes of the current report, it does not matter whether, say, an educator aged 60 leaves the system due to retirement, death or ordinary resignation. The effect on the system is essentially the same. The term 'non-retirement attrition' here should be understood in terms of the model, in other words it means attrition of anyone who is not aged 65.

[19] Department of Basic Education, 2022a: 7.

***Figure 6: Different attrition rates for 2021***




The question is what attrition rate to use when modelling the demand for joiners. The high two-year attrition rates are clearly deceptive insofar as they create the impression that the system is losing more educators than is actually the case. A 2009 DBE report that looks into the matter argues as follows: 'Educator demand figures that are used for planning and in the policy debates should not be calculated on just two years of data, as this exaggerates the extent of the under-supply of new graduates'[20]. Put differently, the higher attrition rate resulting from a two-year approach exaggerates the problem of younger teachers leaving the system[21].

Despite the deceptiveness of two-year attrition rates, such attrition rates will be used for the modelling because they reflect what is actually happening across two years. Attrition rates using a longer series of data are difficult to apply conceptually. This is in part because the number of years of data chosen is fairly arbitrary. There is nothing special about a series of four years of data. A series of three, five or six years would also assist in controlling for churning. A cleaner approach for the work that follows seems to be to use the two-year attrition rates, *but also joiner statistics based on two years of data.* Attrition and joiner inputs need to be aligned. The approach would then involve translating *outside the model* joiner numbers to the demand for newly qualified teachers, based on recent trends trends seen in the payroll data. This indirect approach is necessary because, unlike in England (see section 2.1), we do not have easy availability of student-level records of who has graduated when, something captured in DHET's HEMIS[22] system. How joiner numbers can be translated to the demand for new graduates is explained in section 5.3 below.

Returning to the retrospective analysis, in adjustment B the attrition rates for ages 56 and below were cut by 25%. Attrition rates for ages 57 to 60 were as for adjustment A. This produced an overall non-retirement attrition rate for adjustment B of 4.4%. As one might expect, adjustment

[20] Department of Education, 2009.
[21] An earlier teacher supply and demand study by Centre for Development and Enterprise (CDE) concluded that high attrition rates, or a 'leaky bucket' syndrome, was a central problem in the schooling system (Centre for Development and Enterprise, 2015; Simkins, 2015). It has been argued that the CDE's conclusion is in part driven by an under-estimation of levels of churning, and that if alternative attrition rates are used, South Africa's attrition rates do not emerge as high in an international comparison – see Department of Basic Education (2015).
[22] Higher Education Management Information System.

A with its elevated attrition produces more joiners overall than adjustment B, the average annual joiner figures for 2012 to 2021 being 25,080 and 22,096 respectively, a difference of 14%. If the focus is only on joiners aged 30 and below, the figures are 16,774 and 15,369, a difference of 9%. For joiners *above* age 30, the difference is a relatively large 23%, with more joiners in adjustment A. It should be remembered that there is no supply constraint in the modelling as run here, so enough joiners to reach the annual total educators are always available.

Despite a spike at age 25 in the *proportion* of joiners in adjustment B (Figure 5), the proportion of teachers of ages 21 to 30 is similar across the two adjustment scenarios: 70% in adjustment B against 67% in adjustment A.

The key thing emphasised by adjustment B is that that same future age distributions in the workforce can be reached with rather different attrition rates, as long as joiner age inputs are adjusted. For instance, while adjustment A sees a few joiners aged 48 to 53, in adjustment B there are no joiners in these ages. This can be thought of as the fact that in adjustment B the effects of churning are removed, while in adjustment A this effect is reflected.

# 5 Headcount projections beyond 2022

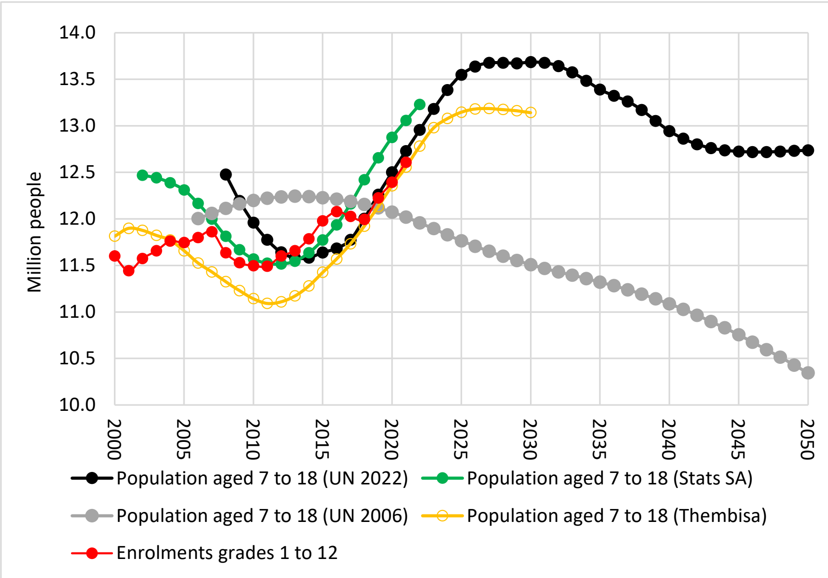
## 5.1 Child population, enrolment and LE ratio assumptions

The expected future size of the twelve age cohorts corresponding to grades 1 to 12 is illustrated in Figure 7 below. Clearly, expectations have changed dramatically over time. The 2006 United Nations Population Division projections foresaw a decline in the school-age population, specifically the population aged 7 to 18, of around half a million between 2020 and 2030. However, 2022 UN projections point to an *increase* of just over a million over the same period. The earlier expectation of a decline informs the National Development Plan's concept of a 'demographic dividend, in the sense of a freeing up of resources arising out of having fewer children to care for[23]. Clearly, the number of children is increasing. The increase in the school-age population between 2022 and 2030 comes to 5.6%, using the UN projections of World Population Prospects 2022.

Two patterns relating to the UN projections are noteworthy. Firstly, there is an expected peak in the school-age population in around 2028, after which this population declines somewhat. Secondly, actual grades 1 to 12 enrolments have, at least since 2007, displayed trends which are consistent with the UN population trend. Figure 7 thus suggests that enrolments can be expected to increase substantially to 2030, even without improving levels of participation, or 'survival' to particular grades.

[23] National Planning Commission, 2012: 98. It should be noted that despite an unexpected increase in the child population, a demographic dividend still exists for the country insofar as the percentage of the population *not* aged 15 to 64, or the dependency ratio, is expected to decline slightly from 34% to 32% between 2022 and 2030. These figures use the Thembisa projections, and UN definitions found at https://www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/demographics/dependency_ratio.pdf.

*Figure 7: Projections for school-age population*




*Sources: The source for population is the World Population Prospects of 2006 and 2022 of the United Nations, available through https://population.un.org. For projections, the UN's 'medium variant' was used. For Stats SA, values in the 2022 MYPE were used. For the UN 2022 series figures for ages 7 to 18 were derived using the UN data and Stats SA's Sprague tool to calculate single age values, and a simple linear trend to derive years between the every fifth year of the UN data. Stats SA's Sprague tool was last released online together with the 2016 Mid-Year Population Estimates files. The source for the enrolment values is published reports of the national education department. These values include both public and independent ordinary schools. Thembisa projections were obtained from the Thembisa website (https://www.thembisa.org) in October 2022, and were produced in 2022.*

Enrolments over school-age population in 2021, using values from Figure 7, come to 96%. This is high, if one considers that only around 78% of youths have reached Grade 12 in recent years[24]. The explanation lies partly in grade repetition[25]. Repetition, meaning children take specific grades more than once, pushes up participation ratios such as the 96%.

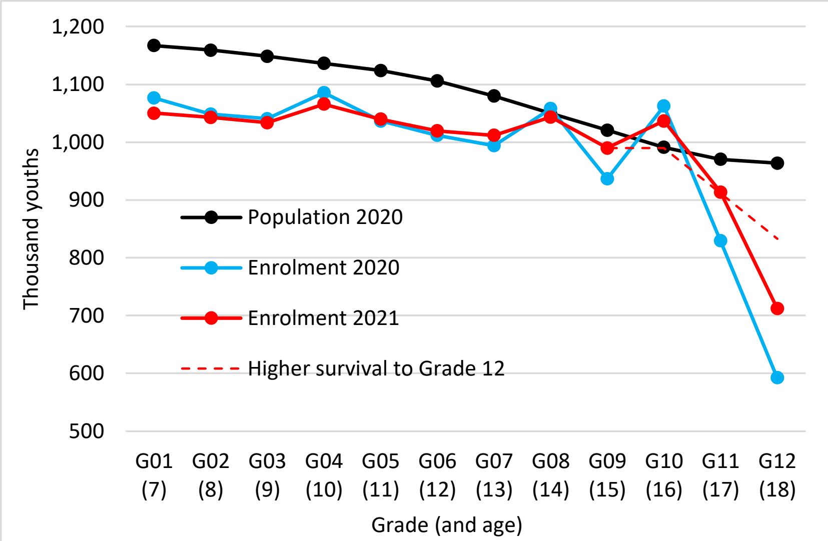
Stats SA population estimates follow a trajectory which largely agrees with the UN trajectory in Figure 7. Projections produced by the Thembisa project in April 2022 also point to large increases – here the 2022 to 2030 increase in the school-age population is 2.8%. However, this increase is much smaller than the 5.6% seen in the World Population Prospects 2022 data. This fact, and the fact that the Thembisa projections needed no Sprague disaggregation as values were already in single ages, should caution against uncritical acceptance of the higher 5.6% increase.

Figure 8 below provides a somewhat crude picture of survival to Grade 12 in the public schooling system. There was a dramatic increase in Grade 12 enrolments in 2021, linked to the COVID-19 pandemic. If the 2021 situation is used as a point of departure, and if beyond that year public Grade 12 enrolment as a percentage of the age 18 population is assumed to increase by 1.4 percentage points each year, the result is a percentage of 84% by 2030. The annual increase of 1.4 percentage points a year is what has actually been seen in the period 2012 to 2020. The 84% is thus informed by recent trends, and is roughly in line with government

[24] This is a grand total of 750,478 Grade 12 learners for 2021 published through the DBE's *School Realities*, divided by 964,000 eighteen-year-olds in 2020 based on the UN data behind Figure 7.
[25] A further reason would be over-estimation of the population – see Gustafsson (2012a).

targets[26]. As can be seen in Figure 8, the alternative enrolment scenario, 'Higher survival to Grade 12', includes some savings insofar as Grade 11 enrolment is expected to decline slightly due to lower grade repetition. If the abovementioned 5.6% population-driven increase is combined with the higher level of Grade 12 survival, the result is that enrolments, and by implication educators, would increase by 6.2% between 2022 and 2030.

***Figure 8: Higher survival to Grade 12 in public schools***




*Sources: As for the previous graph in the case of enrolments, and 2019 WPP for population..*
*Note: Only public ordinary school enrolments are reflected here. Note that the 'Higher survival to Grade 12' curve is an adjusted version of 'Enrolment 2021', without taking into account future population trends. The reason why the population curve is considerably above the enrolment curve for the younger ages is due to independent school enrolments not being counted, and a strong likelihood that the population values are over-estimates (see for instance Gustafsson [2012a]).*

Turning to the learner-educator ratio, this has steadily increased from 27.4 in 2011 to 29.8 in 2021. These LE ratios are calculated by dividing official public ordinary school enrolments in grades 1 to 12 by the number of publicly paid educators as defined for Table 4 above[27]. This means that additional educators employed by the school governing body, and who tend to work in public schools in middle class areas, are not included in the calculation. More details on the LE ratio trend are provided in an internal DBE report[28]. The effect of a worsening in the LE ratio has clearly been larger classes, particularly in historically disadvantaged schools[29].

A publicly available analysis of LE ratios for the 2003 to 2017 period indicates that the years 2009 to 2012 were good years with respect to the ratio[30]. Before that period, and after that period, values were higher. For the purposes of the educator projections, one scenario assumes the LE ratio would move gradually and linearly back to the 27.4 it was in 2011, by the time we

[26] Van der Berg *et al*, 2020.
[27] One difference is that for these LE ratios there was no age exclusion when counting educators.
[28] Report titled 'What are our learner-educator (LE) ratio trends?', dated 18 June 2022, by the author of the current report.
[29] The percentage of learners in grades 1 to 7 in classes with more than 45 learners clearly increased in many education districts across the country – see Department of Basic Education (2021: 14-15). An important study by Köhler (2020) found class size not to have an impact on Grade 12 results in historically disadvantaged schools. However, no such research exists for the primary level, where class size is likely to be a stronger determinant of learning, given the need for more individualised attention.
[30] Department of Basic Education, 2020a: 30.

reach 2030. However, this value must be adjusted slightly to take into account that the envisaged percentage of enrolments at the secondary level would rise, as implied by the previous discussion. LE ratios are slightly higher at the primary level than at the secondary level. The required adjustment would take the 27.4 ratio to 27.3.

If one compares South Africa's LE ratio to that in other middle income countries, it emerges that it was about five learners higher than the norm in around 2016[31]. The norm suggests the ideal for South Africa is around 23. Thus, taking the LE ratio back to the 27.4 level seen in 2011 is still conservative insofar as this would still place South Africa's ratio considerably above the norm.

If the improvement in the LE ratio is added to the 6.2% growth in the educator workforce referred to previously, the result is a much larger growth figure of 15.7%. Taking the LE ratio back to its previous and more favourable level is clearly an ambitious undertaking.

Beyond 2030, the total stock of educators is assumed to remain constant. Given that beyond 2030 enrolments are likely to decline somewhat – Figure 7 above points to a 7% decline between 2030 and 2050 in the school-age population – keeping educator numbers constant implies a reduction in the LE ratio, though the extent of this would be sensitive to issues such as grade repetition and survival to Grade 12. The reason for having a constant stock of educators beyond 2030 is to keep the modelling simple for that period, in part because what stock of educators will be affordable so far into the future is highly unpredictable. What is of greatest interest beyond 2030 is, firstly, the evolving age structure and, secondly, unit costs. These model outputs would not be very sensitive to minor changes in the LE ratio.

## 5.2 Employee counts emerging from the model

The three key non-zero percentage increases discussed in section 5.1 are listed in Table 9 below. With the 0% 'Constant educators' scenario, there are four scenarios. The three growth scenarios imply an increase in the educator workforce, between 2022 and 2030, of 22,691, 24,946 and 63,385 respectively.

***Table 9: Drivers behind total educator demand to 2030***

| Driver of the increase | Short name of scenario | Increase in stock of educators 2022 to 2030 |
|---|---|---|
| | Constant educators | 0% |
| Growth in population aged 7 to 18 | Population | 5.6% |
| Above plus improvement in survival to Grade 12 | Population + Grade 12 | 6.2% |
| Above plus reduction in LE ratio to levels seen a decade ago | Population + Grade 12 + LE | 15.7% |

Joiners are needed because educators leave. Before joiner estimates are discussed, two graphs relating to leavers are provided. Figure 9 uses the 'Constant educators' scenario in order to reduce the number of effects occurring simultaneously and thus simplify the explanation. What is clear is that as the age curve moves rightwards, as educators age, the peak becomes smaller. This is because attrition begins to rise already from age 54 – see Figure 6.

[31] Department of Higher Education and Training, 2020: 44.

*Figure 9: Educators by age up to 2030 in 'Constant educators' scenario*

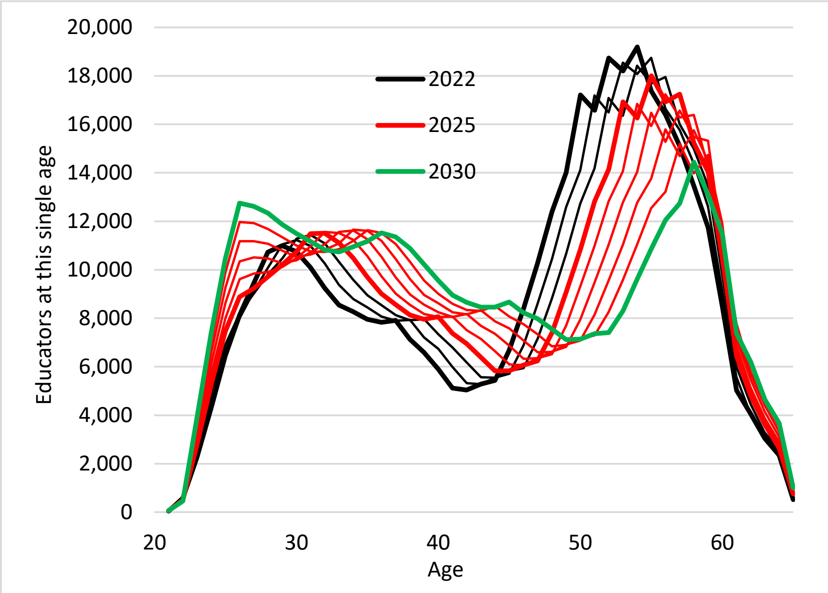
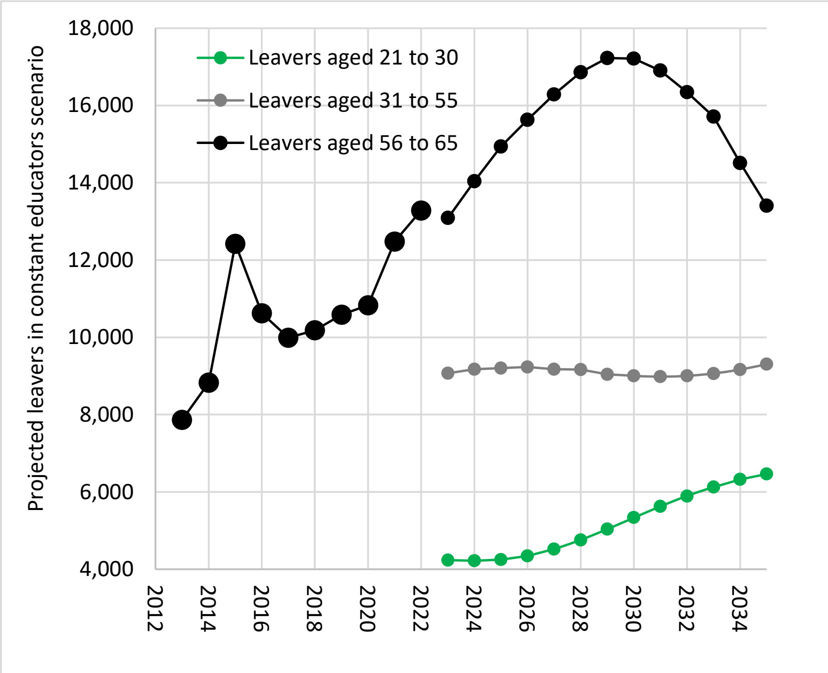



Figure 10 illustrates the number of leavers per age category in the 'Constant educators' scenario. Historical values from 2013 for ages 56 to 65 are also provided. The 2015 spike in departures was due to uncertainties and rumours relating to pension reform, which prompted many educators to take out early retirement. The 2021 increase in leaving among older educators largely reflects deaths and illness due to the pandemic (details provided below). There is a clear upward trend among leavers of retirement age, which reflects the fact that an increasing number of educators have reached retirement age. The model's projections point to departures among those aged 56 to 65 reaching just over 17,000 by 2030. The cumulative number of leavers in this age range for the years 2022 to 2030 is 142,000, or 35% of the original 2022 workforce of some 403,000[32]. Most, but not all of this would be due to retirement, other reasons being resignation and death. If the analysis is extended to cover the years 2022 to 2035, then 53% of the original workforce would have left due to being of retirement age.

While it is true that 56% of the educator workforce was aged 46 or above in 2022, and would therefore be aged 55 or above in 2030, and hence possibly eligible for *early* retirement from age 55, it is clear that few educators take early retirement and that retirement only begins to be clearly visible from age 60 – this can be seen from Figure 6[33]. Moreover, what should be taken into account is that the number of educators aged between 61 and 65 is likely to *increase* as the peak in the age distribution moves into this age range. In fact, number of educators aged 61 to 65 in Figure 9 increases from 14,988 to 22,895 between 2022 and 2030.

[32] 142,000 is the sum of the values for 2023 to 2031. Each year's value represents people who left between the previous year and the current year.
[33] Though this graph appears to display a steep rise at age 59, much of this would be accounted for by educators who would turn 60 in the months following November 2021, and would retire at age 60.

*Figure 10: Leavers by age category in ‘Constant educators’ scenario*




*Note: Year for each point is the year in which the educator is no longer in the system. Age is the age in the previous year.*

The increase in young leavers in Figure 10 is noteworthy. This occurs because there are more young teachers in the system, so the absolute numbers of young leavers can be expected to rise in the absence of large changes in the attrition rates.

Figure 11 below presents the number of joiners per year for the period up to 2040 produced by three of the four scenarios listed in Table 9. ‘Population’ is not reflected as it is almost indistinguishable from the similar ‘Population + Grade 12’ scenario. Moreover, two of the scenarios in Figure 11 have variants labelled ‘HIGH ATTRITION’. These variants use what are clearly the higher levels of attrition for *younger* educators seen around ten years ago – this is clear in Figure 15 below. This higher attrition reflects what might be seen if the economic situation improves and young educators have more opportunities outside public employment in teaching.

In all scenarios, the age distribution of joiners was managed in a manner that ensured that annual joiners aged 31 and above was between 11,000 and 12,000 in 2030, the level seen between 2018 and 2019. Behind this was the assumption that much of the joining and leaving among older educators was churning, but above all that any rise in the demand for joiners would have to be met mostly by younger and newly graduated educators, as the reserve pool of older educators was limited. The age distribution of joiners over the years was managed through manipulation of just one value per scenario: the future year in which the target age distribution was arrived at. The baseline age distribution for joiners was derived from an analysis of 2018 and 2019 Persal data – comparing 2020 to 2021 was deliberately avoided to exclude unusual COVID-19 pandemic effects. Using joiners between 2018 and 2019 as a guide has the advantage that this takes into account a 2018 policy change which essentially penalised re-joining financially, and which reduced the incentives for churning (see section 6.1).

The target age distribution assumes that the great majority of joiners are young, specifically aged 23 to 26. Age distributions are illustrated in Figure 17 below. To illustrate the target years that produced stability in the number of older educators who are joiners, in the scenario

‘Constant educators’ the year 2048 emerged as an optimal target year, while for the scenario ‘Population + Grade 12 + LE’ the optimal target year was 2038.

***Figure 11: Joiners in five scenarios***

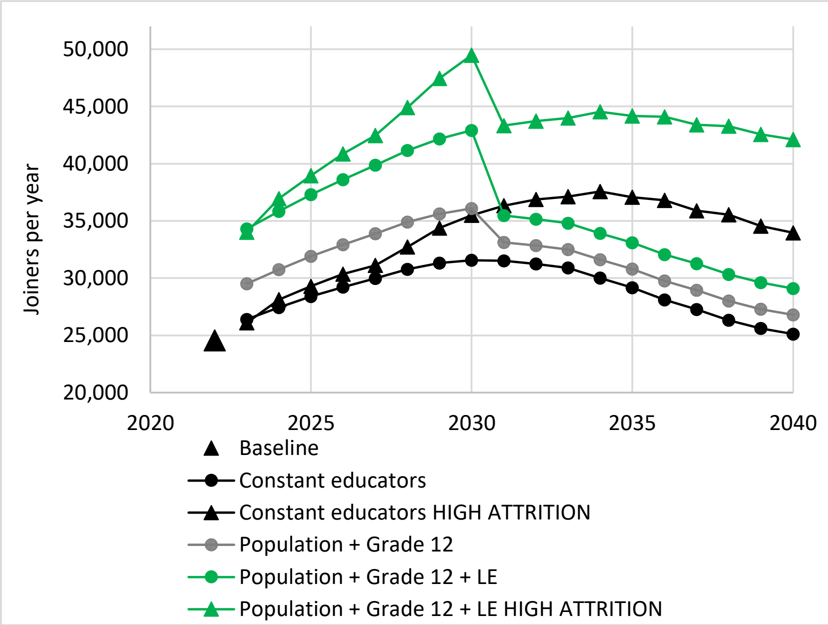
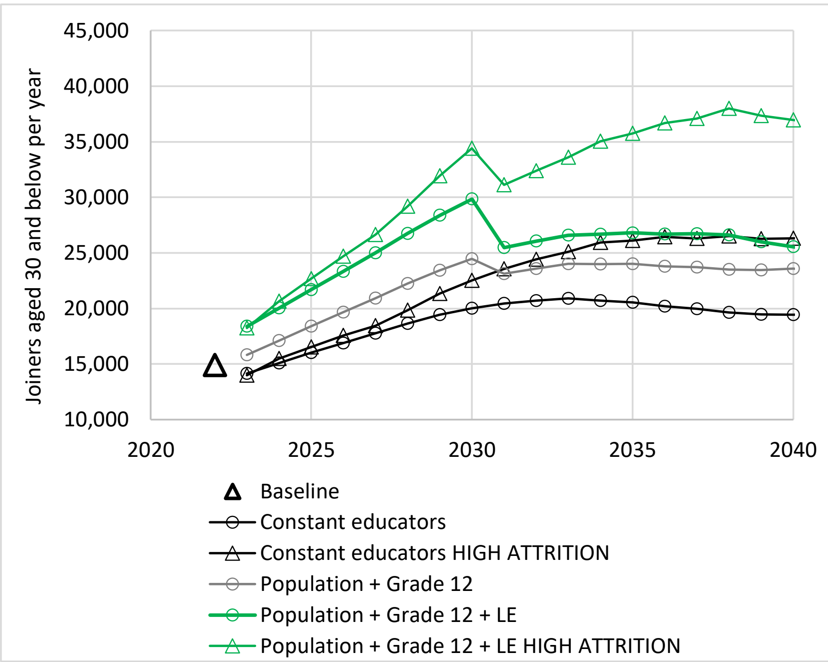



Figure 12 reflects just the projected joiners aged 30 and below. This is of obvious importance for the question of the extent to which university-based training will have to be ramped up.

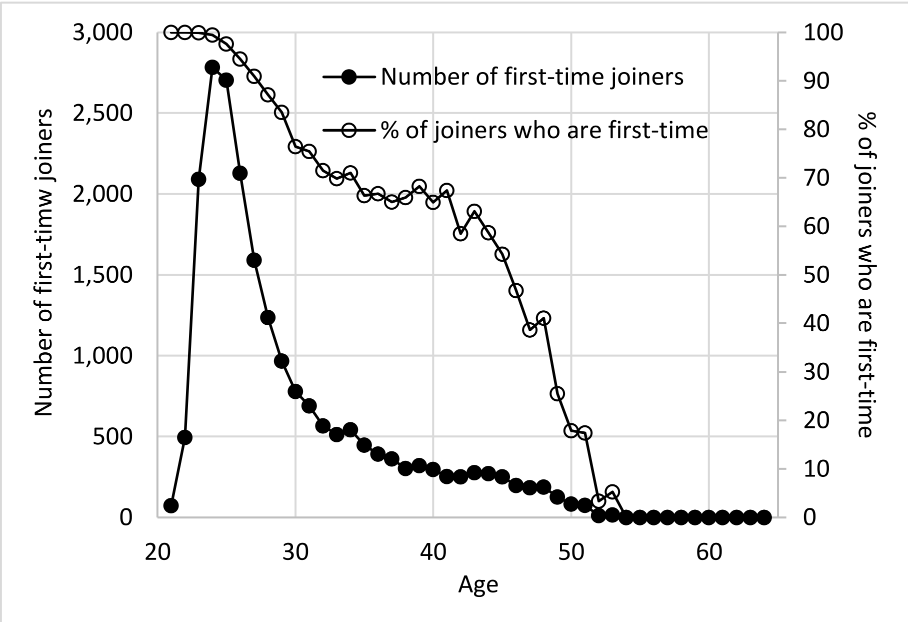
***Figure 12: Young joiners in five scenarios***




Previously, ‘young joiners’, or joiners aged 30 and below, were the only point of departure for calculating graduate demand. However, a recent analysis presents what seems better point of departure, namely estimated first-time joiners across *all ages.* This analysis (Department of Basic Education, 2023) used three approaches in obtaining the percentage of joiners who are first-time joiners, by age: modelling historical presence over multiple years of payroll data;

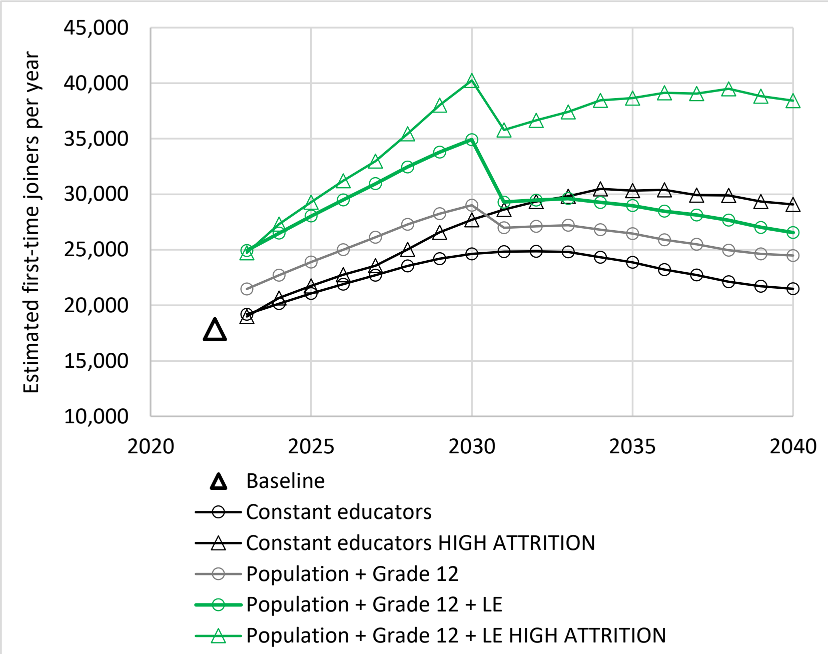
examining the salary notch of joiners; and linking one year of university graduates data to payroll data. The conclusion was that treating joiners aged 30 and below as first-timers, and those above as re-joiners, as a rule-of-thumb, leads to an under-estimation of first-time joiners of around 25%. The evidence thus suggests that there are more older first-time joiners than is commonly believed. Figure 13 below illustrates the age-specific percentages emerging from the analysis, and absolute numbers of first-time joiners, using joiner age distributions in the modelling, and a total number of joiners of 29,518, which is the 2023 total in 'Population + Grade 12' in Figure 11.

***Figure 13: First-time joiner patterns***




The Excel model incorporates the percentages from Figure 13 and is thus is able to reflect first-time joiner numbers as shown in Figure 14. Importantly, the separation of first-time joiners occurs outside the five main calculation processes of the model illustrated in Figure 1. The 2030 projections from Figure 14 are between 17% and 23% higher than those seen in Figure 12, which would be in line with the finding that simply considering young joiners as all first-time joiners leads to an under-estimation of the latter. The gaps between the two graphs are lower for 2040, the new approach producing figures which are between 4% and 11% higher.

*Figure 14: First-time joiners in five scenarios*



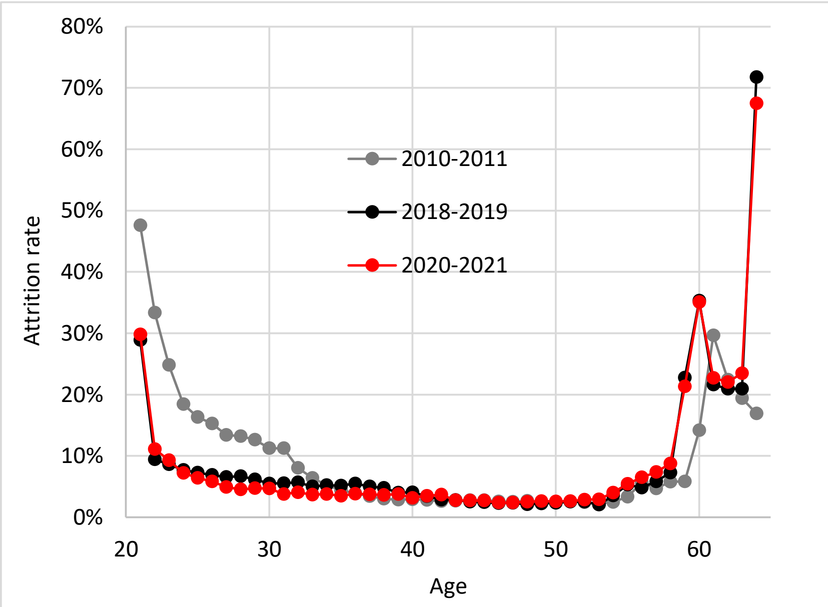

In the three previous graphs the 2022 baseline is given. Scenarios other than 'Constant educators' reflect large jumps between the 2022 baseline and the 2023 projection, but also large declines between the 2030 projection and the 2031 projection. This is because the total demand for educators increases up to 2030, while this increase is made to suddenly halt in 2031[34]. In reality, enrolment increases are unlikely to reach such a sudden halt, and the decline in the first-time joiners in 2031 in the more expansive scenarios is thus exaggerated. However, some decline beyond 2030 can be expected across all scenarios after the wave of retirements has passed through the system.

The source for the 2022 baseline values is the report Department of Basic Education (2023b), where joiners are calculated using the 'simple approach' of using just two years of Persal data. As discussed in section 5.3, for at least younger joiners, whether one uses a 'simple approach' or an approach using several years of data does not make a substantial difference to the number of joiners found.

The attrition rates illustrated in Figure 15 below were calculated afresh for the current analysis using the same approach for each pair of years, in the interests of comparability. The 2018-2019 rates were used for the three scenarios in Figure 11 (and Figure 12) without 'HIGH ATTRITION', while the 2010-2011 rates were used for the 'HIGH ATTRITION' scenarios. It is clear that there was much higher attrition among young educators in 2010 than a decade later. Especially for younger educators, a slight drop in attrition between 2018 and 2020 is visible in the graph. This would have been driven in part by the crisis of the pandemic, specifically even fewer employment opportunities outside teaching.

[34] Importantly, the increase in the total workforce between 2022 and 2023 is the same as that between 2023 and 2024 in, for instance, the 'Population + Grade 12 + LE' scenario. It is the number of joiners that displays an exceptional increase between 2022 and 2023. If the workforce had been increasing before 2023, then the 2022 joiner baseline would have been considerably higher. A similar explanation lies behind the 2030 to 2031 declines in joiners in the expansive scenarios.

***Figure 15: Attrition by age statistics used***




In calculating the attrition rates, an adjustment was made to exclude the effect of an overall decline or increase in the size of the workforce. For instance, the workforce grew by 1.2% between 2018 and 2019, and attrition rates were thus increased proportionally. If the workforce is growing, because there are more posts available, attrition will be artificially reduced, relative to a stable post situation.

In Figure 16, numbers of leavers seen in the most recent pairs of years are shown. The green arrow points to a rise in attrition during the pandemic among older educators. Analysis of a field capturing reason for departure from Persal was analysed (in a separate study[35]), and pointed to excess deaths of around 3,500 educators from April 2020 to March 2022. That analysis drew from downloads for every month during the pandemic, and for the whole of 2019 to establish a baseline. These losses due to COVID-19 mortality came to around 0.8% of the publicly employed educator workforce.

[35] Gustafsson *et al* (forthcoming).

*Figure 16: Leavers by age in recent years*

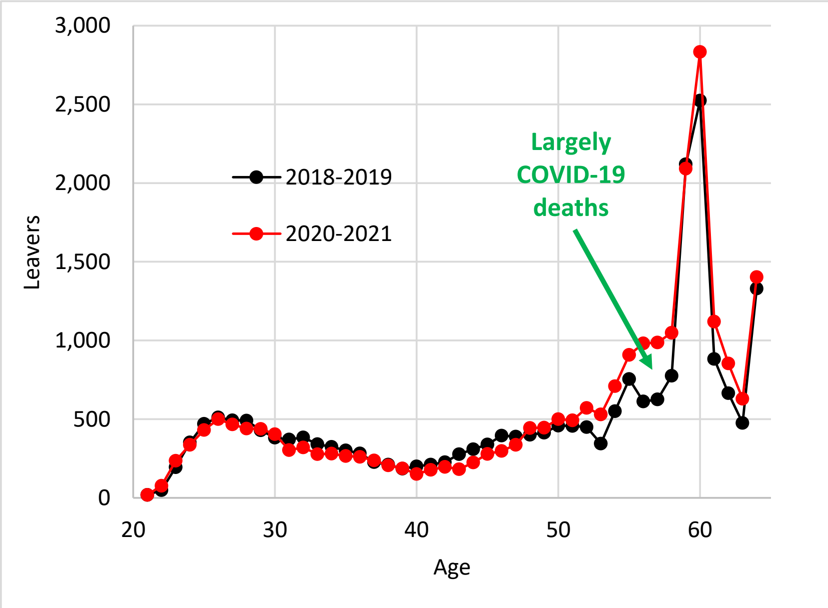
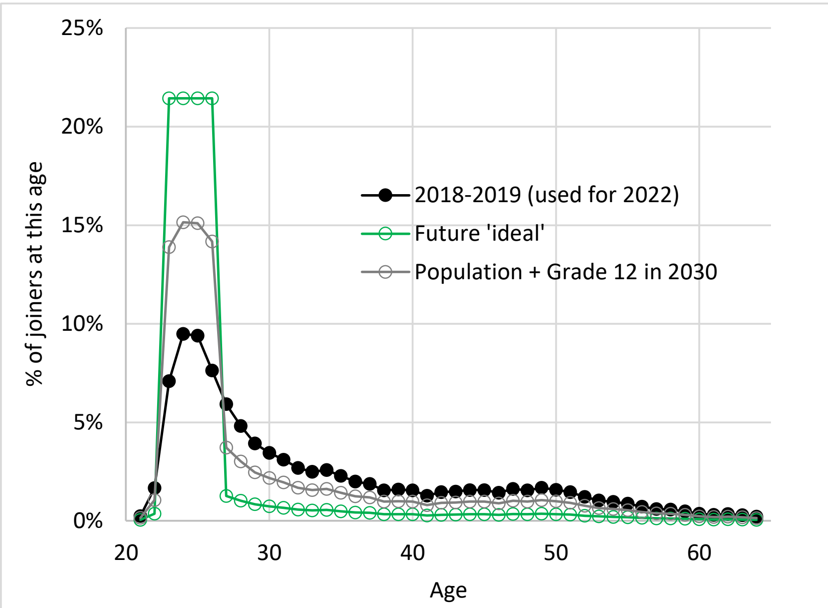



Figure 17 below illustrates the joiner age distributions used for all five future scenarios illustrated in Figure 11 – see '2018-2019 (used for 2022)' and 'Future 'ideal''. This was discussed previously. The age distribution applicable in 2030 would be somewhere between the 2022 baseline (for which an analysis of 2018 to 2019 data was used) and the 'ideal', depending on the year attached to this future situation. The 2030 distribution applicable in the scenario 'Population + Grade 12' is provided for illustration. The future year for the 'ideal' was always beyond 2030. As mentioned previously, an attempt was made to keep joiners aged 31 and above between 11,000 and 12,000 a year, thus forcing the model to seek educators of age 30 and below to address large increases in the demand.

*Figure 17: Joiner by age statistics used*




The last five graphs in this section illustrate projections to 2072. All the scenarios in Figure 18 (which is an expanded version of earlier Figure 11) point to a peak in the demand for joiners occurring between 2030 and 2035, this being an exceptional response to the exceptional peak in retirements. The sharp peaks in 2030 seen for all scenarios other than the two constant educators scenarios reflect the fact that the size of the workforce increases to 2030, and then plateaus. Figure 19, which focusses on young joiners, suggests that the decline in the demand for new graduates beyond 2030 may not be as pronounced as was suggested by the DHET report. Much depends on the availability of a reserve pool of older educators from which joiners can be drawn. Lastly, Figure 20 below extends the analysis of earlier Figure 14.

***Figure 18: Joiners in five scenarios to 2072***

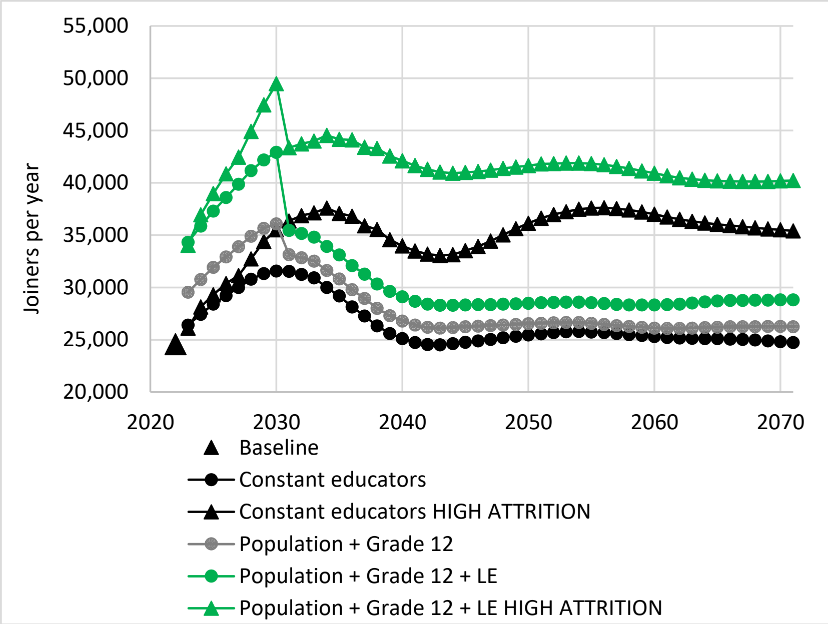



***Figure 19: Young joiners in five scenarios to 2072***

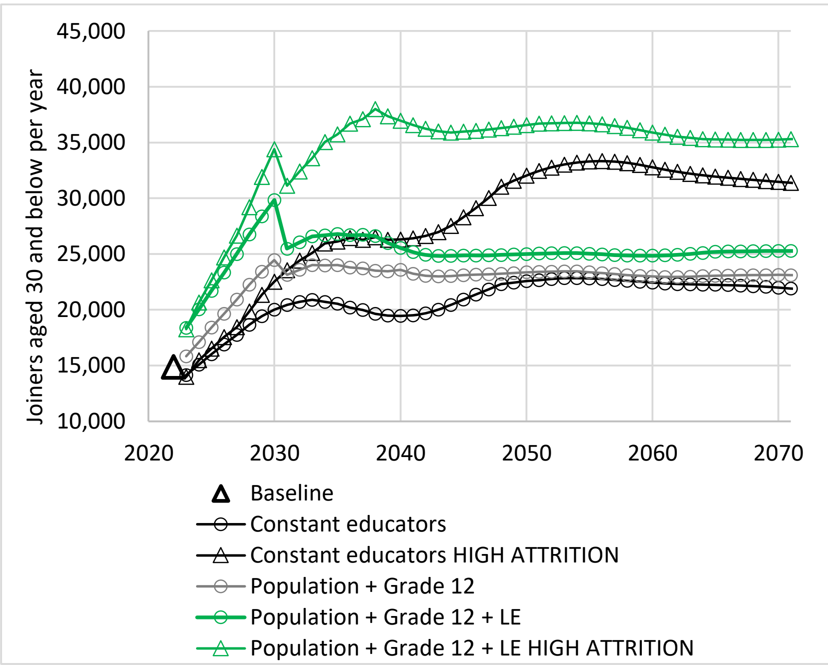


*Figure 20: First-time joiners in five scenarios to 2072*

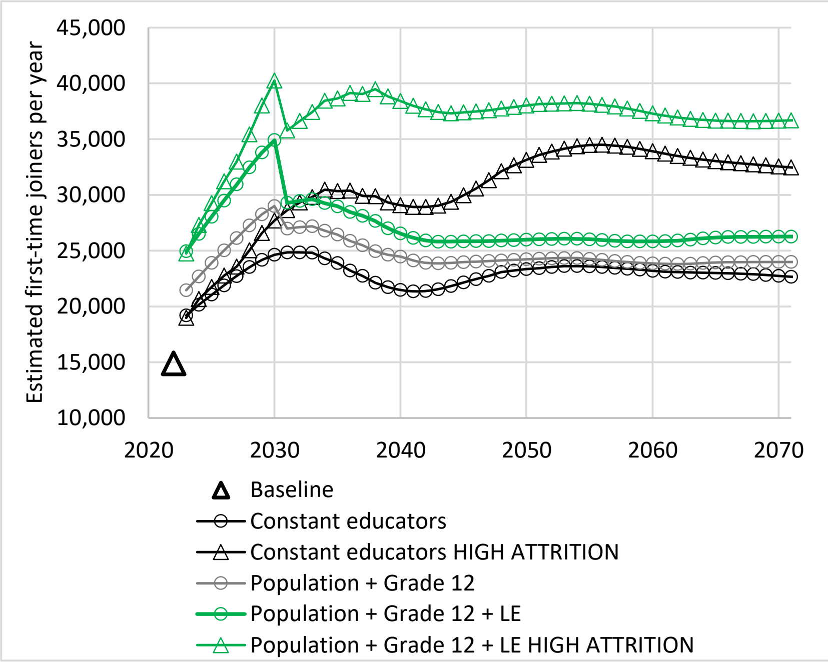



Figure 21 below suggests that the average age for educators will decline from the current 45 years to somewhere between age 39 and age 41 in 2040, after which this indicator remains roughly stable. For this graph, three of the five scenarios were selected.

*Figure 21: Average educator age up to 2072*

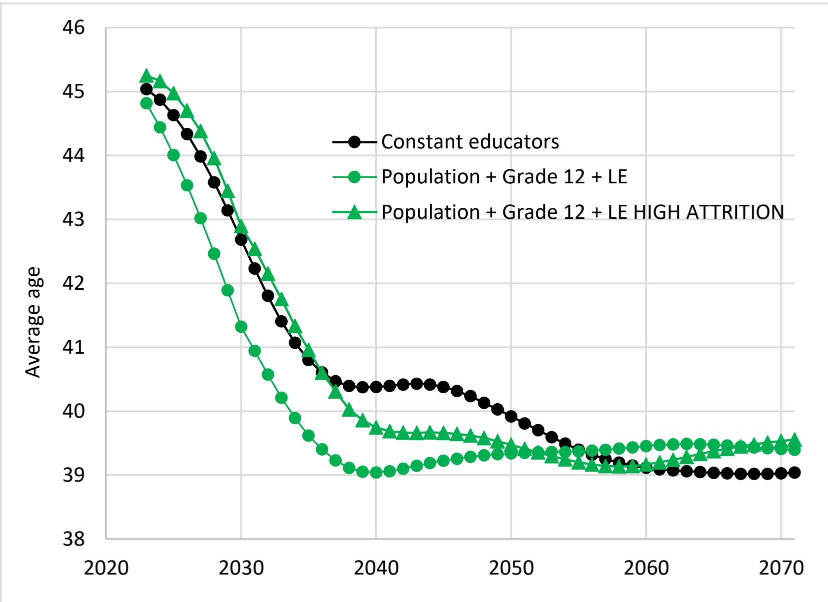
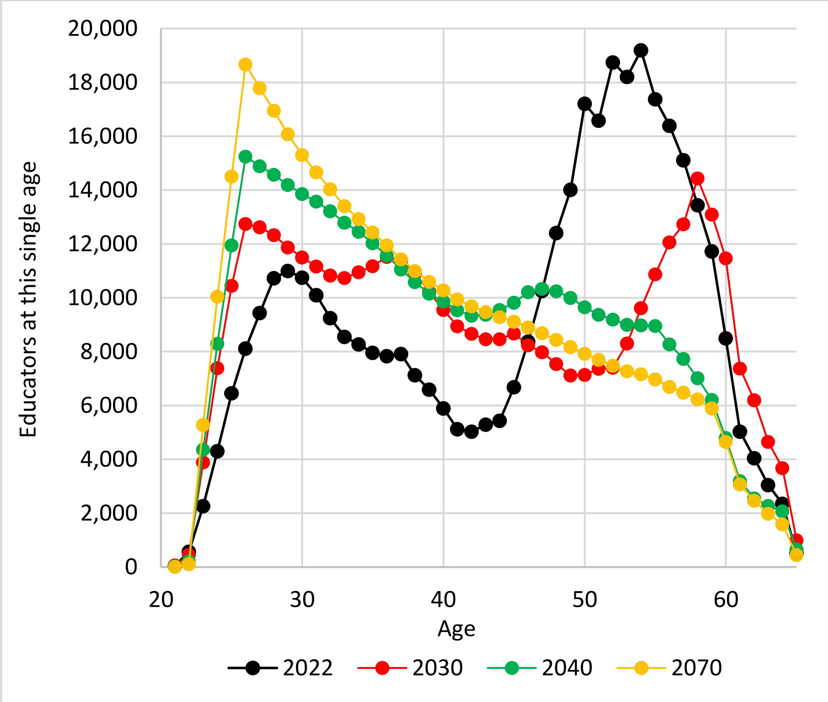



Figure 22 focusses on the 'Constant educators' scenario, though other scenarios would display similar patterns. Only between 2030 and 2040 does the age distribution become more 'normal' in the sense that the major peak shifts to young educators, or the left-hand side of the graph. A peak among young educators is normal if one assumes that people become educators and enter public service early in life, and then gradually leave the pool of publicly employed educators for a number of reasons, including employment opportunities elsewhere, either in the public or private sectors. Such a 'normal' situation would prevail if the size of the schooling system had been roughly stable for many decades. A key reason for the current peak of older educators in

South Africa are the very large increases in the number of teachers in the decades preceding 1990[36].

**Figure 22: Educators by age up to 2070 in 'Constant educators' scenario**




### 5.3 Translating first-time joiner numbers to graduate demand

Figure 14 above points to the annual demand for first-time joiners increasing from the current level of around 18,000, to a level of between 25,000 and 40,000 by 2030, depending on various demand-side assumptions. To translate the 2030 demand figures to the number of initial teacher graduates which South African universities should graduate by that year, the following six factors should ideally be considered.

- There are graduated teachers who become **employed privately as teachers within the country**. While there are some 400,000 publicly paid educators working in the schooling system, there are a further approximately 29,000 teachers paid by school governing bodies in public schools[37], and an additional 42,000 educators working in independent schools[38]. This stock of 71,000 privately paid educators would currently require replenishment amounting to some 3,200 individuals a year (the 18,000 multiplied by 71,000 over 400,000). This demand on the private side would increase, along the lines of what has been seen above, assuming that on the private side a bulge of older educators also exists. There are currently no statistics on the age structure of privately employed educators, but it seems likely that these educators are a bit younger than publicly paid educators[39].

- There are graduated teachers who **take up employment in other sectors of the economy**, without entering teaching. A critical question is the following. If there are some 470,000 educators working in the schooling system (based on figures in the previous bullet), then how many qualified teachers are there in South Africa as a whole, and how many of these are of a pre-retirement age? These grand totals do not seem available anywhere, though a

[36] Fedderke *et al*, 2000: 265.
[37] Department of Basic Education, 2018.
[38] Department of Basic Education, 2022c.
[39] Preliminary analysis of SA-SAMS data points to this being the case.

potentially useful source is the database of qualified educators of the South African Council for Educators (SACE). How many people are on this database does not appear to be a published statistic. This seems like a matter worth following up, in part because it would throw some light on how many teachers are outside teaching in the labour market.

- Some **young graduate teachers emigrate each year**, possibly without ever teaching within South Africa. It is difficult to obtain reliable figures on this phenomenon, and on the related phenomenon of teachers who spend just a few years abroad and then return. Foreign demand includes the demand for South African English teachers in countries, such as China, with a large private teaching English as a foreign language (TEFL) sector. Available statistics almost certainly under-represent the extent of emigration. One set of figures points to around 18,000 originally South African teachers working as teachers abroad, but this statistic only covers rich OECD[40] countries, and not countries such as China and Vietnam[41]. To replenish a stock of around 18,000 teachers outside South Africa would require just under 1,000 graduated teachers to leave South Africa each year. The actual annual out-migration of younger teachers could easily be higher than this figure.

- The **in-migration of qualified teachers from outside South Africa** relieves the country of some of the obligation and expense of training teachers. While the South African Qualifications Authority (SAQA) reports on the number of holders of foreign qualifications which become recognised per year, statistics relating just to teachers are not provided. It is possible that SAQA could provide these statistics on request. On the other hand, SACE has provided some statistics on foreigners becoming registered to teach in South Africa. The recent figures are low, with newly registered foreign teachers declining from 395 in 2018 to 129 in 2019[42]. Online news sites explain that the decline is in part due to a more stringent verification process having been put in place. November 2019 Persal data point to 0.8% of publicly paid educators nationally, or 3,239, not being South African citizens. Of these, 70% are Zimbabwean while Ghana and India each account for 8% of the total. Importantly, only 1% of foreign educators on Persal were age 30 or below in 2019, compared to 10% for South African educators[43]. Young foreign joiners thus appear to be an extremely small portion of all joiners in the public system.

- A recent analysis of Persal data examines the extent to which **incompletely qualified teachers enter public service and complete their qualifications through distance education while on the job**[44]. Some statistics in this regard were provided in section 4.1 above. While this phenomenon would not change the overall demand from South African universities, it could help ‘flatten the curve’ when there is an increase in demand, of the kind expected in South Africa in the coming years. Put differently, if there is a surge in teacher retirements, young teachers can be pulled in a few years before they qualify, to ensure that there is a teacher in front of every class. This is facilitated by the fact that around 38% of teachers obtain their first qualification through distance education. The recent analysis reveals that of the addition to the stock of young qualified educators in Persal in 2021, 93% was due to qualified teachers entering the system, while 7% was due to pre-qualified teachers *already within the system* obtaining their full qualification. The 7% translates to just over 1,000 teachers. The phenomenon is thus relatively small, but the important thing is that the system is already geared towards dealing with an under-supply in this manner. The presence of pre-qualified teachers is higher in certain provinces,

[40] Organisation for Economic Co-operation and Development.
[41] Mlambo and Adetiba, 2020. The South African Council for Educators (2011) produced a report on the migration of educators into and out of South Africa around ten years ago, but it lacks many key statistics.
[42] South African Council for Educators, 2021: 13.
[43] Statistics provided by Department of Basic Education.
[44] Department of Basic Education, 2022d.

particularly North West, and in schools serving poorer communities, which are likely to be schools that are affected first by teacher supply problems, given that teachers tend not to prefer such schools.

- Lastly, there are **lags between graduation and entry into the public educator workforce which are poorly understood**. Of the first-time joiners illustrated in Figure 13 above, 22% are aged 31 and above. Some of these joiners would have graduated many years ago, and may have been employed privately in a public school, with the hope of entering a publicly funded post at a later point. Some would have graduated at an advanced age, and entered the public workforce soon afterwards. There is not enough research available to quantify these phenomena well. There are clearly teachers who graduate relatively late in life: among teachers graduating in 2018 and entering the public educator workforce in 2019, 17% were aged 31 and above in 2019, and 5% were aged 41 and above[45].

Figure 23 below illustrates the recent trend for first-time joiners, based on an analysis of historical Persal data, as well as the trend for young teacher graduates, as reported by DHET[46]. This graph will be used as a basis for establishing two inter-related measures: (1) roughly the ratio of graduates entering the public educator workforce to graduates drawn into other areas of the labour market looking for teachers; and (2) the magnitude of a reserve stock of graduates that has been built up in recent years and that could alleviate an under-supply of new graduates in the coming years.

The gap between the two solid curves of Figure 23 has clearly been widening. By 2021, only 58% of the 30,809 teachers graduating from universities in the previous year were being absorbed into the public system as public employees. If one considers that around 3,200 young graduates would be required to replenish the 71,000 privately employed teachers working in schools, that leaves some 10,000 young teachers who are going elsewhere. The discussion of the above six factors suggests these 10,000 teachers would mostly be moving into other segments of the South African labour market, or other countries.

There have been public concerns around young teachers wishing to find employment as teachers, but not succeeding, and thus ending up unemployed. Analysis of the DBE's database of unemployed educators[47] reveals that the 7,100 teachers declaring themselves in need of a post in 2022 translate to an 'unemployment rate' of around 1.7%. These unemployed teachers are slightly older than the employed. Around a fifth of the 7,100, or some 1,400, are aged 34 and below, and patterns suggest they wish to be employed in specific locations, such as Gauteng and more urban areas in KwaZulu-Natal, and would be reluctant to work in schools far from these locations. It is difficult to draw hard conclusions from this, but these figures suggest that

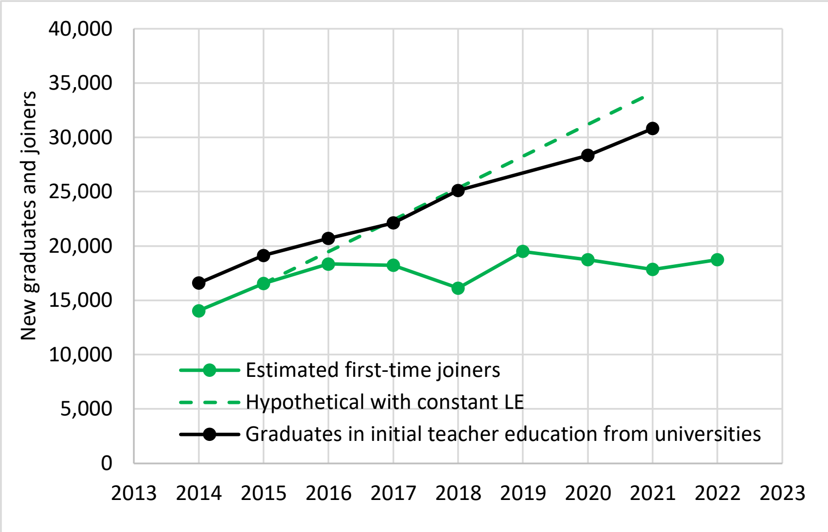
[45] Based on Figure 6 of Department of Basic Education, 2023a.

[46] The DHET figures are not incompatible with SACE figures on 'new educators registered' (South African Council for Educators, 2020: 27). For instance, where DHET refers to 25,223 newly graduated teachers in 2018/19, SACE refers to 29,765 newly registered educators. There are several possible reasons for the 18% discrepancy: the SACE figure would include teachers trained abroad, but there could also be definitional differences relating to, for instance, adult educators, pre-school teachers, and so on. Even within DHET's reporting system substantial differences across different sources can appear. For instance, according to DHET's *Trends in teacher education* reports, the number of university students receiving either a Bachelor of Education (BEd) or a Post-Graduate Certificate in Education (PGCE) was 28,203 in 2018 (Department of Higher Education and Training, 2020: 74), a figure that is a few thousand higher than the corresponding figure reflected in Figure 23. The current discussion relies strongly on the assumption that *within* an indicator, such as the DHET one reflected in Figure 23, there is definitional consistency. Note the joiner numbers reflected in Figure 23 are highly comparable over time.

[47] Department of Basic Education, 2022e.

the great majority of the abovementioned 10,000 young graduates find employment somewhere, either in some non-teaching job in South Africa, or in some occupation abroad.

***Figure 23: Initial teacher graduates and young Persal joiners***




*Sources: For graduates, source is the DHET annual reports of 2019/20 to 2021/22. To illustrate, the DHET value for 2020/21 would be plotted as the 2020 value in the graph. The annual report indicates that these are teachers who would have graduated in 2019, and it is thus assumed they would be able to take up employment in 2020. For first-time joiners, historical Persal data were processed, using methods explained in Department of Basic Education (2023a), in order to estimate values.*

Critically, while only around 60% of graduates were moving into public employment as teachers in 2021, 85% were doing this in 2014. Analysis presented in the 2020 DHET report, using a different method, points to a figure of 75% in around 2018[48]. It appears that while universities have responded to pressure to train more teachers, the schooling system has not been successful in absorbing the increase, in part due to budgetary constraints. DHET university enrolment plans from 2014 make growth in teacher training a priority for universities. DHET's 2022/23 annual performance plan envisages future growth in teacher outputs, beyond the growth already seen, the target being 30,000 by 2024. This contrasts with less moderate growth in the absorption of young teachers into public employment by the nine provincial education departments responsible for schools. To illustrate, while graduate output in Figure 23 increases by around 1,900 a year between 2015 and 2020, the increase for first-time joiners for the same period is just 600 a year. Importantly, this is not because more teachers than this were not needed in schools.

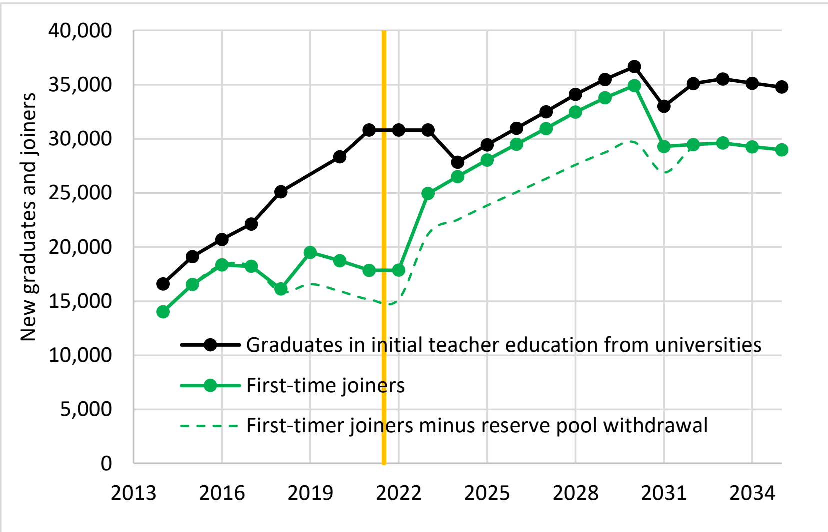
As discussed in section 5.1, the learner-educator ratio worsened considerably between 2011 and 2021. Had the LE ratio been maintained at 2011 levels, the publicly employed educator workforce would have consisted of around 457,000 people in 2021, and not the 405,000 actually seen in 2021. The dotted line in Figure 23 is what the young joiner numbers would have looked like if the decision had been taken to expand the educator workforce, starting in 2016, in a gradual manner in order to 'inject' the additional 52,000 teachers into the system, completing this process in 2021. It is clear that in such a scenario, demand from the schooling system plus additional employers would have exceeded graduates exiting universities. The fact that the

[48] Department of Higher Education and Training (2020: 106) reports that of 5,862 people who enrolled for the first time in a Bachelor of Education programme in either 2010 or 2011, 4,436 had graduated by eight years later, so by 2018 or 2019, and of these graduates, 3,285 were found in Persal in those later years. The figures 3,285 and 4,436 provide a ratio of three is to four.

hypothetical joiner trajectory was not followed is a result of both budget constraints, and arguably the decision to improve the annual notch progression of educators from 1.0% to 1.5%, in line with the 2018 agreement between the employer and unions[49].

It is assumed here that the system would return to a situation where graduate production and teacher demand would be better aligned, and 80% of graduates would find work in the public sector. Figure 24 below illustrates how future graduate demand is calculated for the purposes of the current analysis, the scenario here being 'Population + Grade 12 + LE' from earlier Table 9. It is assumed that any past graduate production exceeding 1.25 of the number of first-time joiners feeds into a reserve pool (1.25 is 100% over 80%). Teachers from the reserve pool can enter the public workforce in a future year, though it is assumed that this part of the annual intake is never greater than 10%. From 2024, graduate output is allowed to decrease, if demand drops, but not by more than 10% a year. Up to 2023, graduate output is assumed to remain at the 2021 level, meaning the level of new graduates available to begin work at the *start* of 2021. The dotted line in the graph represents first-time joiners who are assumed to be newly graduated teachers, with withdrawal from the reserve pool subtracted. The reserve pool can obviously 'run dry', as it does in 2033 in Figure 24.

***Figure 24: Grade demand to 2035 in 'Population + Grade 12 + LE'***




*Note: Graduates to the right of the yellow vertical line are future projections. For this graph only, q is 15%, as this produced a clearer picture of the dynamics. For the analysis that follows, however, q is 10%.*

The key equations are shown below.

$$T_y = min(R_{y-1,}A_y \times q) \quad (1)$$

$$B_y = A_y - T_y \quad (2)$$

$$S_y = max(0, G_y - B_y - (1-p) \times A_y) \quad (3)$$

$$G_y = max(G_{y-1} \times (1-r), B_y + (1-p) \times A_y) \quad (4)$$

$$R_y = R_{y-1} - T_y + S_y \quad (5)$$

[49] Public Service Co-ordinating Bargaining Council (PSCBC) Resolution 1 of 2018.

In year $y$, the number of graduates moving out of the reserve pool and into the public workforce is $T_y$. This is the minimum of two values: (a) the number of people left in the reserve pool the previous year, $R_{y-1}$; and fraction $q$ of first-time joiners $A$, where $q$ is the maximum withdrawal from the reserve stock in one year. The number of first-time joiners coming straight from university ($B$) is total first-time joiners ($A$) minus the $T$ educators who came from the reserve pool. Teachers joining the reserve stock in one year ($S$) is graduates ($G$) left over after subtracting those who have just joined the public workforce, and the expected number taking other jobs where teachers are typically sought after, the latter being one minus the aforementioned 80%, this 80% being $p$. Graduates ($G$) is the maximum of two values: (a) previous year's graduates decremented by $r$, or 10% ($r$ limits year-on-year declines in graduate output); and (b) joiners after withdrawal from the reserve stock has been taken into account, plus teachers required outside the public workforce. Finally, the size of the reserve pool $R$ is the previous year's reserve pool minus those leaving the pool ($T$) plus those joining the pool ($S$).

To what extent are the six bullets at the beginning of this section taken into account with the methodology outlined here? The first three bullets, dealing with graduates who take up employment outside the public educator workforce is dealt with through the 80% parameter $p$. Regarding in-migration of foreign teachers, if this occurred on a large scale, the graduate demand figures presented below would be higher, because in-migration has not been modelled. However, in-migration has been very low in recent years, and is currently not viewed as a desirable solution by policymakers. Regarding the employment of pre-qualified teachers, this is also not taken into account. This phenomenon would not change the total graduates demanded, but could shift demand to the right in the graphs below, as graduation is delayed. Lastly, lags between graduation and entry into the public workforce is partly taken into account, through the reserve pool, but there could be lags even in the absence of this pool, or lags not connected to the suppressed and budget-constrained demand from the public sector. Such other lags would affect the patterns seen in the graphs below in complex ways. Graduates from, say, 2010 could enter the public workforce in 2023, alleviating the demand for graduates in 2023. On the other hand, 2023 graduate demand would be pushed up by, for instance, the phenomenon of young teachers who plan to graduate, then teach English abroad for some years, and then return to take up employment as a teacher in the country. Many of these forces would cancel each other out, and may not change the patterns seen in the following graphs substantially.

Figure 24 indicates that using the assumptions that withdrawal from the reserve pool has a ceiling, and that the output of graduates would not decline drastically between two years, the reserve pool would continue to exist up to 2032. Because of the existence of this reserve pool, the university sector could afford to reduce the number of graduates after 2021 a little, though it would soon have to increase this output again.

The following two graphs illustrate estimated graduates required, to 2035, for the five scenarios illustrated in earlier graphs, such as Figure 14. Figure 25 assumes teachers move from the reserve pool to the public workforce, within the 10% parameter $q$ described above. Figure 26 assumes no reserve pool, meaning $q$ becomes zero. The aim here is to illustrate the effects of the reserve pool. Without the reserve pool, the demand for graduates in 2030 rises by around 10% in all scenarios.

*Figure 25: New graduates in five scenarios to 2035 WITH reserve pool*

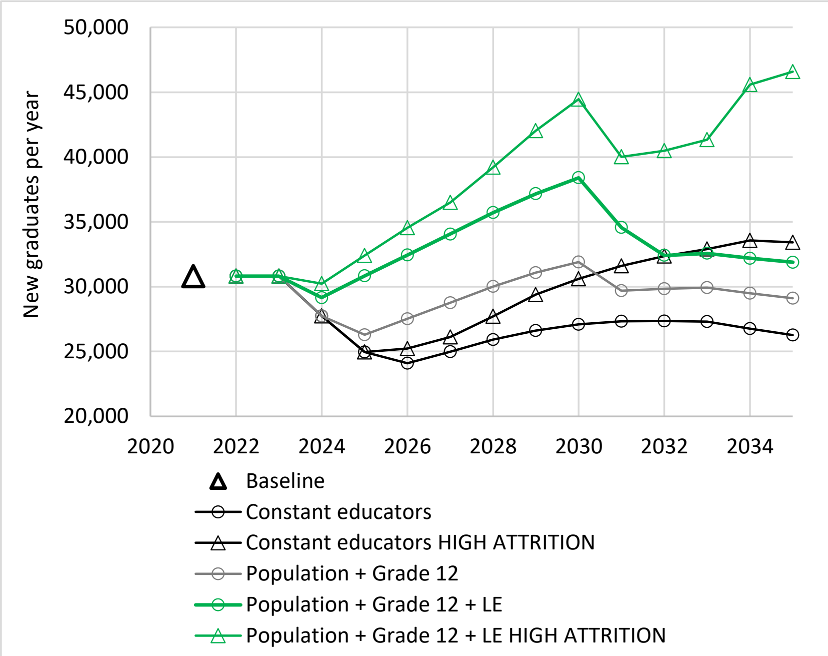



*Figure 26: New graduates in five scenarios to 2035 WITHOUT reserve pool*

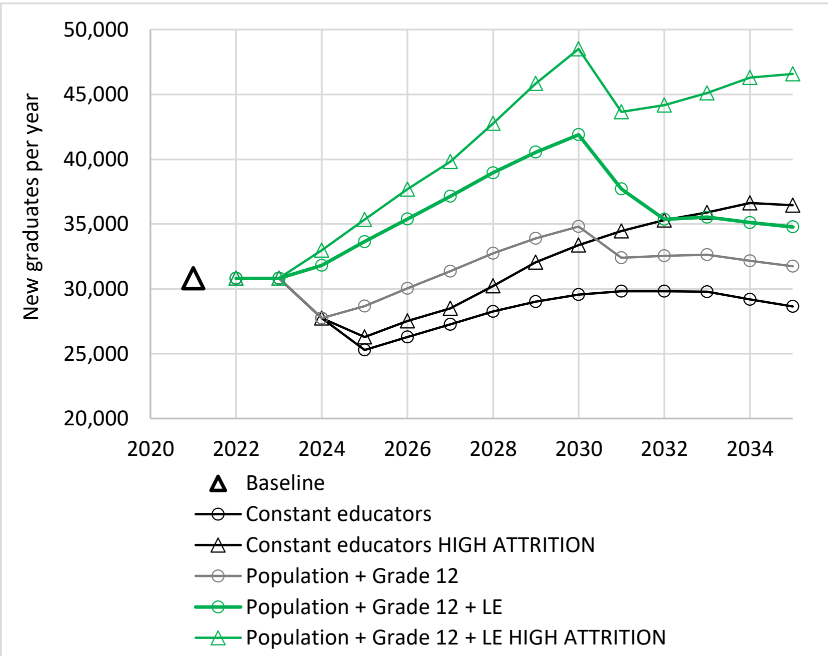



Table 10 below displays university graduates needed in 2030, using the five scenarios illustrated in the previous two graphs. The average across the two graphs was used, implying a limited withdrawal from the reserve pool. As indicated earlier, the difference across the two estimates is around 10%.

***Table 10: 2030 demand for graduates***

| **Driver of the increase** | **Short name of scenario** | **Graduates needed (was 30,809 in 2021)** | **Graduates needed *assuming higher attrition among the young*** |
|---|---|---|---|
| Constant educators | Constant educators | 28,319 | 31,984 |
| Above plus improvement in survival to Grade 12 | Population + Grade 12 | 33,353 | |
| Above plus reduction in LE ratio to levels seen a decade ago | Population + Grade 12 + LE | 40,150 | 46,489 |

The values seen in Table 10 are all lower than the headline 2030 graduate demand figure in the 2020 DHET report, which was around 59,000. The highest estimate in Table 10 is around 20% lower than that. Given the number of assumptions at play, and given the far more rudimentary modelling behind the 59,000 figure in the DHET report, the discrepancies are not surprising. Closer analysis of the two modelling exercises reveals that it is above all higher attrition in the earlier modelling that drives up the projected 2030 graduate demand. Specifically, overall attrition in 2030 in the modelling behind the DHET report was 11%, versus 8% for the modelling presented here. While this difference may seem small, it is large enough to produce substantial differences in the 2030 graduate demand figures. Attrition is clearly more rigorously dealt with in the new modelling.

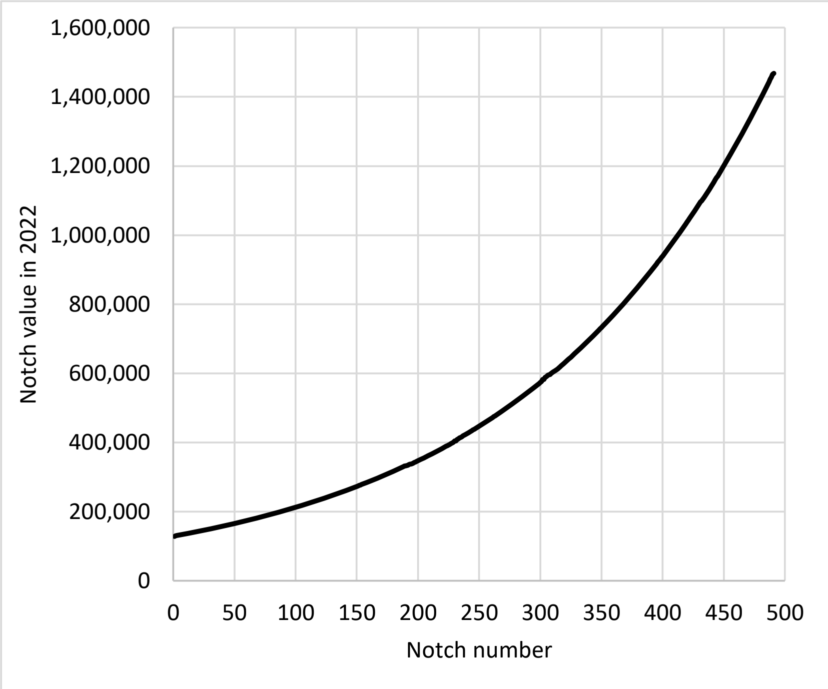
# 6 Unit cost projections beyond 2022

## 6.1 Background on progression, re-joining, promotion and benefits

The focus now shifts to the financial aspects of the modelling. The current section discusses issues that influence the unit cost modelling, drawing from various existing analyses.

Figure 27 below illustrates the 2022 notch values appearing in the Excel model. Notch-on-notch increases are widely understood to be 0.5%, and this is mostly true if the values are examined, though there are minor deviations. If the lowest notch value of 128,838 is taken as a point of departure, and increases of exactly 0.5% over the 491 notches are calculated, notch 491 takes the value 1,491,352. This is just 2% above the actual notch 491 value of 1,467,768.

***Figure 27: The notch values of the salary scale***

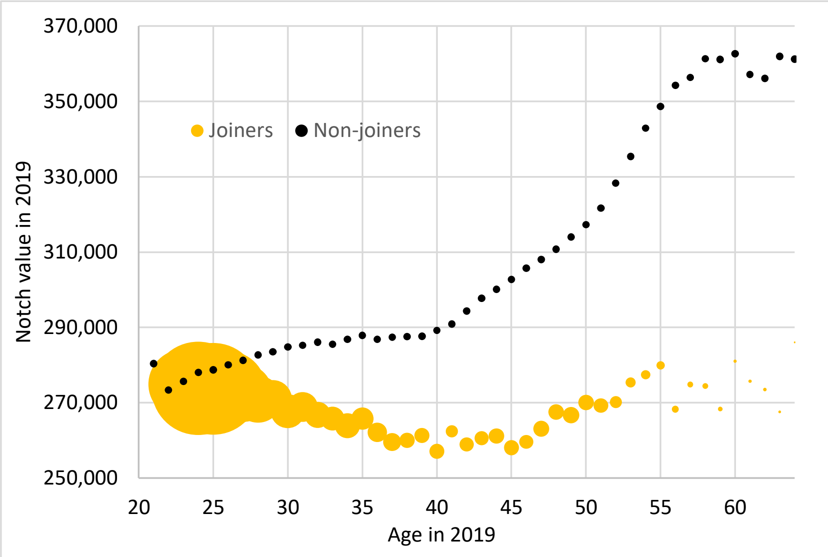



Educators have experienced a different notch progression dispensation in the education sector relative to non-educators in the sector at a comparable salary level. For the approximately 8,000 non-educators at salary levels 7 to 12[50], the levels applicable to qualified educators, notch progression is not nearly as automatic as it is for educators. While over 99% of educators experienced the policy-stipulated annual notch progression between 2020 and 2021, assuming they were present in both years, the figure for non-educators in the sector has been around two-thirds for many years. As already mentioned in section 5.3, a 2018 policy change increased the annual notch progression for educators from 1.0% to 1.5% to bring it in line with practices in more favourable parts of the public service. What was not widely discussed in the lead-up to this policy change was the extent to which the likelihood of experiencing the progression differs across parts of the public service.

The following two graphs illustrate the effects of another important policy change occurring in 2018[51]. Resolution 2 of the Education Labour Relations Council (ELRC) made it very likely that an educator with a break in service would return to the public schooling system at the entry level notch for teachers, and not the notch the educator was on when he or she left the system. The motivation for this change was a phenomenon whereby older educators were taking a break from service mainly in order to access their pension savings, a practice which was considered undesirable. Older joiners in 2014 (Figure 29) were clearly entering on higher notches than in 2019 (Figure 28), after the policy change – these graphs represent joiners in general, whether they were in the system previously or not. More specifically, up to 2018 older joiners aged 40 and above moved on average to a pay level which was 4% *above* the entry level for teachers, while from 2019 to 2021, this has been around 3% *below* the entry level for teachers. This lies behind the decision to place all older joiners at the entry level notch for teachers in the Excel model.

[50] These would largely be office-based administrators, managers, as well as professionals outside the field of education, but working in the education sector.
[51] See also Department of Basic Education (2022g).

*Figure 28: Notches of those joining in 2019 and non-joiners*




*Note: The bubbles representing joiners per year have a width which is proportional to the number of joiners. The size of the non-joiner markers has no meaning.*

*Figure 29: Notches of those joining in 2014 and non-joiners*

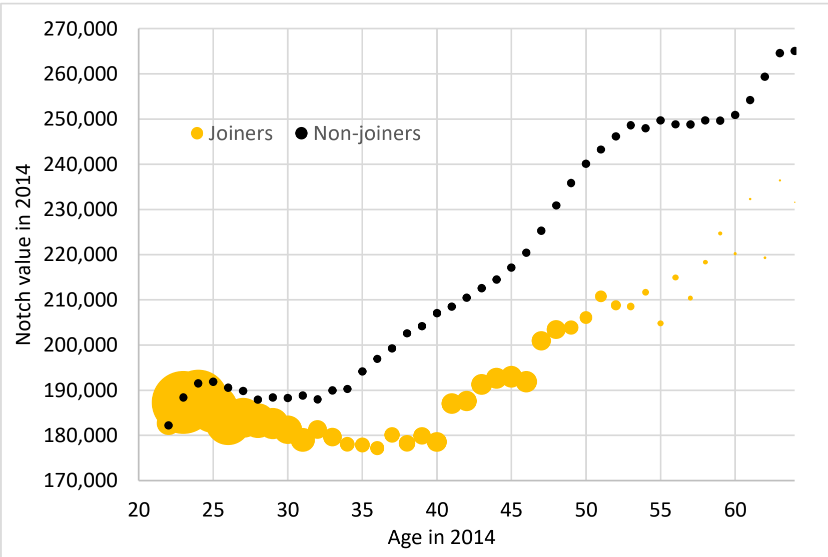



Figure 30 and Figure 31 below reflect the inputs to drive the promotions process in the model. This has not been discussed in earlier sections because the promotions process only affects the unit cost, and does not affect the total number of *all* educators projected by the model, or even the total number of level 1 teachers and senior teachers, variables which are determined outside the model. The two graphs reflect some of the 101 boundary points that divide the range of notch values into 100 equal parts. The derivation of the statistics in both graphs is based on a detailed 2022 analysis of promotion patterns in the system[52]. The statistics presented here draw from an analysis of 2020 and 2021 Persal data. In Figure 30, the fact that the peak for the total number of promotions for teachers should be on the far left of the range should not be surprising if one considers that around half of teachers are situated below an annual notch value of around 300,000 Rand. The number of promoted people in Figure 30 should be read against the right-hand vertical axis, while the probability of being promoted, as a percentage, should be read

[52] Department of Basic Education, 2022f.

against the left-hand vertical axis. It is the latter series of values which are inserted into the model.

***Figure 30: Promotion probability inputs in the model***

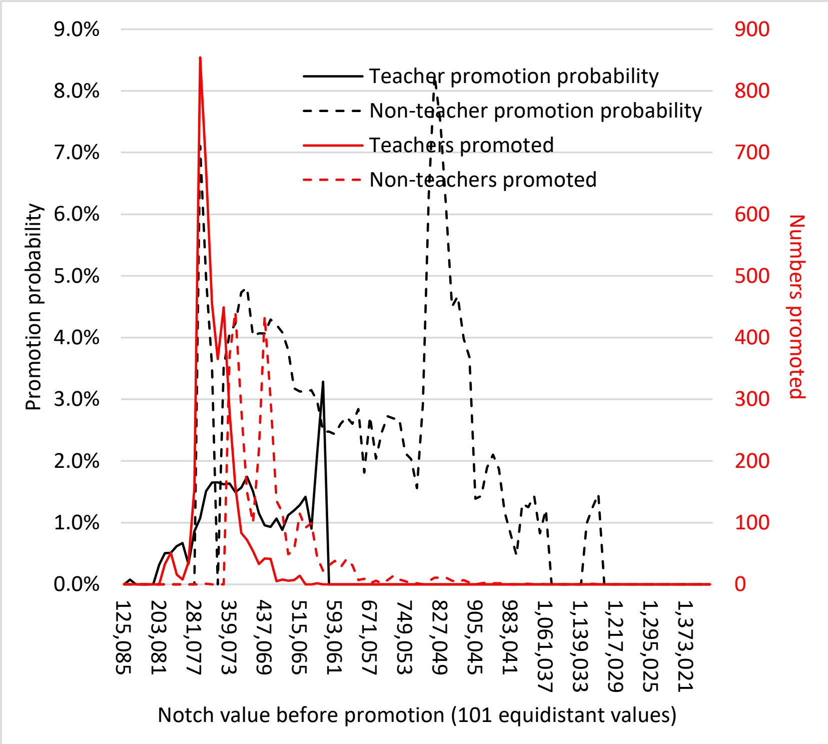
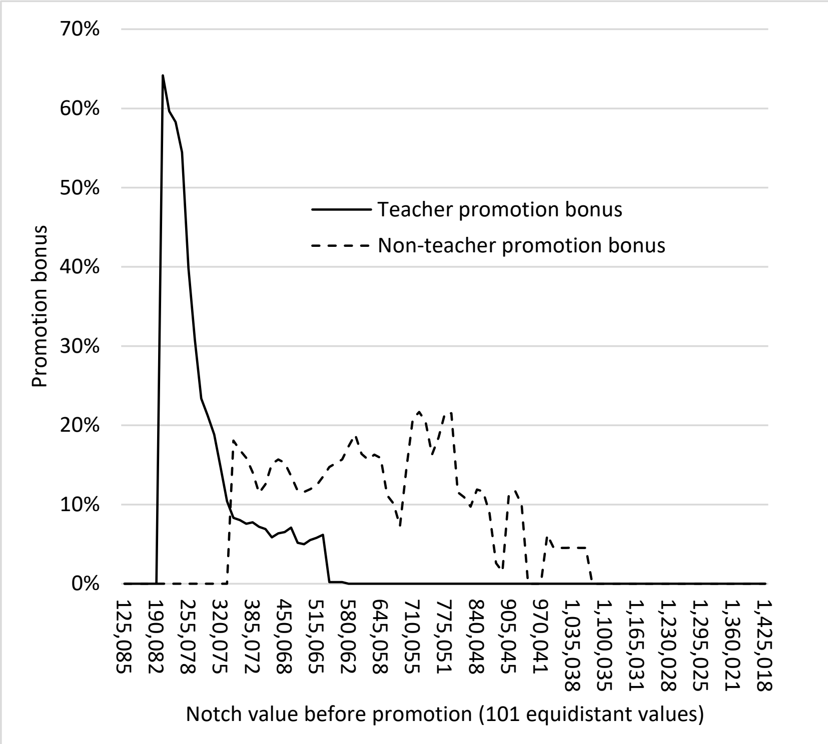



Figure 31 reflects the percentage increase in the notch value experienced by teachers and senior educators ('non-teachers'), at different points in the range of notch values, as a result of the promotion. This 'promotion bonus' is over and above any increases relating to annual notch progression.

The Excel model does not allow people to move into the system and straight into a senior educator position. This does occur in reality, but it is very limited. Of all people moving into a senior educator post per year, roughly half are teachers and a further half were educators occupying a lower senior educator position. Only 4% are joiners to the system. These patterns are based on several years of historical data.

*Figure 31: Promotion bonus inputs in the model*




It should be noted that every year a few educators, mostly senior educators, move to senior non-educator public servant posts within the sector. Though these educators would consider themselves promoted, the model considers them leavers, as the model does not cover non-educators. This phenomenon is extremely small: annually the number of people experiencing this move is around ten.

Though average benefits received over and above the basic salary, such as medical aid, increase in absolute Rand terms as age increases, benefits as a *percentage* of the basic salary *declines* slightly with age. This can be seen in Figure 32 below. The 2021 values are exceptionally high in part due to the special cash payment intended to compensate for a zero cost-of-living adjustment in 2021[53], a payment which 95% of educators received. Across all educators, this cash payment produces an average in one month of R1,397. However, an even larger factor behind the unusual 2021 patterns is backdated basic pay, paid to 96% of all educators in November 2021. This works out to an average of R2,009 across all educators.

[53] Public Service Co-ordinating Bargaining Council (PSCBC) Resolution 1 of 2021.

***Figure 32: Total cost and notch cost by single age***

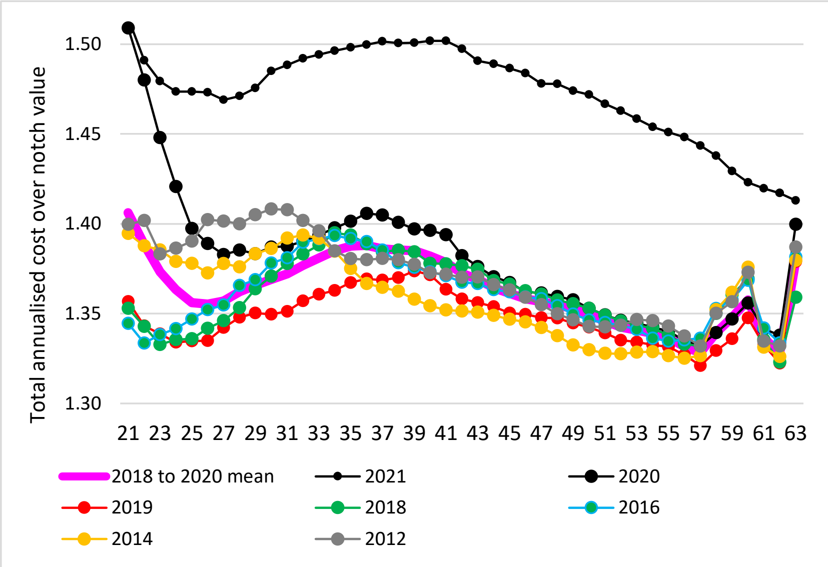
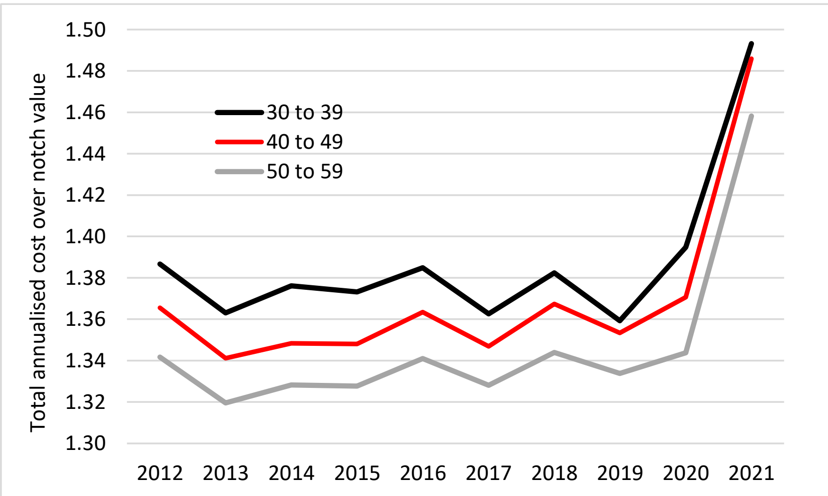



Figure 33 provides an alternative view of the benefits data, and indicates that monthly benefits over basic pay, which is one-twelfth of the notch value, has not changed much over time if the exceptional developments in 2021 are ignored. The '2018 to 2020 mean' values from the previous graph were inserted into the Excel model and drive the conversion of notch values to total cost.

***Figure 33: Total cost and notch cost 2012 to 2021***

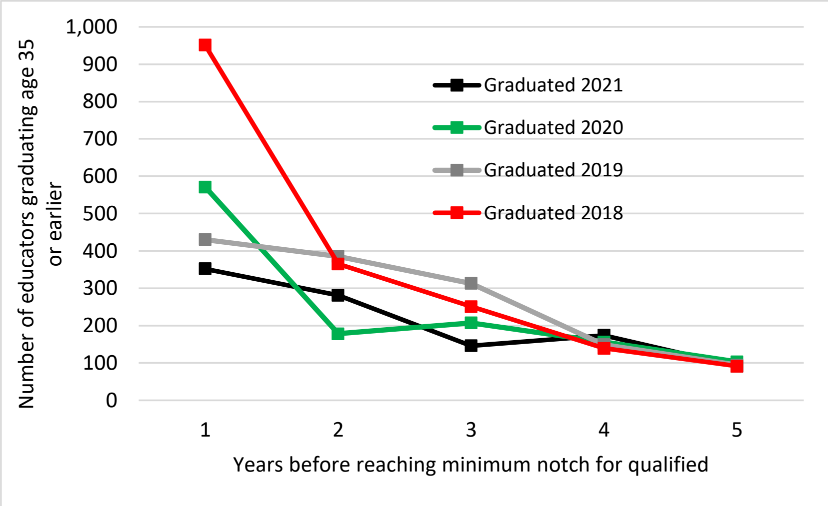



Allowing young pre-qualified joiners into the educator workforce, who subsequently become fully qualified on the job, was discussed in section 5.3. It was mentioned that 7% of the addition to the stock of qualified educators in 2021 came from educators already employed within the system who became qualified while working. In producing scenarios, discussed in section 6.2, involving the explicit joining of pre-qualified individuals, the aforementioned 7% figure was applied to the similar parameter, required in the model, of the percentage of joiners who are pre-qualified. Moreover, analysis points to the notch increase associated with becoming qualified on the job being on average as high as 50%. The starting notch that produces an increase of 50% relative to the entry notch for newly qualified teachers, notch 164, is notch 83. The following graph[54] illustrates how long it has taken pre-qualified joiners to obtain their

[54] From Department of Basic Education, 2022d.

qualification in recent years. The values behind this graph produce mean time lags ranging from 1.9 years for 2018 graduates to 2.4 years for 2021 graduates. On the basis of this, it was decided to make the lag inputted into the Excel model two years. This would make the entry notch for the pre-qualified six notches below notch 83, in other words notch 77 (educators, including the pre-qualified, move up three notches a year).

***Figure 34: Lag between entry and attainment of the minimum notch***




Importantly, programmatically qualifying pre-qualified joiners in the model occurs only for those joining the workforce from 2023 onwards. There are of course under-qualified educators in the 2022 baseline data, and these are not subject to any of the processes applicable to post-2022 pre-qualified joiners. As pointed out in section 4.1, the under-qualified in the 2022 data tend to be older educators. These educators are made to progress up three notches each year. What this in effect does is that it assumes that the teachers do become qualified, but the duration of this process depends on the gap between the 2022 notch of each teacher and the official entry level notch of 164.

## 6.2 Unit costs emerging from the model

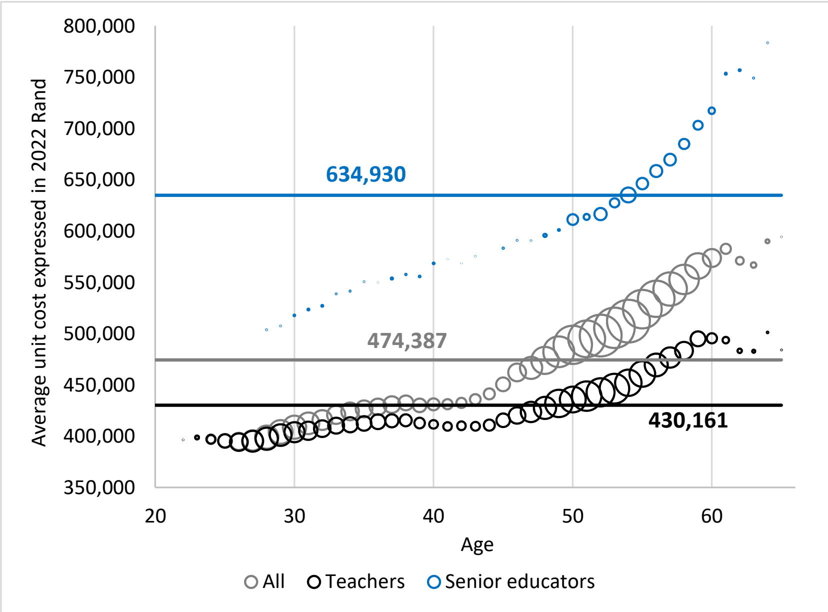
Turning to the unit costs seen in the model, Figure 35 below illustrates the age and cost breakdown of the 403,245 educators of 2022 referred to in earlier Table 5. This was obtained by using actual notch values, and inflating these by the '2018 to 2020 mean' values illustrated in Figure 32 to take into account benefits.

The National Development Plan has referred to the problem of the 'flat wage gradient' in the educator workforce[55]. Indeed, up to around age 43, the curve for all educators rises relatively slowly, though beyond that there is a stronger upward slope. This is in part due to the fact that first-time joiners are often relatively old in the sense of being above age 22, the age at which most joining would occur if teachers completed their schooling and post-school education with no interruptions or delays. A teacher entering at, say, age 29 would typically enter at the official entry level, this being notch 164, with a value of 292,764 Rand in 2022. The difference between the average notch value of a teacher aged 60 and that of a teacher aged 43, is 1.2% for each additional age – here senior educators are excluded. Considering that prior to 2019 annual notch progression came to just 1.0%, the obvious question is how an age-related gap of 1.2% for notch values came about. This 1.2% gap would in part be driven by notch increases experienced a couple of decades ago, as as well as adjustments made in 2009 to deal with inequalities in the historical trajectories of teachers. In other words, the relatively steep upward curve for teachers

[55] National Planning Commission, 2012: 309.

beyond age 43 seen in Figure 35 is the result of policies applicable many years ago. The 1.5% annual progression promulgated in 2018 has as its intent a slope slightly steeper than that of teachers between 43 and 60.

***Figure 35: Age and average cost in the 2022 data***




*Note: The width of each bubble is proportional to the number of employees of that age. Horizontal lines illustrate averages.*

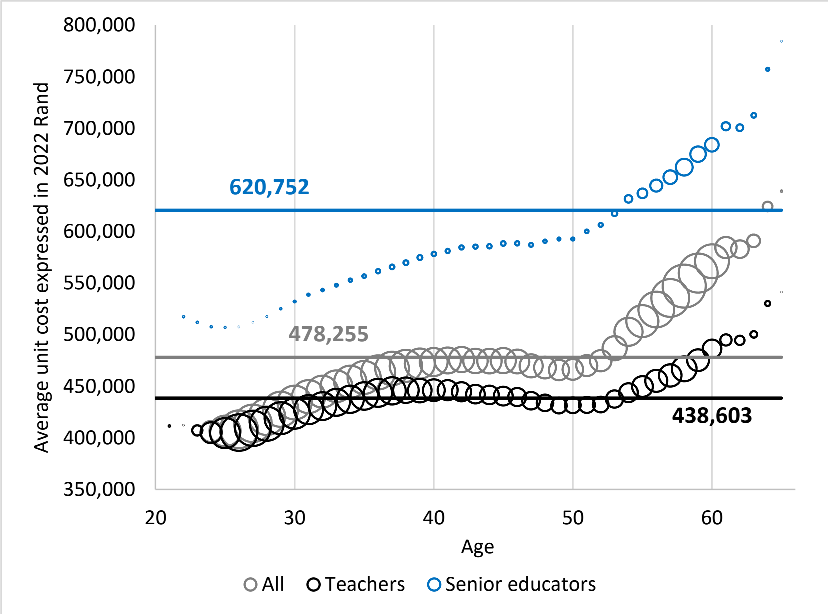
Figure 36 below illustrates the situation in 2030, assuming a constant number of level 1 teachers and senior educators, and the 'Constant educators' scenario referred to previously. No cost-of-living adjustments are applied, meaning unit costs in Figure 36 (and subsequent Figure 37) are expressed in terms of 2022 Rand values. One clear difference between the 2030 situation and the 2022 situation seen in the above graph is larger bubbles at the lower ages and smaller bubbles at the higher ages in 2030. This would be in line with the age decline for all educators seen in Figure 21.

The bubbles for younger senior educators are also larger in 2030 than 2022. The average age for these educators declines from 51.6 to 49.4 between 2022 and 2030.

A further difference that stands out is below average wages for a substantial number of teachers aged around 50. This is due to many teachers, especially in relatively high notches, moving into promotion posts, thus leaving lower paid teachers behind. The average cost of a teacher rises from 430,161 in 2022 to 438,603 in 2030, a 2.0% real increase that works out to 0.2% a year. This increase would be smaller if joiners were permitted to enter at a notch below the entry notch for fully qualified teachers. In 2022, there were 30,614 employees below the R292,764 entry level, while by 2030 only 12,909 remain. The average cost of a senior educator declines by 2.2%, from 634,930 to 620,752 between 2022 and 2030, an annual decline of minus 0.3%. Largely, this would be due to the fact that the average senior educator is younger in 2030 than in 2022.

The average cost for educators as a whole increases by 0.82%, from 474,387 to 478,255, which is 0.10% a year. Essentially, the average unit cost barely changes in real terms.

**Figure 36: Age and average cost projected for 2030**




If the Excel model is made to accept pre-qualified joiners, being 7% of all joiners, and entering at notch 77, with movement into notch 164 occurring two years later when the teacher qualifies, the difference made to the unit cost is small. Instead of the 478,255 average unit cost seen in Figure 36 for all educators, the cost becomes 477,198. The 2022 to 2030 annual increase for all educators becomes 0.07% instead of 0.10%, a tiny difference. While bringing in pre-qualified joiners could alleviate graduate supply problems, by effectively spreading the demand peak out over more years, this measure does not appear to be an effective cost-cutting measure.

Figure 37 illustrates the 2040 situation for the 'Constant educators' scenario. Between 2030 and 2040 the real increase in the average educator cost is 0.19% per year, around twice as steep as the 0.10% applicable to 2022 to 2030.

**Figure 37: Age and average cost projected for 2040**

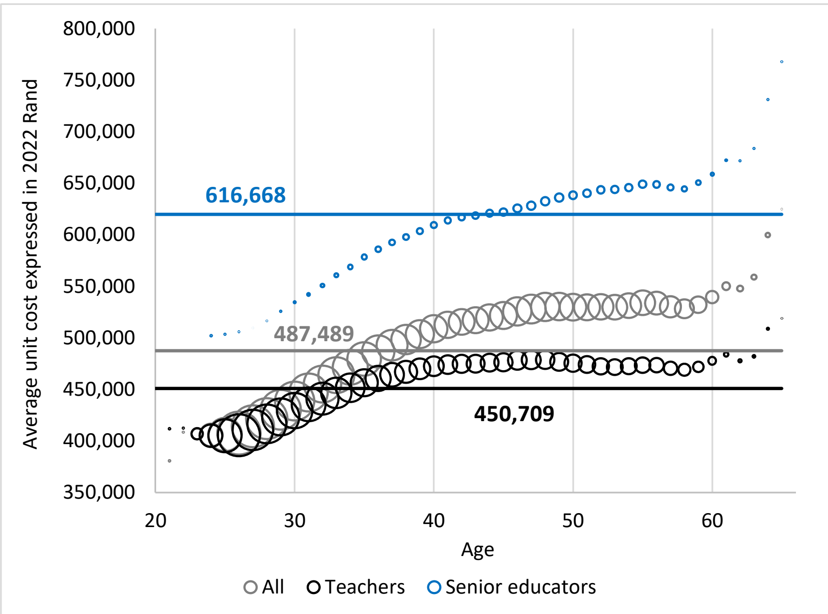


Figure 38 below illustrates the distribution of the 403,245 educators across *notch* values in three years, using the 'Constant educators' scenario. The fact that the model normally does not place joiners below the 292,764 entry level for teachers results in educators below this level declining from 7.6% in 2022 to 3.2% in 2030 and 0.7% in 2040. The fact that the 2022 distribution statistics are higher than the 2030 and 2040 statistics for the range 290,000 to 325,000 is largely due to the placement of many educators *below* the 290,000 level in 2022. The percentages on the vertical axis are *cumulative.* But there is a further explanation. The relatively high number of teachers in 2022 at the entry level represents not just joiners, but also teachers who were in the system previously but obtained their full qualification. This delayed attainment of a qualification beyond 2022 is not a feature of the scenarios used for Figure 38[56].

***Figure 38: Distribution of notch values in 2022, 2030 and 2040***

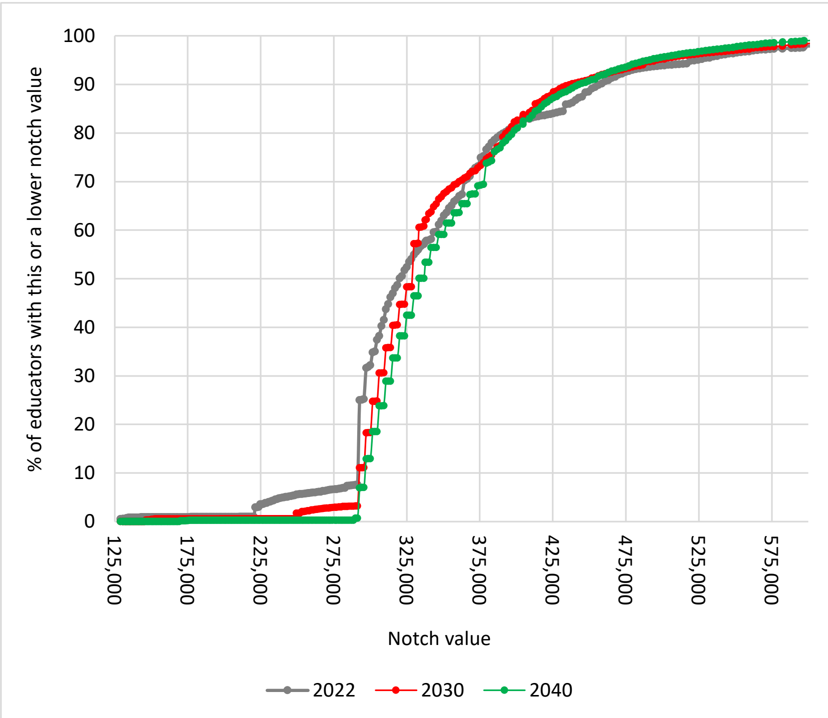



Figure 39 below places projected unit costs in the context of historical trends since 2012. The matter of average notch values is relatively straightforward. Here projections use the 'Constant educators' scenario. Essentially the 2022 point of departure is identical to the last point of a 2012 to 2022 series based on analysis of Persal data. This series uses the average notch value seen for all educators in November of each year[57]. In years where there were delays in the salary negotiation process, it is possible that the November notch value is an old value that will be retroactively updated in a later month, resulting in backdated payments. Importantly, this is true for 2022. The 2022 average notch value reflected in Figure 39 is based on the November 2022 data, but a January 2023 policy[58] stated that all notch values would be increased by 3% for the financial year April 2022 to March 2023. It could therefore be argued that the 2022 baseline for the projections should be 3% higher. However, this would not affect the future year-on-year increases produced by the modelling. It seemed more reliable to base the 2022 baseline on actual data than on a simulation of the January 2023 agreement. It should be noted that a March

[56] In Figure 38, the small number of educators below notch value 292,764 in 2030 can be considered under-qualified teachers existing in the system already before 2023.
[57] The exception is 2014, for which October data were used.
[58] Government Notice 2952 of 2023.

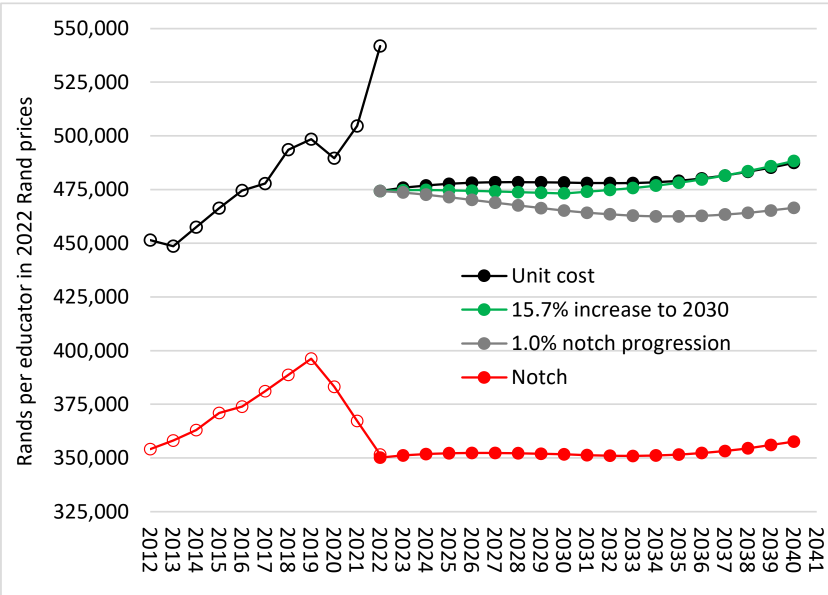
2023[59] wage agreement essentially pegged increases in the notch values to inflation for the 2023/24 and 2024/25 financial years. This would be in line with what the modelling does.

The historical notch values make it clear that the purchasing power of the average educator increased between 2012 and 2019, and thereafter declined. With the abovementioned 3% increase, by 2022 the average notch value would have declined to a point between the historical 2013 and 2014 values.

The historical *total* unit cost trends are striking as inflation-adjusted values increased even after average *notch* values began declining in *real* terms[60]. This is largely explained by backdated payment of the basic salary made in November. Actual payments are far less stable from month to month in the Persal data, compared to the notch values. Backdated payment of the basic salary constituted 0% of all payments to educators in November 2019 and 2020, 5% in November 2021 and 13% in November 2022. Moreover, non-pensionable cash allowances paid to educators, to offset the effects of below-inflation increases in the notch values, started featuring prominently in the 2021 data. From a baseline of zero, such allowances accounted for 3% of all payments to educators in both the 2021 and 2022 data. It was agreed that these allowances would cease from April 2023.

Without backdated basic salary payments, and without the cash allowances, the historical unit cost trend in Figure 39 would essentially mirror the shape of the historical notch trend. Moreover, the 2022 historical value would essentially agree with the 2022 value used for the start of the unit cost projections. It should be remembered that the latter 2022 value is based on the underlying notch value and pre-2021 age-specific patterns of benefits payments (see section 6.1).

***Figure 39: Unit cost trends 2012 to 2040***




Projected unit costs from 2023 onwards are clearly far more stable in real terms than patterns seen in the recent past. This is largely due to the assumption of CPI-linked cost-of-living adjustments, though the 'demographic dividend' of having younger educators also plays a role. The relative magnitudes of these two factors are discussed in section 6.3 below. The 'Unit cost'

[59] Public Service Co-ordinating Bargaining Council (PSCBC) Resolution 2 of 2023.
[60] Though notch progression continued throughout, the effect of both below-inflation increases in the value of the notches, and the declining average age, contributed to the post-2019 decline in the *real* average notch value of educators.

projections in Figure 39 use the 'Constant educators' scenario. The '15.7% increase to 2030' projections indicate that expanding the workforce by 15.7%, as discussed in section 5.2, results in slightly lower unit costs than those associated with the constant educators scenario. This would be due to the larger presence of younger educators in the more expansive scenario.

The '1.0% notch progression' projection in the graph reflects the outcome of switching the annual progression from 1.5% to the 1.0% that had existed before the 2018 policy change. Though only impacts on costs from 2023 onwards are modelled, this calculation nonetheless provides some sense of how large the impact of changing the progression was. In this scenario, the annual average change in the unit cost between 2022 and 2030 is minus 0.26%, which can be compared to the positive annual change of 0.10% for the same period in the 'Unit cost' scenario. The difference between these two figures is 0.36 percentage points, considerably less than the 0.5 difference a more naïve calculation, which does not consider demographics, would suggest. In terms of total spending, the difference between the 'Unit cost' and '1.0% notch progression' projection comes to R5.3bn in 2030, in terms of 2022 prices.

### 6.3 How large is the 'demographic dividend'?

The project within which this report has been produced is named the Teacher Demographic Dividend project, because there is an interest is quantifying and planning for expected financial savings arising out of the declining average age of educators in the future (see Figure 21 above). When the project began, it was estimated that roughly the demographic shifts would result in a steady reduction in the educator wage bill, reaching a saving of around R13bn in 2030. This assumes no increase in the size of the educator workforce, in other words the 'Constant educators' scenario referred to above. The R13bn estimate was based on rather crude and dated modelling exercise that did not take into account dynamics such as the shift from a two-notch to a three-notch annual progression following the 2018 policy change, and how the demographic changes would affect promotion patterns.

The new modelling described in the current report provides a much more reliable basis for estimating the dividend. As explained below, a dividend as originally conceptualised does not exist. In fact, even with no change in the size of the workforce, and assuming cost-of-living adjustments which equal CPI, the wage bill in 2030 will be 0.8% *higher* in 2030 than 2022 in real terms, as explained in section 6.2. This translates to an additional R1.6bn. This is virtually a no-increase scenario – the annual increase is 0.1%.

Despite there being no large saving in absolute monetary terms, there is still a dividend in the sense that the wage bill, assuming no workforce growth, would grow much more slowly than what is implied by Treasury budgeting manuals, which are firmly entrenched in the planning and budgeting cycle. These manuals specify that provincial education departments should take into account cost-of-living but also annual progression in their cost forecasts[61]. In the absence of above-CPI cost-of-living increases, this implies cost increases equal to 1.5% a year. Clearly, the 0.1% annual increase referred to above is well below 1.5%. The former is just one-fifteenth of the latter.

In a further sense, there is a demographic dividend. If the age distribution of educators in 2021 had looked like it was in 2011, the future trajectory of the average educator unit cost, using the 'Constant educators' scenario, would look substantially different. A simulation found that the

[61] See for instance National Treasury (2021). It is worth noting that even in the case of an ideal demographically stable workforce, where the average age and age distribution do not change over time, the assumption that budget forecasts should simply add what educators gain as experience-linked increases annually is problematic. That approach ignores that even with a constant age distribution, annual 'progression' increases are more less or offset by older employees leaving and younger employees entering each year. It is this demographic effect which is too seldom taken into account in South African budgeting.

average educator cost would have been 3.2% higher in 2030, relative to the 'actual' scenario, because the effects of the declining average age would have been felt a decade later[62]. Put differently, instead of an annual increase in the average unit cost of 0.1%, this would have been 0.4%. In terms of overall costs, instead of a total cost in 2030 of R193.5bn (in 2021 Rand values) this would be R199.8bn, a difference of R6.4bn[63].

# 7 Economic growth and the trade-off between wages and workforce size

## 7.1 Economic growth uncertainties

To understand how much can be spent on teachers in future, two statistics are particularly important. One is economic growth. Public spending on the educator workforce, and the schooling system as a whole, as a percentage of gross domestic product (GDP), tends to be relatively stable in most countries, and this is largely true of South Africa. In South Africa, spending on the public educator workforce over GDP has moved unevenly downward, from 3.5% in 2012 to 3.3% in 2020 – see Figure 40 below (the black curve should be read against the right-hand vertical axis)[64]. After 2020 there was an abrupt decline due mainly to the below-inflation cost-of-living increases in 2021 and 2022. Extending the analysis to the pre-2011 period, Treasury sources point to the figure being lower in 2007/08 at 3.0%. On the whole then, spending on educators over GDP has remained fairly stable.

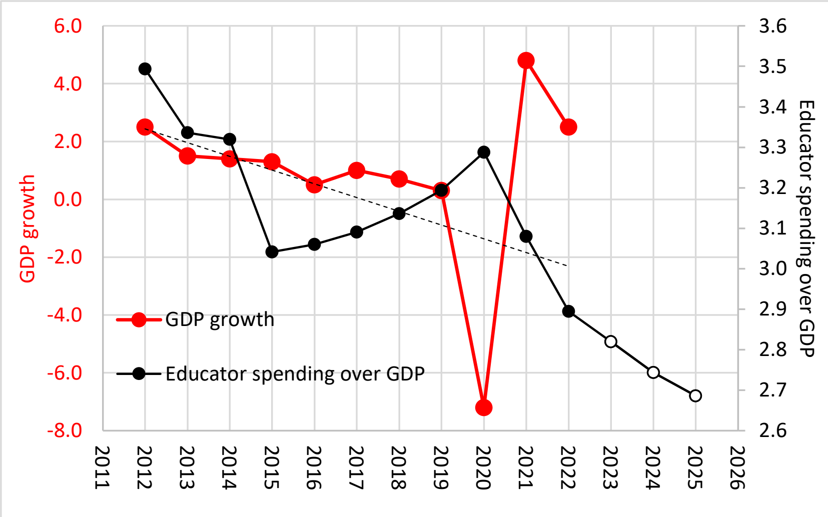
GDP growth is also illustrated in Figure 40, partly to demonstrate the important fact that over the 2015 to 2020 period educators accounted for an increasing share of GDP while GDP growth was mostly in decline.

[62] For the counterfactual age scenario, a different educator input sheet in the model was constructed as follows. 2011 educators were lined up individually in a dataset, and sorted by age. Some educators were excluded randomly so that the total number of educators equalled the actual 2021 total. Then the 2021 educators were lined up and sorted by age, and within each single age educators were sorted randomly. The 2011 ages were then imported and replaced the original 2021 ages. The educator input sheet in the Excel tool was then recompiled.

[63] The original simulation, which used 2021 as the base year for the projections, is described here. This simulation was not updated to use 2022 as the base year. The basic finding stands, whether 2021 or 2022 is the base year.

[64] The large decline between 2014 and 2015 is explained by the fact that the most recently published nominal GDP (which was used as the denominator) displays a particularly large increase between 2014/15 (from 2021 *Budget Review*) and 2015/15 (from 2022 *Budget Review*), beyond what would be expected from published real GDP growth rates.

*Figure 40: Public spending on educators over GDP*

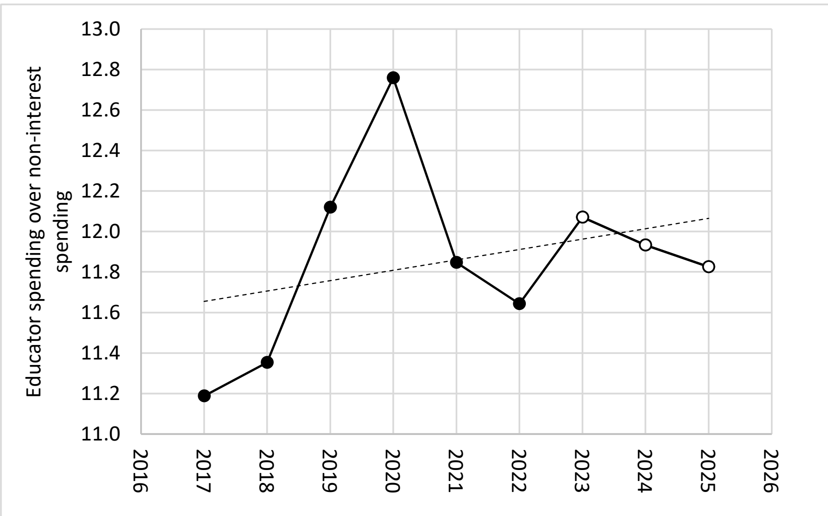



*Sources: Treasury publications, with analysis of Persal used only to calculate the percentage of provincial education compensation of employees that goes to educators, as opposed to non-educators.*

It is worth noting in that if the aforementioned 'Constant educators' scenario is used, where there is no workforce growth, the total cost of the educator workforce over GDP is likely to decline from the current 2.9% to 2.6% in 2030, and 2.2% by 2040. This assumes a fairly pessimistic GDP growth trajectory of 1.8% from 2023 onwards.

The general decline in the ratio over the 2012 to 2022 period (see the dotted black trendline in Figure 40) is in large part due to the fact that less of government revenue has been spent on services and investment, given increases in spending on government debt. Debt service costs of government rose from 2.8% of GDP in 2012 to 4.7% in 2023 according to Treasury publications. As can be seen in Figure 41, spending on educators over non-interest spending by government, in other words what government has to spend on services and investment, displays an *upward* trend for the 2017 to 2022 period. The trend for this same period in Figure 40 would be negative.

*Figure 41: Public spending on educators over non-interest spending*

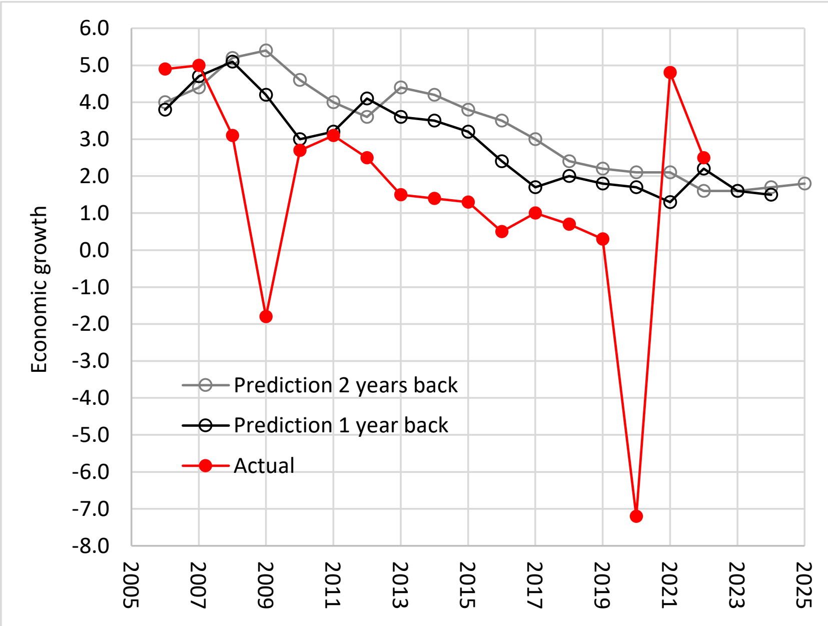



*Sources: As for previous graph.*

As shown in the following graph, economic growth is expected to be 1.5% to 1.8% in 2023 to 2025. This is according to Treasury's 2023 *Budget Review*. However, the graph also shows that

Treasury's estimates of future growth have mostly been over-estimates, with the margin of over-estimation being on average 1.4 percentage points in the pre-pandemic 2006 to 2019 period. This compares estimates made one year back with actuals.

***Figure 42: Expected and actual GDP growth in Treasury publications***

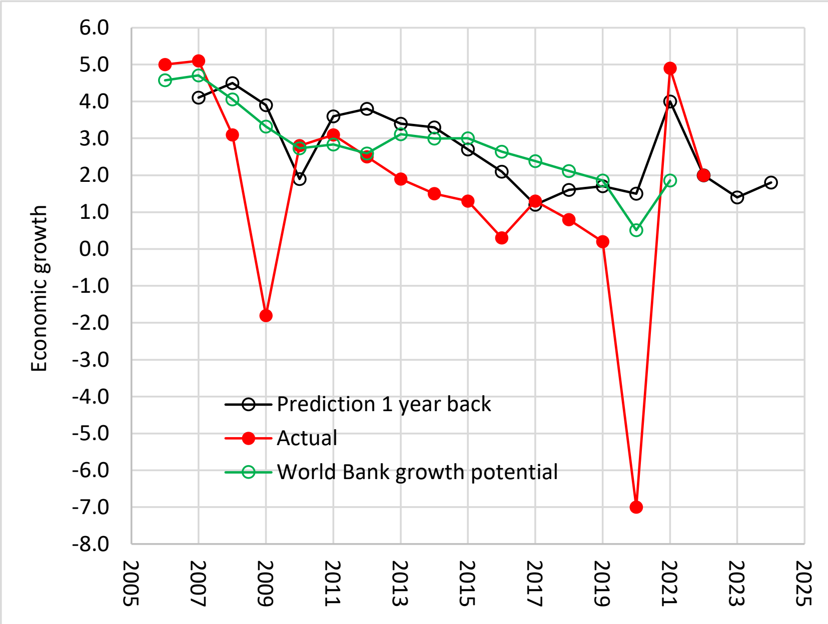



*Source:* Budget Review *of Treasury from various years.*

The International Monetary Fund (IMF), like Treasury, puts estimated growth in 2024 at around 1.8%[65] – see Figure 43 below. The IMF has historically also over-estimated future growth, but to a smaller extent than Treasury. To illustrate, for 2006 to 2019, the IMF has over-estimated South Africa's growth by 0.8 percentage points (against 1.4 for Treasury). Figure 43 also illustrates the World Bank's estimated potential growth for South Africa[66]. In the period 2006 to 2019, potential growth has exceeded actual growth by 1.0 percentage point.

[65] 1.7% according to Treasury, 1.8% according to the IMF.
[66] See World Bank (2023) and Celik *et al* (2023).

*Figure 43: IMF and World Bank growth figures for South Africa*




*Sources: Actual and predicted from IMF's World Economic Outlook (April publications used wherever possible). Potential growth values are from the 'Cross-Country Database of Potential Growth' database of the World Bank, available on the World Bank website. The March 2023 version was used.*

To conclude, future economic growth is difficult to predict, even if some assumption around future growth is needed to inform current teacher training plans. In particular, future growth provides a vital indication of the extent to which the country can afford to expand the teacher workforce to avoid excessive learner-educator ratios. The above analysis points to an expected growth rate of 1.8%, by authoritative organisations. Yet these organisations tend to over-estimate future growth. Growth below 1.0% as a continuous phenomenon seems unlikely – in the 14 years of the 2006 to 2019 period this has occurred four times.

## 7.2 Scenarios within the economic growth context

Table 11 brings together information from previous sections in presenting six future scenarios. Both historical baseline figures and estimates for 2030 are provided. Roughly, scenarios are arranged left to right from more to less favourable.

Scenario 1, **'Population + Grade 12 + LE'** is driven by the need to revert to the more favourable learner-educator (LE) ratio seen in 2011, namely 27.4. This would deal with a decade of increases in the school-age population, and improved survival to Grade 12, and is intended to undo the worsening of class sizes seen in recent years. The number of educators would have to increase by 15.7%, with the same increase being applied to teachers and senior educators. This would take the size of the publicly paid educator workforce from 403,245 in 2022 to 466,555 in 2030. This would mean an increase in the annual availability of newly graduated teachers from universities from 30,809 in 2021 to a peak of 40,150 in 2030. This draws from the projection methods explained in section 5.3. In scenarios 1 to 5, CPI-linked cost-of-living adjustments to the notch values are the point of departure, as the focus is on growing the workforce. CPI-linked adjustments would be a break from both the 2015 to 2019 period, when adjustments exceeded CPI by 1.8 percentage points on average, and from the 2020 to 2023 period, when adjustments were on average 2.5 percentage points *below* CPI[67]. For the

[67] Partially based on figures compiled by Spaull *et al* (2020: 24).

entire period 2015 to 2023, the figure would be 0.4 *below* CPI[68]. Crucially, the average real increase in the unit cost from 2022 onwards would be essentially zero, *even though the purchasing power of individuals in the workforce would rise annually by 1.5%, in all six scenarios, through notch progression.* This is made possible by the fact that on average the workforce is becoming younger during this period, as a bulge of older educators are replaced by relatively young educators. Between 2023 and 2030, the average age of an educator declines from 44.8 to 41.3. To compare, over the 2011 to 2022 period the unit cost increased annually by 0.4% on average. The first scenario produces an annual *total* expenditure increase of 1.8%, which happens to match medium term growth forecasts of both Treasury and the IMF (see section 7.1) – this is a coincidence, as Scenario 1 is not driven by a 1.8% total expenditure growth figure.

Scenario 2, **'Population + Grade 12'**, is less ambitious as it only aims to keep the LE ratio at the 2021 level, not to take it below that level. Here the number of educators would have to increase to 428,246 in order to deal with increases in the child-age population, as well as some improvements in survival to Grade 12. In this scenario, some lowering of the grade repetition rate is envisaged, as explained in section 5.1. In general, however, grade repetition patterns are implicitly assumed to remain mostly unchanged across all scenarios. This is implicit in the use of school-age population increases as an inflator of future enrolment numbers. It is important to bear in mind that the modelling described in this report does not cover major changes to grade repetition, which could impact substantively on LE ratios.

Scenario 2 is arguably more realistic than Scenario 1 for two reasons. Firstly, it acknowledges there are limits to how quickly the workforce can grow. This growth relies not just on the capacity of universities to produce more graduates, but also on whether the physical infrastructure of the schooling system will expand fast enough to accommodate the additional teachers in a manner that reduces class sizes. Moreover, Scenario 2 requires less economic growth, of 0.8%. Section 7.1 suggested that even a low growth rate of 1.8% may not be reached.

Scenario 3, **'Population + Grade 12 + LE HIGH ATTRITION'**, is like Scenario 1 except that it assumes there is more attrition among young teachers, of the kind seen in around 2011, when there were more employment opportunities elsewhere in the economy. The key feature to note about Scenario 3, is that there would need to be a higher number of new graduates available in 2030. Specifically, the figure is 46,489, against 40,150 in Scenario 1. This underlines the fact that demand is not static, and that universities and DHET should periodically revisit educator attrition patterns in the schooling system when planning how many teacher trainees to admit.

The reason the average cost of an educator rises a bit faster in the 'HIGH ATTRITION' scenarios is that more attrition raises the average age in future years somewhat. While the high attrition is concentrated at the younger ages, the age distribution of *joiners* remains the same[69]. Most of the increase in the unit cost is accounted for by increases in the average cost of senior educators.

[68] In the calculations, notch values at the start and end of the period as published in policy were compared, and the annualised real above-CPI increase was then calculated.
[69] See Figure 15 and Figure 13.

***Table 11: Comprehensive 2030 outputs for six scenarios***

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| | Historical | Population + Grade 12 + LE | Population + Grade 12 | Population + Grade 12 + LE HIGH ATTRITION | Constant educators | Constant educators HIGH ATTRITION | Population + Grade 12 EXTREMELY LOW GROWTH |
| LE ratio | **27.4** in 2011, **29.8** in 2021 | 27.4 | 29.8 | 27.4 | 31.6 | 31.6 | 29.8 |
| Total educators 2030 | **403,245** in 2022 | 466,555 | 428,246 | 466,555 | 403,245 | 403,245 | 428,246 |
| Newly graduated teachers 2029-2030 | **30,809** in 2021 | 40,150 | 33,353 | 46,489 | 28,319 | 31,984 | 33,353 |
| Above-CPI annual CoL increase 2022-2030 | **1.8** (2015-2019) **-2.5** (2019-2023) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.3 |
| Annual real % increase in unit cost 2022-2030 (2030 unit cost in 2022 Rand) | **0.4%** (2011-2022) 2022 unit cost 474,387 | 0.0 (473,285) | 0.0 (476,105) | 0.1 (478,898) | 0.1 (478,255) | 0.3 (484,756) | -0.3 (464,797) |
| Annual real % increase in total cost 2022-2030 (2030 total cost in 2022 Rand) | **0.8%** (2011-2022) 2022 total cost **R192bn** | 1.8 (R221bn) | 0.8 (R204bn) | 1.9 (R223bn) | 0.1 (R193bn) | 0.3 (R195bn) | 0.5 (R199bn) |

Scenario 4, **'Constant educators'**, is undesirable insofar as it would allow the learner-educator ratio to rise to levels not seen in the recent past. It would rise to 31.6 by 2030. What does this mean? Because there is a concentration of learners around thresholds such as 40 or 50 learners in a class, just a small change in the LE ratio can result in many learners crossing the threshold. A threshold put forward in DBE's *Action Plan to 2024* is reflected in the following indicator 'The percentage of learners who are in classes with no more than 45 learners'. Simulations point to a worsening in the LE ratio of just 1.0 pushing some 200,000 grades 1 to 3 learners over the 40 threshold, this being a threshold used in the infrastructure policies. This is in a finding where the percentage of grades 1 to 3 learners in classes exceeding 40 rises from a current level of 49% to 55%. By extension, the worsening of the LE ratio from 29.8 in 2021 to 31.6 in 2030, as seen in Scenario 4, would result in some 360,000 grades 1 to 3 learners, or over one-tenth of these learners, moving to the wrong side of the threshold.

Scenario 5, **'Constant educators HIGH ATTRITION'**, is Scenario 4 with the high attrition parameters applied to Scenario 3. Again, unit costs increase somewhat faster, and universities must produce more graduates, relative to Scenario 4.

Scenario 6, **'Population + Grade 12 EXTREMELY LOW GROWTH'**, illustrates what is found if the LE ratio is not allowed to worsen, relative to 2021, and if the fiscal space for spending more on the workforce is severely limited, specifically to an annual growth figure of 0.5%. Notch progression would be respected, but what could change is the cost-of-living adjustments applied to the notches. In order to remain within the fiscal envelope, cost-of-living adjustments would have to be 0.3 percentage points *below* CPI in all years. This would still result in an increase in the purchasing power of educators, via notch progression, but this would now be around 1.2% a year, and not 1.5%.

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