Education industrial policy and fiscal incentives for AI productivity and employment

Category: Postgraduate

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1 Introduction

“There are a thousand hacking at the branches of evil to one who is striking at the root” (Thoreau: 1854). This research essay examines how South Africa can redesign education, industrial policy and fiscal incentives to harness artificial intelligence (AI) for productivity growth while limiting labour-market disruption. It focuses on developing skills and applying AI effectively at work. Section 2 examines educational constraints and learning interventions; Section 3 considers workplace performance and employment transitions; Section 4 examines inequality and financing. Section 5 synthesises the evidence, followed by coordinated recommendations in Section 6.

2 Constraints in South African education

2.1 Teacher shortages and unemployed graduates

The teacher paradox refers to the coexistence of unemployed qualified teachers and schools needing additional educators (Ralph: 2026). Ralph reports that provincial budget pressures can prevent departments from filling posts when teachers leave. Social demand for teaching therefore differs from effective labour demand: schools may need teachers without having funded posts available. The Department of Basic Education (DBE) also identifies educator employment costs and shortages in particular subjects, languages and locations as planning constraints (DBE: 2026). Recruitment and allocation must consequently be considered alongside the overall supply of graduates.

2.2 Education expenditure and teacher remuneration

A substantial education budget does not necessarily provide substantial resources per learner. Statistics South Africa (StatsSA) reports education expenditure of approximately R491.4 billion in 2024/25, equivalent to 6.7% of gross domestic product (GDP) (StatsSA: 2025a). The Organisation for Economic Co-operation and Development’s (OECD) 2025 country note reports government spending of USD 3,108 per student from primary to post-secondary non-tertiary education in purchasing-power-parity terms, using its 2022 comparison. This places South Africa near the lower end of the countries covered (OECD: 2025a). These measures use different coverage and reference periods, but together illustrate why fiscal effort and resources available to each learner must be distinguished.

The composition of expenditure also matters. Staff compensation accounts for 79% of current expenditure in South African primary educational institutions, matching the OECD average (OECD: 2026). This is not a measure of teacher basic salaries alone. Using household assets as a proxy for living standards, Gustafsson and Maponya (2020) find that South African teachers’ purchasing power is broadly comparable to that of teachers in other middle-income countries.

Pampallis (2022) shows why benefits and progression must be included when assessing remuneration. These approaches caution against judging pay from a single salary figure. Reporting reproduced by the South African Commercial Catering and Allied Workers Union (SACCAWU) indicates that increases in the entry-level salary scale between 2019 and 2026 lagged inflation (SACCAWU: 2026). That comparison does not establish that all teachers are underpaid, since benefits, experience and progression affect total remuneration.

Table 1 presents selected salary notches to distinguish basic pay from the full cost of employing teachers. The figures vary with qualifications, position and experience (Hilliard-Lomas: 2026). Relative Education Qualification Value (REQV) classifies qualifications for salary determination (DBE: 2011).

Table 1 Selected educator basic salary notches in 2026

Salary notch	Monthly basic pay	Annual basic pay
164 — entry notch for REQV 14–17	R30,504	R366,051
200	R35,970	R431,640
232	R42,109	R505,302
268	R50,042	R600,504

Source: Hilliard-Lomas (2026). Monthly amounts are annual basic salaries divided by 12 and rounded to the nearest rand. Benefits are excluded; amounts are before deductions.

The entry notch shown corresponds to about R30,504 per month. It is not the entry salary for a departmental head. More broadly, individual pay levels and the affordability of the aggregate wage bill are separate questions. A staffing system can face budget pressure even where salary-scale increases do not keep pace with inflation.

The DBE reports that real spending per educator in 2024 was 30% above its 2007 level, while resources purchasable per learner, after accounting for educator costs, declined by 5% between 2011 and 2024. It also reports a learner–educator ratio of approximately 29.3, compared with 27.4 in 2011 (DBE: 2026). These are system-level measures: the learner–educator ratio is not identical to classroom size. The figures reinforce the need to distinguish individual salary scales from average employment costs and the resources remaining for learners.

2.3 Technology expenditure and implementation

The Eastern Cape tablet programme illustrates the importance of implementation. An August 2026 investigation reported a R686 million commitment in 2025 to provide tablets and connectivity to 54,000 matric learners. None of the 12 schools contacted was operating the programme as designed in 2026; reported problems included interrupted data provision, missing devices and damaged equipment (Ntsaluba et al.: 2026). These findings identify serious failures at the schools investigated, but do not establish that the entire programme budget was lost.

Infrastructure information must also be interpreted carefully. The DBE’s Education Facility Management System report records school facilities as at August 2025, including computer

centres, and notes that provinces are updating condition assessments (DBE: 2025). A computer centre is not equivalent to reliable access to working devices and internet connectivity. The policy implication is that procurement must be accompanied by maintenance, secure storage, connectivity and practical support for teachers.

2.4 Learning outcomes and the skills pipeline

Weak foundational learning limits what later educational interventions can achieve. Trends in International Mathematics and Science Study (TIMSS) 2023 recorded a Grade 5 mathematics score of 362, down from 374 in 2019, and a science score of 308. South African Grade 5 learners participated in an assessment generally administered internationally at Grade 4 (DBE: 2024). These assessments establish the scale of learning difficulties; they do not isolate a single cause.

Furthermore, Progress in International Reading Literacy Study (PIRLS) 2021 found that 81% of South African Grade 4 learners could not read for meaning, while the national score was 288 against the international scale centre point of 500 (University of Pretoria: 2023). Further analysis of PIRLS data shows that reading achievement declined significantly between 2016 and 2021 among learners in South Africa's poorest 70% of schools, while the wealthiest 20% experienced no statistically significant decline (Böhmer and Wills: 2025). This widening educational divide highlights the need to address unequal learning opportunities long before learners compete for employment.

School performance also shapes access to further study. Van Broekhuizen et al. (2016) linked school and university records for the 2008 matric cohort and found that school results strongly influenced university access and success. Their historical cohort should not be treated as a current enrolment estimate. More recently, the Department of Higher Education and Training reported about 345,000 bachelor's passes in the 2025 National Senior Certificate (NSC) examinations, compared with approximately 230,000 first-time university places annually (Department of Higher Education and Training: 2026). Eligibility, admission and degree completion are therefore distinct outcomes. South Africa's science, technology, engineering and mathematics (STEM) share of bachelor's or equivalent graduates was 15% in 2022 compared to the OECD 2023 reporting average of 23% (OECD: 2025a).

These findings suggest a mechanism through which weak schooling can constrain the supply of skills required for productive AI adoption. They do not establish that education alone explains unemployment or that additional qualifications automatically create jobs. Education reform must therefore connect with industrial policy that enables firms to employ and develop those skills.

2.5 International evidence and its relevance

2.5.1 Supervised AI tutoring and writing feedback

In Nigeria, a randomised trial evaluated six weeks of teacher-supported, after-school tutoring using Microsoft Copilot. Participants improved by 0.31 standard deviations on a combined assessment of English, digital and AI skills. The paper's main text reports an English effect of 0.24 standard deviations. Its comparison with 1.5–2 years of typical learning is a statistical benchmark, not evidence that tutoring replaces two years of schooling (De Simone et al.: 2025).

The study supports testing supervised, curriculum-aligned tutoring, but its short duration and participating schools limit conclusions about national implementation.

In Brazil, a randomised evaluation across 178 public schools assessed Letrus automated writing feedback. Both intervention versions improved university entrance examination essay scores by about 0.09 standard deviations, equivalent to approximately 9% of the public–private essay-score gap. Students practised more and received more feedback, while teachers shifted attention towards more complex writing tasks (Abdul Latif Jameel Poverty Action Lab: n.d.). This supports using AI to assist feedback and revision. However, the participating schools had computer access, so equivalent results cannot be assumed in schools lacking functional equipment.

2.5.2 Adaptive instruction and support for teachers

In India, a randomised evaluation of Mindspark found gains of 0.37 standard deviations in mathematics and 0.23 in Hindi after 4.5 months. The software adapted instruction to learners' knowledge rather than assuming that all learners had mastered the same material (Muralidharan et al.: 2019). A subsequent study adapted the intervention for public-school schedules and evaluated it in a substantially larger sample (Muralidharan and Singh: 2025). Together, these studies make implementation and adaptation central to the case for technology-supported learning. Adaptive software should also be distinguished from unrestricted generative-AI chatbots.

Kenya's Tusome programme offers a complementary example of instructional reform. It combined learning materials, structured teaching support and classroom monitoring, with government systems involved in implementation (Piper et al.: 2018). NORC's independent evaluation found significant reading improvements between baseline and endline, but this design cannot establish causality as strongly as a randomised comparison. Substantial donor funding also limits direct fiscal comparisons with South Africa (NORC at the University of Chicago: n.d.). The relevant lesson is that technology must fit within a functioning system of instructional support.

Education reform can improve the capabilities needed to work with AI, but firms must also be able to invest, adopt technology and employ those capabilities. The next section therefore examines the industrial constraints that influence whether better skills translate into productive employment, and considers how international experience can inform workable South African policy.

3 Industrial policy and labour demand

The teacher paradox illustrates how skills can remain underused when suitable job opportunities are unavailable. South Africa consequently experiences substantial unemployment alongside shortages of specialised skills. In the second quarter of 2026, unemployment reached 33.6%, while youth unemployment among individuals aged 15–34 reached 47.4% (StatsSA: 2026).

3.1 Skills mismatch

South African employers report recruitment difficulties across technical and professional occupations. In Xpatweb's 2025 survey, engineering was the most frequently identified

shortage area, cited by 38% of respondents, followed by information and communication technology (ICT) specialists and artisans at 22% each (Xpatweb: 2025), corresponding to the low share of STEM graduates in the country covered earlier. The Institute of Information Technology Professionals South Africa (IITPSA) identifies artificial intelligence and machine learning, big data and data science, data storage, cybersecurity, DevOps and systems design among the ICT skills experiencing the greatest shortages in South Africa (IITPSA: 2024). Furthermore, Collective X estimated approximately 118,000 unfilled digital roles in South Africa in 2025, including around 41,000 junior roles. Its analysis combined online job-advertisement data with the Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA) and StatsSA information (Collective X: 2025). These findings indicate demand for STEM and ICT skills. Some firms source skills abroad, potentially reducing opportunities for South Africans. Harambee's 2020 research estimated approximately R8.5 billion annually in forgone export revenue associated with digital work being outsourced abroad. Its survey covered 102 enterprises, and 69% reported outsourcing digital work and expertise internationally (Harambee: 2020). Even though this is a historical report it points to the evidence of an issue, outsourcing and missed employment due to skills mismatch.

3.2 Education–industry partnerships

The OECD also identifies shortages of skilled and semi-skilled workers, together with mismatches between qualifications and available jobs, as constraints on South Africa's economic growth. It also recommends stronger coordination between vocational education providers and employers, including internships and workplace experience (OECD: 2025b). Singapore's SkillsFuture Work-Study Programme demonstrates how education–industry partnerships connect qualifications with workplace experience. Participants combine salaried employment and structured workplace training with further study. An evaluation found that Post-Diploma graduates earned approximately 9% more than comparable graduates who entered employment directly one to two years after completion, with a 6% premium persisting over the subsequent two years (Ling and Tan: 2024). These findings support exploring similar partnerships between South African employers and education institutions, with paid placements linked to practical AI and digital skills.

3.3 AI in the workplace

AI can be used to strengthen education–industry partnerships by accelerating learning during workplace placements. Brynjolfsson et al. (2025) found that customer-support agents using AI reached the performance of workers with more than six months' experience after only two months. The system provided real-time suggestions that helped less-experienced workers apply effective practices. Workers also handled conversations faster during subsequent AI outages, suggesting that some learning persisted without assistance, although these estimates were less precise. Faster acquisition of effective practices links AI-assisted training to workplace productivity, without establishing economy-wide effects.

3.4 AI as a threat

In 2024, Klarna reported that AI was helping it operate with fewer employees, as its workforce declined from approximately 5,000 to 3,800, largely through attrition and restricted hiring

(Reuters: 2024). Similarly, Singapore's DBS announced plans in February 2025 to reduce approximately 4,000 temporary and contract roles over three years as AI increasingly performed their tasks. This reduction was expected through contracts ending and natural attrition, rather than immediate retrenchments (Reuters: 2025). These examples illustrate how AI can narrow employment opportunities through reduced recruitment even without widespread dismissals.

Nevertheless, the International Labour Organization (ILO) (2025) identifies job transformation as the most likely overall effect of generative AI, because many occupations still require substantial human input. Its subsequent skills research emphasises the growing importance of higher-order thinking, interpersonal capabilities and digital literacy (ILO: 2026). South Africa's education–industry partnerships should therefore prepare workers for responsibilities such as investigating unfamiliar problems, evaluating AI outputs and managing complex customer needs. Combining AI adoption with supervised training and opportunities for progression will help workers move beyond routine tasks vulnerable to automation.

3.5 International workforce policies

Singapore demonstrates how workforce policy connects training directly to employers' needs. Its Career Conversion Programmes support firms to hire and train workers for new occupations or retrain existing employees for redesigned roles. The programme for data analysts and AI professionals provides structured workplace training and salary support of up to 90% for qualifying participants (Workforce Singapore: 2026). An evaluation of the broader Place-and-Train programme found that employment retention improved by 3.9 percentage points and wages increased by approximately 5.8–6.5% during the subsequent four years compared with control groups (Ministry of Trade and Industry: 2025).

Germany illustrates how shared facilities help smaller firms participate in technological upgrading. Its inter-company vocational training centres supplement workplace and vocational-school instruction, providing specialist facilities that individual employers cannot afford independently (BIBB: n.d.). Complementary programmes, including Mittelstand-Digital's AI trainers and the Future Centres, provide practical AI guidance and develop workplace training with employee participation (Mittelstand-Digital: n.d.; Federal Ministry of Labour and Social Affairs: n.d.). Their contribution is an established support infrastructure; the available programme descriptions do not demonstrate a specific number of jobs saved.

Germany also combines technological adaptation with worker protection. Its qualification allowance supports retraining for employees threatened by structural change, replacing 60% of the relevant net earnings loss during training, or 67% for eligible workers with children, while employers finance the training. The objective is continued employment within the same company (Federal Employment Agency: n.d.). The 2021 Works Council Modernisation Act further strengthened employee representation concerning AI and access to specialist advice (Federal Ministry of Labour and Social Affairs: 2021). These measures provide mechanisms for managing displacement.

4 Fiscal incentives and inequality

Educational improvement and workforce development require financing that connects improved learning to employment opportunities. Brollo et al. (2024) identify training grants

and coordinated income and employment support as mechanisms for overcoming financial barriers to skills acquisition and reducing the costs of workforce transitions. Building on this principle, this section examines fiscal mechanisms that could encourage firms to co-finance disadvantaged schools, support occupational training and provide paid placements. These mechanisms address financial barriers to developing workers' capabilities.

4.1 Persistent income and wealth inequality

South Africa has made progress in reducing income inequality, but substantial economic disparities persist. The income-per-capita Gini coefficient declined from 0.720 in 2006 to 0.635 in 2023, with StatsSA (2025c) describing the pace of improvement as relatively slow. Wealth concentration has proved more persistent. Chatterjee et al.'s (2020) UNU-WIDER study found no sustained decline in wealth inequality, a conclusion retained in their subsequent journal article: the richest 10% held between 80% and 90% of household wealth throughout 1993–2017 (Chatterjee et al.: 2022).

These disparities also retain a strong racial dimension. In 2023, white-headed households received an average annual income of R676,375, approximately 4.7 times the R143,632 received by black African-headed households. Furthermore, 78.1% of white-headed households occupied the highest expenditure quintile, compared with 13.0% of black African-headed households (StatsSA: 2025b). These household-level differences do not isolate the effects of particular policies, but demonstrate that economic opportunities remain deeply unequal.

4.2 Education and inequality reduction

Brazil demonstrates how expanding education can contribute to reducing broader income inequality. The expansion of basic education during the 1990s and 2000s increased the supply of educated workers and helped narrow earnings differences between education levels. Lustig et al. (2012), reporting decomposition estimates, identify improvements in the distribution of education and narrowing education-related earnings differentials as jointly explaining almost 30% of the decline in household per-capita income inequality. Education therefore formed part of a wider inequality-reduction strategy alongside progressive government transfers. Although estimates differed across studies, this experience supports investing in educational opportunity as a complement to redistribution. For South Africa, the next question is how public funding and employer partnerships can jointly finance these opportunities and connect them to employment.

4.3 American education partnerships

California's Partnership Academies link academic and technical education with business partnerships, requiring private organisations to match 100% of the state grant through cash or in-kind contributions (California Department of Education: 2026). A randomised evaluation of the broader American Career Academies model across nine high schools found average annual earnings gains of 11% over eight years following expected graduation. Gains were concentrated among young men, while educational attainment did not significantly improve (Kemple and Willner: 2008). Together, these examples support testing co-funded education–industry partnerships in South Africa.

5 Conclusion

This research essay examined how education, industrial policy and fiscal incentives can support AI-driven productivity growth while limiting labour-market disruption. The evidence supports stronger foundational learning, employer-linked training and shared transition costs. Workplace AI assistance illustrates improvements in task performance; employment and earnings gains provide separate evidence of workers' outcomes. South Africa should test these complementary mechanisms together, measuring learning, workplace performance and employment retention before expansion. International findings inform this approach but do not establish its national productivity effects.

6 Recommendations

6.1 Education

Firstly, implement a two-year literacy and numeracy pilot in disadvantaged schools, defined here as public schools in quintiles 1–3 serving low-income communities (South African Government: n.d.). This provides an official targeting basis rather than an undefined label. The DBE and provinces should combine structured lessons, diagnostic assessment and coaching. Tusome's staged implementation across 2015–2016 informs the proposed two-school-year observation period; the study does not establish an optimal duration (Piper et al.: 2018). Separately, match qualified teachers to funded vacancies by subject, language and location. Better allocation addresses recruitment mismatches but cannot create funded posts (DBE: 2026).

Secondly, select technology according to learners' stage and assessed needs. India's adaptive-instruction evidence supports teaching matched to existing knowledge, while Nigeria and Brazil support supervised tutoring and writing feedback for secondary learners (Muralidharan et al.: 2019; De Simone et al.: 2025; Abdul Latif Jameel Poverty Action Lab: n.d.). Use shared devices or existing laboratories, provide practical teacher training, and check curriculum and language suitability.

Thirdly, publish a full pilot budget. The Eastern Cape tablet programme's failures justify including connectivity, security, maintenance and replacement alongside procurement, coaching and evaluation costs (Ntsaluba et al.: 2026). Establish transparent partnerships through which firms contribute funding, expertise or equipment, supported by the incentives in Section 6.3. Assess external offers, including SpaceX's reported school-connectivity proposal, against educational value and sustainable costs rather than assuming that donated access resolves implementation constraints (Staff Writer: 2026). Commission an independent expenditure audit, but fund expansion from reprioritisation only where actual savings are identified.

Finally, assess learning gains against a credible comparison group, alongside attendance, device availability and cost per learner. Use the second school year to assess whether gains persist under continued implementation. Employment progression remains a longer-term objective; the industrial recommendations also address current labour-market entrants.

6.2 Industrial policy

Firstly, establish partnerships between employers, technical and vocational education and training (TVET) colleges and universities for ICT occupations with documented vacancies, requiring participating employers to commit to paid placements before occupational training begins. This responds directly to reported recruitment difficulties. Singapore's Work-Study evidence supports combining qualifications with salaried workplace learning (Ling and Tan: 2024). Incorporate supervised AI assistance into placements, drawing on evidence that it can accelerate learning among less-experienced workers (Brynjolfsson et al.: 2025). Connect pilot schools to these partnerships through career guidance and subsequent study opportunities.

Secondly, to enable small and medium-sized enterprises (SMEs) to participate, develop shared specialist training capacity at selected TVET colleges, following Germany's inter-company model (BIBB: n.d.). Use suitable existing facilities and allocate equipment and instructors against verified employer demand. Measure task completion time and quality alongside placement costs, employment retention and earnings after six and twelve months.

Lastly, alongside support for new entrants, address the transition needs of existing employees. AI-related reductions in recruitment justify requiring firms receiving public AI-adoption support to identify affected tasks, consult employees and specify retraining and redeployment opportunities. Germany's worker-representation arrangements provide a precedent for consultation; linking transition plans to public funding is the proposed South African adaptation (Federal Ministry of Labour and Social Affairs: 2021). Delivering these school, placement and retraining pathways requires the shared financing arrangements outlined below.

6.3 Fiscal incentives

Firstly, use shared financing to address constrained school resources. California's Partnership Academies provide a precedent for combining public grants with required private contributions (California Department of Education: 2026). Adapt this arrangement through capped public contributions towards verified company spending on approved pilot costs. The broader Career Academies evaluation supports testing the partnership pathway, although it does not isolate matching grants' effects (Kemple and Willner: 2008).

Secondly, extend cost-sharing to paid workplace training. Adapt Singapore's salary-support mechanism to reduce employers' costs while recruits acquire occupational skills (Workforce Singapore: 2026). Applying this approach to inexperienced entrants extends the principle beyond mid-career conversion. Evaluation must therefore establish whether assistance generates additional training and employment, rather than merely subsidising recruitment that would have occurred anyway.

Lastly, support existing employees by following Germany's division of costs: public support replaces part of earnings lost during retraining while employers finance instruction (Federal Employment Agency: n.d.). Together, these incentives fund skills for productive AI use and employment transitions, applying Brollo et al.'s (2024) training and transition-support principles.

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