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Factors Affecting Grade 12 Learners Performances: Analysis using Propensity Score Methods

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Abstract

This research examines the impact of pre-existing disparities on Grade 12 examination performance in Gauteng and the Western Cape Provinces of South Africa, utilising propensity score matching to balance influencing factors. The analysis focuses on learners from both provinces who participated in Grade 12 examinations from 2017 to 2019. Based on the 2017 datasets, it was found that learners in the Western Cape had significantly lower odds of passing compared to those in Gauteng when using unmatched datasets. However, after matching, the likelihood of passing for Western Cape learners improved to 69%, though they remained less likely to pass than their Gauteng counterparts. This trend was observed for the years 2018 and 2019. These findings emphasise the importance of using matched data to avoid misleading conclusions in comparative assessments of educational performance.

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INTRODUCTION

In 1996, following the country's first democratic elections in 1994, South Africa's new constitution dismantled the “homelands” and established nine new provinces. The new democratic government oversaw the administration of the first national examination in November 1996, employing a highly decentralised approach. Following this transition, the newly recognised non-racial provincial divisions within the Department of Education—now referred to as the Department of Basic Education—took on the responsibility for the Senior Certificate (SC)(Sibanda, 2025). Each of the nine provincial departments retained the responsibility for formulating their own examination papers. This decentralised approach significantly challenged the maintenance of equivalent standards for examinations across the various provinces.

The SC was replaced by the National Senior Certificate (NSC), which was first administered at the Grade 12 level in 2008 and represents a significant milestone in the educational reforms implemented by the new government (Sibanda, 2018). Since 2008, all Grade 12 learners, irrespective of their racial backgrounds or geographical locations, have written the same examination administered by a unified national education department. This initiative ensures that all learners are

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assessed according to the same academic standards; however, it also presupposes comprehensive consistency in the formulation of the examination process (Sibanda, 2025). The NSC is the only school leaving certificate written by learners after 13 years of schooling at the end of the year. Similar to other countries, the NSC serve a dual purpose – as a school exit and as an entry into tertiary education

The introduction of the National NSC examinations has given rise to a significant trend wherein the pass rates of learners are used as a basis for comparisons and rankings at various levels, including schools, circuits, districts, and provinces(Sibanda, 2025). The pass rates of provinces are systematically ranked, with the highest-performing province being recognised as the leader in educational outcomes (Department of Basic Education, 2022). Unfortunately, the learners within these provinces present systematic differences, which render interprovincial comparisons susceptible to bias(Sterne et al., 2019).

The paper does not intend to discuss the factors that affect learners' performances exhaustively but to briefly address some of them. Some of them may be effect modifiers, while others may be confounders

Studies have shown that socioeconomic status (SES) is one of the most critical factors that account for learner performance variability (Umalusi, 2015). SES is a combination of parents' education, occupation, income, and facilities provided to their children (Akhtar, 2012; Nyoni et al., 2017; Letsoalo et al., 2018; Owusu Amponsah et al., 2018; Getachew, 2018). Most studies indicated that the higher the learner's family's SES score, the better the learner's performance (Farooq et al., 2011; Hamid, 2011; Singh & Choudhary, 2015; Martins & Veiga, 2010). It may be argued that parents belonging to higher SES categories exhibit greater engagement in their children's school-related endeavours when compared to parents in lower SES groups.

Dockrat (2016) emphasised a complicated association between age and learner performance, noting that most studies have struggled to draw definitive conclusions regarding the relationship between these variables. However, McCarey et al., (2007) substantiate the existing evidence supporting a positive association between age and learner performance. In contrast, Grissom (2004) and Khan and Golder (2021) concluded that an inverse correlation exists between age and learner performance, suggesting a decline in academic performance as learners progress in age. Despite numerous studies regarding age and learner performance having been published, experts do not agree on the extent to which a learner's age affects learner performance or if it produces a consistent effect at all (Ede, 2004; Grissom, 2004).

The influence of gender on learner performance has been a central focus for researchers over an extended period, as evidenced by studies conducted by(Guiso et al., 2008; Letsoalo, 2018a) and (Wrigley-Asante et al., 2023). Males tend to exhibit superior performance in specific spatial and visual tasks, such as Mathematics and Science. In contrast, females tend to excel in reading and writing skills, as indicated by research conducted by (Demirbas & Demirkan, 2007; Guiso et al., 2008). However, Farooq et al., (2011) presented contrasting findings, demonstrating that females performed better in Mathematics and English, with cumulative advantages.

Language skills are regarded as the currency of academic participation and success in academic and other social life areas(Brock-Utne, 2012; Mudaly & Singh,

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2018). Numerous studies have addressed the issue of the language of instruction and its impact (Mudaly & Singh, 2018; Setati & Adler, 2000; Dockrat, 2016; Al Husaini et al., 2022). These investigations have consistently revealed a substantial and favourable association between the language used for teaching and learner performance. For instance, Mushtaq et al., (2012) demonstrated that language competency accounted for 20% of the positive variance in learner performance. This finding aligns with the conclusions of Al Husaini et al., (2022), who identified English proficiency as the most critical factor positively influencing students' academic achievements. As evidenced by Al Husaini et al., (2022), learners equipped with strong communication skills and a solid grasp of the English language exhibit enhanced academic performance.

The concept of "home" serves as the fundamental locus for learning and education, exerting a profound impact on learners' psychological, emotional, social, and economic welfare (Dev, 2016). Ozcan (2021) further contends that the state of the home environment significantly impacts the learner, as parents play a pivotal role as the primary socialising agents in a learner's life. The family background and context significantly shape a child's reactions to life situations and academic achievements. Parents, children, and other family members encourage a supportive learning environment within their homes to foster favourable academic outcomes. Educated parents can create an atmosphere that optimally nurtures their children's academic success (Ozcan, 2021).

The study's purpose is to demonstrate the effectiveness of propensity score methods in reducing the influence of factors influencing learner performance. This will be determined by comparing the findings of the analyses based on matched data to findings based on unmatched data. In particular, the study compares the likelihood of a learner passing in a province based on unmatched and matched datasets separately..

RESEARCH METHOD

The research employed a quantitative methodology within the framework of the post-positivist paradigm, wherein the researcher utilises cause-and-effect reasoning to derive knowledge (Creswell, 2014). Secondary data sourced from the Umalusi Quality Council for General and Further Education and Training was analysed, focusing on the academic performances of full-time Grade 12 learners who wrote examinations across the Gauteng (GP) and Western Cape Provinces (WCP) during the years 2017, 2018, and 2019. In this study, the Western Cape was designated as the intervention group, while Gauteng served as the comparison group. These provinces were selected due to their predominantly urban populations, facilitating a relevant comparative analysis. Notably, the research did not incorporate data collection instruments, such as structured and validated tools for data collection. Table 1 below shows the number of learners who wrote the Grade 12 examinations in the period under study.

The propensity score method was used to match learners who wrote the Grade 12 examinations in the Western Cape Province (WCP) to learners who wrote in the Gauteng Province (GP). Rubin (1997) asserts that the propensity score serves to mitigate systematic variations in background attributes among provinces, differences that would not arise in a non-randomised experimental setting. The

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propensity score for a learner, as articulated byRosenbaum and Rubin (1985), is delineated as the likelihood of undergoing an intervention (I) based on the observed covariates (X):

$$(X_i) = pr\ (I_i = 1|X_i).$$

The propensity score represents the estimated likelihood for each learner in the study to be assigned to the province under consideration for comparison, given all relevant confounding variables (Zhao et al., 2021). The score serves as an indicator describing the alignment of observed confounders for each learner in both provinces. Consequently, learners in the WCP and GP with identical propensity scores can be considered comparable, signifying a balanced distribution of confounding variables. This balance allows for an unbiased comparison of pass rates among learners with matching propensity scores in the two provinces.

Table 1: Distribution of learners by gender, quintile, and age by province: The 2017, 2018 and 2019 cohorts.

Academic Year	**2017**		**2018**		**2019**	
Province	**Gauteng**	**Western Cape**	**Gauteng**	**Western Cape**	**Gauteng**	**Western Cape**
Total	**79137**	**44190**	**76742**	**45275**	**78794**	**45474**
Gender						
Male	34426	18868	33367	19303	34085	19528
Female	44711	25322	43375	25972	44709	25946
Quintile						
1	8281	2473	8404	2528	8667	2569
2	9256	3756	8596	3847	9016	3663
3	1515	7677	14209	789	14634	8008
4	15502	9168	14717	9475	14791	943
5	30948	21116	30816	21535	31686	21804
Age (yrs.)						
16	196	55	180	43	163	35
17	14735	6702	1389	6724	13527	6003
18	38256	23914	38403	25004	39307	25521
19	17336	9324	16875	9721	18271	9994
20	8614	4195	7394	3783	7526	3921

The PSM enables the study to account for comparability between provinces by balancing the distribution of factors affecting the performance of Grade 12 learners in different provinces. This simulates the random assignment of learners seen in randomised studies (Baek et al., 2015). In other words, the distributions of the factors affecting learners' performances in the two provinces will be balanced prior to the analysis.

Since the Grade 12 dataset is characterised by its nested structure and inherent correlations among observations and given that the outcome is discrete and classified as either a pass or a fail, a hierarchical linear model was applied. This approach allows for the effective analysis of data organised at multiple levels,

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acknowledging the clustering of data points and providing a robust framework for understanding the relationships within the dataset (Letsoalo, 2018b) Rabe-Hesketh et al., 2004). The parameter of interest was the odds ratio (OR), which represents the odds that an outcome will occur given an intervention. The table below summarises the interpretation of the OR.

Table 1: Interpretation of values of odds ratios (OR)

Odds Ratio (OR)	Interpretation
OR = 1 (equals 1)	The likelihood of passing Grade 12 in WCP is the same as in GP
OR > 1 (greater than 1)	The likelihood of passing Grade 12 in Province WCP is **higher** than in Province GP
OR < 1 (less than 1)	The likelihood of passing Grade 12 in Province WCP is **lower** than in Province GP

RESULTS AND DISCUSSION

The propensity score matching technique was used to match learners who wrote the Grade 12 examination in the WCP with those who took the exam in GP. Table 3 represents the number of *unmatched* and *matched* learners in GP and WCP.

Table 3: Number of unmatched and matched learners for the two provinces

Year	GP	WCP	Number of learners Matched	% of learners Matched
2017	79,137	44,190	42,796	97
2018	76,742	45,275	44,335	98
2019	78,794	45,474	43,957	97

The percentage of learners matched is significantly higher: 97% for 2017 and 2019 and 98% for 2018. To clarify, 97% and 98% of learners in the WCP were successfully matched on a one-to-one/many basis with learners in GP. Table 4 shows the number of matched data by gender, quintile, and age. The number of female and male learners matched in the two provinces is equal, one-on-one. However, the number of learners in quintiles and age groups matched was one-to-many.

A propensity score matching methodology was employed to align each learner who participated in the Grade 12 examinations in the Western Cape with one or more counterparts who sat for the same examinations in the Gauteng Province. This methodological approach facilitates an analytical framework that simulates the conditions of a randomised controlled trial, wherein the same learner effectively appears to have participated in examinations across two different provincial contexts.

Key variables—namely, gender, socio-economic quintile, and age—were controlled to mitigate any potential bias that might influence the outcome. The successful matching of learners on these dimensions allows for the conclusion that the assignment of learners to the intervention group is statistically independent of extraneous variables, closely resembling the principles of randomisation. This is a

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critical aspect, as it ensures the validity of the study's assumptions regarding independence.

Table 4: Distribution of learners after matching by gender, quintile and age.

	2017		2018		2019	
Province	**GP**	**WC**	**GP**	**WC**	**GP**	**WC**
Gender - F	24539	24539	25611	25611	24949	24949
Gender - M	18257	18257	18724	18724	19008	19008
Quintile – 1	1698	2469	2054	2463	2021	2376
Quintile – 2	3827	3627	2863	3589	3777	3504
Quintile – 3	6016	7336	6838	7513	6048	7859
Quintile – 4	8528	8964	9270	9253	8134	9332
Quintile – 5	22727	20400	23310	21517	23977	20886
Age -16	98	54	141	42	83	35
Age -17	7418	6500	7400	6553	7064	5864
Age -18	22371	23059	23438	24573	24116	24513
Age -19	8637	9086	9308	9474	9202	9727
Age - 20	4272	4097	4048	3693	3492	3818

By ensuring this independence, the research design enables a robust comparison between learners who possess an equivalent probability of receiving the intervention, albeit across disparate provincial landscapes. Consequently, the study effectively addresses biases that may arise from non-random assignment of learners, thus contributing to a more credible understanding of the intervention's impact across the two provinces.

Table 5 shows the results of the unadjusted models for the years 2017, 2018, and 2019. It uses both unmatched and matched datasets to assess the performance of learners in the Western Cape Province (WCP) compared to their counterparts in Gauteng Province (GP).

Table 5: Results of the unadjusted models for 2017, 2018 and 2019. based on unmatched and matched datasets

Year	**Data**	**Final**	**Odds Ratio**	**Standard Error**	***Z***	***P*** > |***z***|	**95% Confidence Interval**
2017	Unmatched	GP *	0				
		WCP	0.2213	0.0132	-25.24	0.000	(0.1969 0.2488)
	Matched	GP *	0				
		WCP	0.6881	0.0528	-4.87	0.000	(0.5920 - 0.7998)
2018	Unmatched	GP *	0				
		WCP	1.0135	0.0442	0.31	0.758	(0.9305 - 1.1038)
	Matched	GP *	0				
		WCP	0.0419	0.0029	-45.59	0.000	(0.0365 - 0.0480)
2019	Unmatched	GP *	0				
		WCP	0.5909	0.0275	-11.29	0.000	(0.5394 - 0.6475)
	Matched	GP *	0				
		WCP	0.5919	0.0470	-6.60	0.000	(0.5065 - 0.6916)

*Baseline category

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In 2017, the analysis of the unmatched data indicated that learners from the WCP were significantly less likely to pass Grade 12 when contrasted with their counterparts in GP. Specifically, the odds ratio (OR) was calculated at 0.2213 ($P < 0.001$, 95% CI: 0.1969-0.2488), suggesting that WCP learners had approximately 22% of the odds of passing compared to their peers in GP. This finding reveals a substantial disparity in educational outcomes for Grade 12 learners between the two provinces, highlighting a considerable drop in the probability of success for students in the WCP. However, when analyzing the matched data for the same year, the results showed a notable shift; the likelihood of a learner from the WCP passing Grade 12 was 0.6881 ($P < 0.001$, 95% CI: 0.5920-0.7998). This suggests that while learners in WCP were still less likely to pass compared to those in GP, the difference was reduced, indicating potential improvements when controlling for other variables.

In 2018, a different trend was observed. The unmatched data indicated that learners from the WCP were approximately 1.01 times as likely to pass Grade 12 as their GP counterparts (OR = 1.01, $P = 0.758$, 95% CI: 0.9305 – 1.1038). The high p-value ($P = 0.758$), which exceeds the conventional threshold of 0.001 for statistical significance, suggests that there were no statistically significant differences in the likelihood of passing between learners from the two provinces. In contrast, the matched data for 2018 revealed that learners in the WCP were 0.0419 times less likely to pass Grade 12 than their GP counterparts ($P < 0.001$, 95% CI: 0.0365 – 0.048). This indicates a critical need for further examination of the factors contributing to this decline in performance when the data is balanced for confounding variables.

The findings for 2019 highlighted a persistent trend of diminished performance among WCP learners. The unmatched analysis indicated that these students showed a 0.5909 decrease in the likelihood of passing Grade 12 in comparison to their peers in GP ($P < 0.001$, 95% CI: 0.5394–0.6475). Similar results were corroborated by the matched data analysis, which yielded an odds ratio of 0.59 ($P < 0.001$, 95% CI: 0.5065-0.6916), reinforcing the observation of a consistent performance gap. This sustained trend of lower passing rates for WCP learners underscores a troubling pattern that necessitates a closer investigation into the educational resources, support systems, and socioeconomic factors influencing these outcomes across the provinces.

In summary, while trends varied across the years, the analysis data consistently indicate significant disparities when controlling for other variables in Grade 12 pass rates between learners in WCP and GP, with 2017 and 2019 data particularly underscoring the educational challenges faced by learners in the Western Cape.

CONCLUSION

The study's findings highlighted the differences between analyses done on matched and unmatched datasets. The different results show how important it is to take observed baseline data into account before comparing the two provinces. Comparing the provinces based on the unmatched data draws radically different, erroneous, and costly conclusions. The propensity score method demonstrated how

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to balance the distribution of biases and confounders between provinces, which simulates the random assignment of learners seen in randomised studies. Propensity score matching was used to balance the learners' baseline features, namely, gender, quintile and age in the WCP and GP. In other words, the matching challenges were decreased because all factors were combined into a single score

The propensity score matching is a valuable methodology, enabling researchers to rectify imbalances among non-equivalent groups by employing covariates consolidated into a singular scalar variable. Empirical evidence attests to the substantial mitigation of bias in effect size and the endowment of non-randomised studies with characteristics akin to experimental designs.

The feasibility of conducting extensive experimental studies with true randomisation is limited in educational research. Using quasi-experimental studies as a viable alternative introduces the potential for misinterpretation of treatment effects owing to pre-existing group differences. Therefore, the study contributes to the body of knowledge on evaluating interventions in non-randomised groups or social science settings, such as educational research.

The study is particularly significant since it is the first cross-sectional study to be conducted exploring the use of the propensity score technique to balance the covariates between the two provinces before comparing the overall performance of Grade 12 learners between the two provinces in South Africa. The study proposes the propensity score as a flexible methodological framework that empirically ensures that groups are comparable so that interventions' effectiveness can be measured.

To further expand the knowledge in the field of study, future researchers may consider investigating how the propensity score matching methods can be used to match learners from more than two provinces.

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