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Implications of Separate Marks for Physics and Chemistry in Grade 12 Results

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Abstract. The South African Grade 12 with a bachelor's endorsement is the most common route for admission into university degree programmes. However, many learners do not meet the required Physical sciences and Mathematics marks for admission into mainstream degrees and instead enter Extended Curriculum Programmes (ECPs) that aim to develop their academic capacity. This study assesses whether reporting separate Grade 12 Physics and Chemistry grades, rather than a Physical sciences grade, would better reflect the students' abilities and strengthen admissions and placement decisions in South African higher education. Using a longitudinal analysis of historical performance data from first-year ECP students over a 10-year period, together with stakeholder perspectives, the study examines the likely consequences of separating the subjects on the Grade 12 certificate. The main findings are that (1) learners who know their strengths are better informed when making subject and career choices, and (2) teaching and learning can improve when curriculum changes respond to clearer performance indicators. Based on these findings, the study recommends a pilot project to test the feasibility of awarding separate grades for Physics and Chemistry in South African schools, alongside careful implementation and the ongoing assessment of fairness and practical constraints. If workable, separate reporting could support more accurate admissions decisions and the better placement of students into appropriate programmes, including ECP pathways.

Keywords: Physics; Chemistry; Higher Education; Extended Curriculum Program

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1. Introduction

Physical sciences in South Africa is a subject offered in Grade 12 that combines Physics and Chemistry into a single subject offering (Audu, 2023; De Wee, 2024; Kolobe & Hobden, 2022; Moloi & Motlhabane, 2023). Although this integrated offering facilitates the aggregation of results, it has raised concerns among teachers, students, and higher education institutions regarding not providing separate assessments for each discipline. Since Physics and Chemistry are treated as separate disciplines in university programmes, the unavailability of separate high school scores might conceal students' real strengths and create a misalignment with post-secondary entry requirements (Daker et al., 2021; Orosz et al., 2023).

The aggregated Physical sciences grade may hide a learner's good performance in one component (e.g., Chemistry) if it is counterbalanced by poor performance in another (e.g., Physics). Admission into most South African university programmes requires a bachelor's pass with sufficient results in both Physical sciences and Mathematics. Higher education was once small and elite but has increasingly become the destination for expanding numbers of recent school leavers as well as adults returning to formal education (Douglas, 2021; Jaremus et al., 2022). Physical sciences education is normally offered as an interdisciplinary subject within the general secondary curriculum, bridging Mathematics and non-scientific disciplines (Badmus & Jita, 2022; Kumar et al., 2023; Nkadimeng & Ankiewicz, 2022).

Within this context, Chemistry and Physics still comprise the core domains of science education where many tertiary programmes require minimum competency levels in both fields. The separation of Chemistry and Physics marks was welcomed enthusiastically by students. Most agreed that separate scores in Physics and Chemistry would help access better educational opportunities and lead to discipline-specific careers. Many students felt that having distinct marks for each subject would improve their chances of getting a job (Banda & Nzabanimana, 2023; Maestrales et al., 2021; Mboniyirivuze et al., 2021; Orosz et al., 2023; Salame & Makki, 2021).

In line with this reasoning, the current study aims to determine whether reporting separate assessment scores for Physics and Chemistry, rather than a single aggregated score, provides a more accurate reflection of students' subject-specific capabilities as observed within the Extended Curriculum Programme. The study also aims to determine the public opinion on this proposed change through an administered survey. It was first applied to school-leaving grades and currently, extensive discussions are at an advanced stage to decide whether the separation needs to be extended to Grade 10 Physical sciences (Potgieter et al., 2008).

Some online platforms have sourced the views of students who have been through the school-leaving system, which has combined Chemistry, Physics, and at times, Biology (Holubova, 2024). Many of the views are against the combined system. However, in RSA, the current situation for school-leaving Grade 12 students is a combined system in which Chemistry and Physics are reported as one result on

their high school certificate (Grussendorff et al., 2004; Koch et al., 2001; Kolobe & Hobden, 2022; Potgieter et al., 2008).

For years, Chemistry education practitioners and university lecturers have observed that Grade 12 Physical Sciences results do not correlate well with students' performance in tertiary Chemistry. This misalignment is consistent with evidence that STEM success depends on underlying competencies rather than subject marks alone. For example, Tong et al. 2025 show that students' physics problem-solving performance relies substantially on mathematics skills, with algebraic skills playing a particularly strong role. In addition, because Grade 12 physics courses are designed to prepare learners for further STEM studies at university, more diagnostic measures of the skills that drive performance may strengthen university placement decisions.

Many tertiary institutions in South Africa that offer academic development programs (e.g., extended curricula or foundation programs) for under-prepared students rely on Grade 12 combined system (i.e., Physical sciences) marks in their placement procedures. The accurate assessment of students' actual performance in Chemistry and Physics will ensure appropriate placement in development programs and mainstream programs, where there will be optimal prospects of success, while balancing placement decisions against cost implications for all stakeholders (Potgieter et al., 2008)

The main aim of a combined system is to give students more options to choose from regarding appropriate career paths. Costs and time are also important factors. The combined system requires fewer resources, e.g., in manpower, and generally requires a moderate amount of time for the students. This is perhaps viewed as reasonable since only introductory knowledge is presented (Herman, 1995; Yeld & Haeck, 1997). In 2008, Potgieter et al. investigated the effectiveness of the placement of students into tertiary-level science streams using a novel instrument. The instrument was applied to the school-tertiary interface to assess the level of preparedness of students for tertiary standards, to evaluate the effectiveness of extended programs, and to determine the placement of students in the available streams.

Student selection and placements at tertiary institutions are challenging issues due to past and present inequalities. The above two properties must be balanced with fairness and transparency. As such, the validity of using school-leaving Grade 12 examinations as the main admission criterion, which currently reflects Physical sciences results (Chemistry and Physics) in a combined system, has been questioned (Zaaiman et al., 2000). The understanding is that if the Chemistry and Physics results are reflected separately, then the selection and placement procedures into mainstream degrees and development programmes can be significantly refined. Selection into a specific student programme can be viewed as a contract to teach at the student level, and it also carries a strong message of the expectation of success (Zaaiman, et al., 2000). The writers further argued that the issues of selection and access are closely related to retention and success.

The high failure rates encountered by many tertiary institutions, particularly for disadvantaged students, could be due to inappropriate selection and placements, as well as inadequate support after admission (Scott et al., 2007). Most students lack the core competencies required for success at the tertiary level (Koch et al., 2001) and unfortunately, mainstream programmes do not make provisions for the adequate development of these competencies. This situation has led to the introduction of the development of academic skills, the provision of counselling, support, and career guidance (Davidowitz & Schreiber, 2008; Grayson, 1996; Mabila et al., 2006; Potgieter et al., 2008).

This study aims to assess whether the separate reporting of Grade 12 Physics and Chemistry grades would, through a longitudinal performance data analysis, more accurately reflect student ability and enhance admissions and placement processes in South African higher education than the current practice of reporting a Physical sciences grade. The following research question was formulated: Would separating Grade 12 Physics and Chemistry marks improve predictive validity for university success, and would this compare with the current aggregated Physical sciences reporting system?

2. Method

2.1 Quantitative method

The academic performance data was drawn from students who were registered in the pre-degree Physics and Chemistry modules. The sampling frame consisted of all students enrolled from 2013 to 2024, excluding 2015 and 2021 (N=1,782). The distribution by cohort year was 2013 (n=202), 2014 (n=192), 2016 (n=156), 2017 (n=181), 2018 (n=171), 2019 (n=180), 2020 (n=99), 2022 (n=181), 2023 (n=192), and 2024 (n=228). The dataset contained first- and second-semester results, continuous assessment scores, examination marks, and final aggregate grades. Student records were merged across the years into one dataset. Only officially registered students who completed both semesters of the selected modules were considered for the analysis.

The data captured for the years 2015 and 2021 were omitted from the study. In 2015, the part-time lecturer employed for Chemistry did not capture all the relevant information required of the students. In 2021, the outbreak of the Covid-19 pandemic hindered the studies of many students, especially disadvantaged students who could not afford the mobile data needed to attend online lectures and participate effectively in online tests, including the submission of online assessments.

The datasets were cleaned rigorously after extraction to ensure that any incomplete entries and inconsistencies were removed, especially regarding students who did not complete the full assessment cycle. An automated classification process was then applied once the final validated dataset was ready. The individual performance indicators, such as semester marks, examination results, and final grades, were translated into levels 1 to 7 as stipulated by the Department of Basic Education. These categories were arranged as Exam Physics Level (EPL), Exam Chemistry Level (ECL), Final Physics Level (FPL), Final

Chemistry Level (FCL), Semester Physics Level (SPL) and Semester Chemistry Level (SCL). The analyses were conducted consistently across all years.

2.2 Data Analysis

2.2.1 Quantitative Analysis of Performance Trends

The quantitative method was used to identify the performance of Chemistry and Physics between the years 2013 and 2024. Final marks and their corresponding achievement levels (Levels 1-7) were analysed separately by subject. Using Python libraries such as Pandas, NumPy, and Matplotlib, the data was aggregated and visualised to track grade-level over time between the two subjects and across the student cohorts to facilitate systematic performance shift detection. Longitudinal plots were used to assess the trend in achievement levels over time. Since performance was classified into structured categories, meaningful comparisons could be made both within a given year and across different academic years.

2.2.2 Ethical considerations

The dataset contained no direct identifiers, and no attempt was made to identify any individual student. The data was stored securely and made accessible only to the research team. Hence, clearance has been waived.

3. Results

3.1 Comparison of physics and chemistry performance by year

Figure 1 presents a heatmap of the yearly distribution of students across nine categories, comparing their performance in Physics and Chemistry from 2013 to 2024. The vertical axis groups are compared at three levels (EPL/ECL, FPL/FCL, SPL/SCL) and, within each level, it distinguishes whether the Physics level is lower than, equal to, or higher than the corresponding Chemistry level. Cell values indicate the number of students in each category; darker shading represents larger counts.

Across the observation period, the modal pattern is that Physics performance is lower than Chemistry performance at all three levels. This is particularly evident in the earlier part of the series, where the cells corresponding to $EPL < ECL$, $FPL < FCL$, $SPL < SCL$ are consistently among the darkest in the heatmap. By contrast, categories where Physics exceeds Chemistry are generally lighter in colour and frequently show single or low double-digit counts, indicating that such cases are relatively rare. The equal level categories typically occupy an intermediate position. Their counts are smaller than those in the Physics lower categories but still substantial, suggesting a non-trivial proportion of students whose achievement in Physics and Chemistry is balanced.

In the EPL vs ECL category, the dominant configuration throughout most years is $EPL < ECL$. This suggests that students tend to have a stronger attainment in Chemistry than in Physics. Although this pattern persists into the later years of the series, there is some attenuation toward the end of the period, where the counts for equality and for $EPL > ECL$ increase, implying a gradual narrowing of the performance gap at entry.

At the FPL vs FCL level, a similar asymmetry is visible. The FPL < FCL category exhibits high counts across multiple points in the series, reinforcing the observation that Chemistry generally remains the stronger subject as students' progress. This block also contains one of the most notable deviations from the overall trend: in 2019, the FPL>FCL cell becomes markedly darker, with a sharp increase in the number of students whose Physics level exceeds their Chemistry level, accompanied by a relative reduction in FPL<FCL. This suggests a cohort- or context-specific shift favouring Physics at this stage.

At the SPL vs SCL level, Chemistry again tends to dominate, with SPL<SCL showing consistently high counts across many years. Yet the 2019 cohort once more stands out: the SPL>SCL cell for that year is among the darkest in the entire heatmap, indicating that at this highest level, a comparatively large share of students outperformed in Physics rather than Chemistry.

From the early part of the period, the pattern remains stable: Chemistry systematically outperforms Physics across all levels, as reflected in the predominance of the "Physics lower" categories. The following year largely continues this trajectory, though with some moderation in count.

In 2019, a pronounced departure from the long-term pattern occurred. At the FPL and SPL levels in particular, the balance shifts such that Physics performance equals or surpasses Chemistry for many more students than in previous years. This could plausibly reflect curricular changes, cohort effects, and other contextual influences that temporarily enhanced the relative performance in Physics.

In the subsequent period, the distribution appears to partially revert to the earlier structure, with Chemistry again being more frequently ahead.

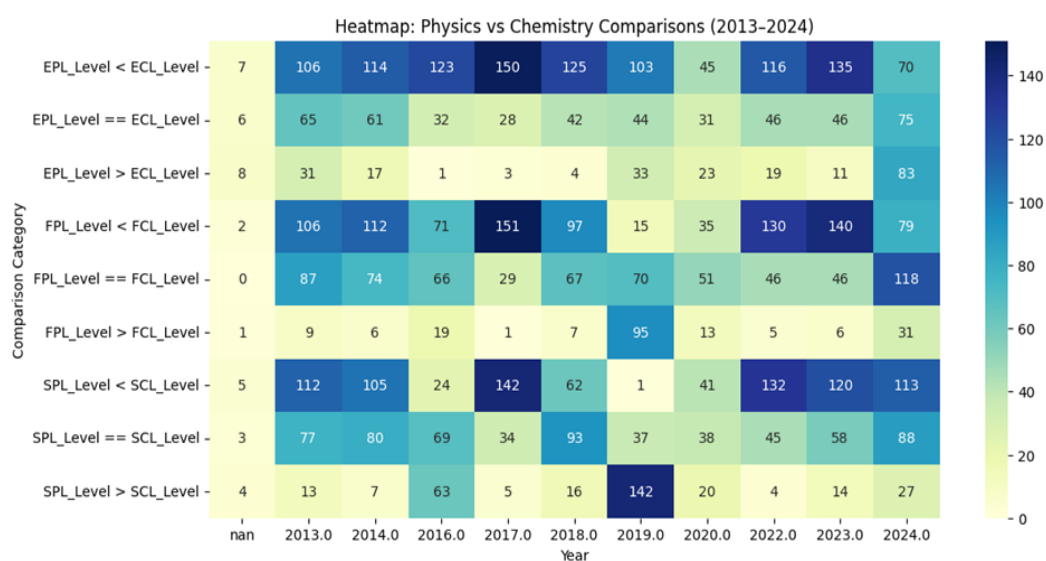


Figure 1: Percentage of students with correct responses

Figure 2 compares the performance of students in Physics to those in Chemistry over a 12-year period. Each year, students are divided into three broad groups based on assessments in the two subjects; those whose Physics performance is equal to or higher than Chemistry, those whose Physics performance is equal to or lower than Chemistry, and those whose Physics performance is higher than Chemistry. These groupings are shown separately for the final marks for Physics and Chemistry (FPL vs FCL), the semester marks for Physics and Chemistry (SPL vs SCL), as well as examination marks (EPL vs ECL), giving a detailed picture of how the balance between the two subjects has shifted over time.

At the FPL vs FCL, the largest share of students in most years is those whose Physics scores are lower than their Chemistry scores. This $FPL < FCL$ trend is especially pronounced in the mid-period and again in the later years where the green line peaks well above the others. In contrast, the group whose Physics and Chemistry scores are equal stays moderately high but is more stable with a noticeable dip in the middle of the period and a strong rise again by the end of the period. Students whose Physics scores exceed their Chemistry scores are consistently the smallest group, though there are visible spikes in the later years. Overall, this suggests that at the initial level of assessment, Chemistry has tended to hold an advantage but there are signs of Physics catching up in the most recent years.

At the SPL vs SCL point, there is a dramatic surge in the number of students with lower Physics than Chemistry in the middle of the period, where the brown line rises sharply to become one of the highest values on the entire chart. Shortly after, there is a striking reversal: the purple line, representing students whose Physics performance is higher than Chemistry at this level, shoots up well above all other categories, while the $SPL < SCL$ group almost disappears. This pattern indicates that whatever was happening in teaching, the curriculum or cohort characteristics produced different outcomes from one year to the next. After this reversal, the balance tilts back again. In the later years, the number of students with lower Physics than Chemistry gradually climbs, while the $SPL > SCL$ group shrinks to small numbers. The equality between the two subjects, represented by the red line, remains in a moderate range, gradually increasing towards the end of the period.

At the EPL vs ECL, Chemistry generally has the upper hand again, but the long-term story is more encouraging for Physics. In the earlier part of the period, the grey line for $EPL < ECL$ dominates, indicating many more students finishing the sequence with stronger Chemistry results. Peaks in the earlier years confirm a substantial gap between the two subjects. The equality group represented by a pink line remains fairly steady, indicating a sizeable core of students maintaining balanced performance.

The standout feature at this level is the behaviour of the yellow line, representing students whose Physics scores exceed their Chemistry scores. For most of the period, this group remains small, but it rises noticeably in the later years and then jumps sharply again by the end of the period, becoming comparable to or even revealing some of the $EPL < ECL$ counts. This late improvement suggests that, by

the end of the course, more students are managing to turn Physics into an area of relative strength, possibly as they become more comfortable with the concepts or benefit from targeted support.

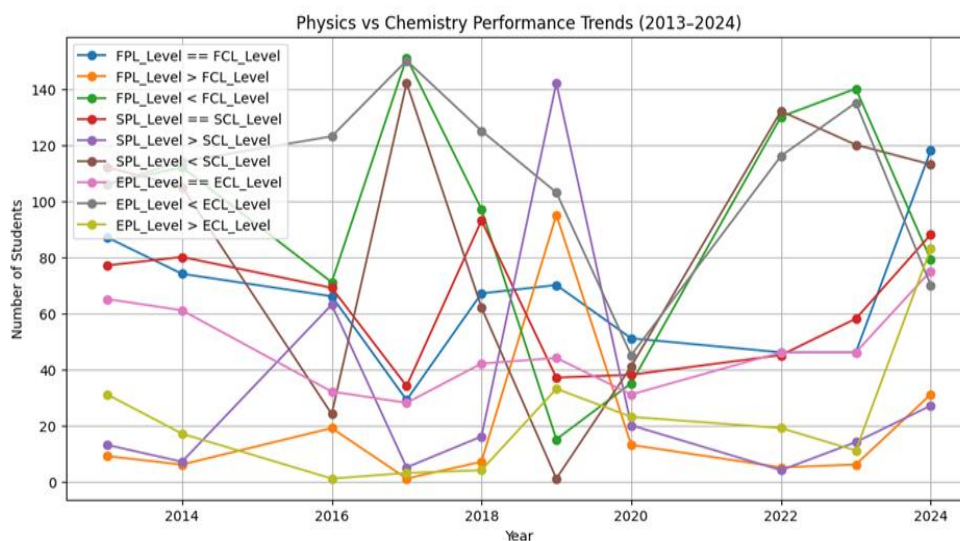


Figure 2: Performance trends of Physics and Chemistry between 2013 and 2024

Figure 3 below compares the performance of students in Physics and Chemistry over several years. The horizontal axis represents the years across the period shown, while the vertical axis indicates the number of students. For each year, three sets of coloured bars indicate whether the students' Physics levels (EPL, FPL, SPL) are less than equal to or greater than their corresponding Chemistry levels (ECL, FCL, SCL). In other words, rather than showing how many students took each subject, it shows how their achievements in Physics stack up directly against those in Chemistry.

For most of this period, the pattern is clear: the tallest bars often belong to the category "Physics level < Chemistry level." This is particularly true for early and intermediate levels (EPL vs ECL and FPL vs FCL). In many years, significantly more students achieve a higher level in Chemistry than in Physics; hence, Chemistry has been historically stronger. The "equal level" bars form a large middle band that indicates a substantial group of students performing similarly in both subjects. On the other hand, "Physics > Chemistry" bars are often the shortest and especially so for the earlier years.

From the later years onward, particularly the most recent, the "Physics equal to" and "Physics higher than" Chemistry bars become more prominent. This indicates that Physics is gradually catching up, as more students are now matching or even exceeding their level in Chemistry. There is a noticeable dip around the middle of the period shown, when the total student numbers fall across nearly all categories. This decline could be due to external disruptions to schooling during that time, followed by a strong recovery later on.

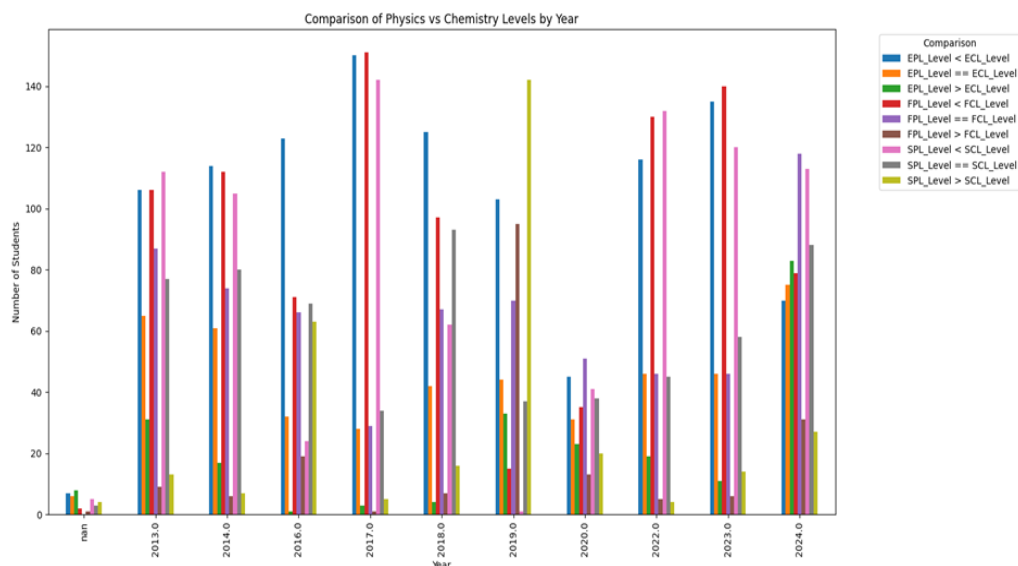


Figure 3: Comparison of Physics and Chemistry levels by Year

In summary, the results show that from 2013 to 2024, students were more frequently classified in Physics-lower-than-Chemistry categories across the EPL/ECL, FPL/FCL, and SPL/SCL comparisons, particularly during 2013–2017, while 2019 represents a pronounced cohort-level departure where Physics equals or exceeds Chemistry more often at the FPL and SPL levels. The resurgence of Chemistry-leading patterns after 2020, alongside the growing visibility of equal and Physics-higher groups by 2023–2024, indicates that performance differences between the two subjects vary by year and assessment level. These findings indicate that reporting Physics and Chemistry separately provides a more accurate representation of learners' competencies across levels, because overall aggregates can obscure both persistent subject gaps and year-specific shifts such as the 2019 reversal and the late-period narrowing seen by 2024.

4. Discussion

From 2020 onward, the graphs show a trend towards equal performance in both subjects. Although Chemistry seems to regain some of its previous strength relative to Physics after 2019, the categories indicating equality keep on increasing. By 2024, FPL = FCL will have reached 118 students, SPL = SCL will have reached 88, and EPL = ECL will have hit 75: these being the highest counts for equality across all datasets. The grouped bar chart for that year has significantly taller bars in the "equal" categories at all three levels than previously seen, while the extreme "less than" and "greater than" categories are not so prominent compared to earlier years.

This is consistent with system efforts to improve the coverage of the curriculum and the alignment of examinations with Curriculum and Assessment Policy Statement (CAPS) objectives. International benchmarking found that Grade 12 Physical sciences is broadly comparable in content and cognitive demand to standalone Physics and Chemistry courses in several other systems, but the importance of skill progression and balanced treatment of the two strands was stressed (Umalusi & Eccis, 2022). As schools and teachers adapt to CAPS and its

associated examination guidelines, it may be that the achievement gaps between Physics and Chemistry naturally narrow.

Professional development for teachers may also help. Qualitative work with South African Physical sciences teachers suggests many felt initially overwhelmed by the breadth of content required for the combined subject but reported increasing confidence as they were trained in practical work, assessment, and new curriculum (Gudyanga, 2017; Gudyanga 2018). Familiarity with both strands could help learners get support more evenly in Physics and Chemistry, which is what the convergence toward 2024 seems to suggest. Counts behind these figures show that there are sizeable groups of learners who are better in one discipline than the other every year.

For example, in 2017, there are 151 learners for whom $FPL < FCL$ but only one learner for whom $FPL > FCL$. In 2024, it looks more balanced but distinct groups of Physics-dominant and Chemistry-dominant learners exist. Follow-up analysis on the students' progress through discipline-specific modules shows that those who did well in Chemistry but poorly in Physics (or vice versa) made better progress when taking modules aligned with their stronger discipline. This finding resonates internationally concerning subject-interest and prior achievement as being important factors for STEM progression (Vilia et al., 2017; Sancassani, 2023).

Gudyanga (2017) argues similarly that from a teacher's perspective, most Physical science teachers recommended separating Physics from Chemistry into distinct school subjects because deep mastery cannot be attained while maintaining high-quality practical work in both at once. This aligns closely with what the dataset reveals empirically that substantial subject-specific variation is often hidden by the combined subject. The amalgamation of Physical science scores into one composite mark may be administratively convenient but misrepresents the actual skills of students. South Africa is the only country that reports one grade for Physical sciences; all other countries report separate grades for Physics and Chemistry (Umalusi & Ecctis, 2022).

5. Recommendations

Conduct a pilot study in selected schools to assess the practicality of this approach. Involve educators, curriculum advisors, and policymakers in a cooperative and consultative process so then all relevant stakeholders can participate meaningfully. Provide teachers and educators with customised resources and professional development in subject-specific instruction and assessment strategies. Work together with the Department of Basic Education (DBE), educational experts, and higher education admission representatives to determine both the feasibility and consequences of separate reporting for consultative purposes.

Initiate pilot projects in certain schools where Physics and Chemistry are reported as separate grades at the school level, but where aggregated marks will still be used for national examinations. Together with the pilot projects, conduct an extensive analysis regarding student performance data and administrative

impacts, and conduct a survey that includes teachers, parents, students, and representatives from the DBE to create a robust dataset that broadens, as well as deepens, the scope of this research.

6. Conclusion

This study examined whether reporting Grade 12 marks for Physics and Chemistry would provide a more accurate and educationally meaningful picture of learner capability than the current Physical sciences grade. The findings indicate that the composite mark systematically obscures substantial strand-specific variation. Across 2013–2024, there are persistent and sizeable subgroups of learners who are Physics-dominant or Chemistry-dominant, differences that become invisible when performance is aggregated into a single score. Although more recent cohorts (notably 2019 and 2024) show greater convergence including instances where Physics meets or exceeds Chemistry, distinct dominance profiles remain, meaning that a single composite indicator can still misrepresent what learners know and can do in each discipline. As a result, universities and other stakeholders lose access to information that is directly relevant to discipline readiness and developmental needs.

These patterns have important implications for fairness, transparency, and outcomes in higher education. When admissions and placement rely on an aggregated Physical sciences mark, strand-specific under preparedness may be masked, strand-specific improvement may be overlooked, and opportunities for precise programme matching and targeted academic support, especially in Extended Curriculum Programme contexts, is likely to be reduced. Separate reporting could strengthen equity and access by recognising discipline-specific strengths that a composite score can suppress, while also improving the signalling and diagnostic functions of the Grade 12 for learners, schools, and institutions.

This study therefore recommends adopting separate Grade 12 reporting for Physics and Chemistry (while retaining “Physical sciences” as an umbrella designation if needed) or, as an interim step, reporting mandatory strand-level sub-scores alongside the composite grade. Higher education institutions should accordingly review admissions and placement criteria to incorporate strand-specific requirements where appropriate, and schools and relevant authorities should use strand-level feedback to strengthen guidance, support planning, and advising. Future research should replicate these analyses beyond ECP cohorts, link strand-level marks to first-year performance and progression, examine the effects on learner choices and STEM uptake, extend the stakeholder consultation to key system actors, and model unintended consequences and feasible implementation options for reporting reforms.

7. Conflict of Interest

In this study, there is no conflict of interest to disclose.

8. Acknowledgement

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