ST344 - Group ROC Report

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Contents

Abstract

This report investigates global patterns in educational access and equity using data from the United Nations Sustainable Development Goal 4 (SDG4) framework. Drawing on multiple indicators—including completion rates (4.1.1 and 4.1.2), literacy (4.6.1), school facilities (4.a.1) and teacher qualifications (4.c.1)—the analysis examines regional disparities, temporal trends, and intersections with related SDGs on poverty (SDG 1) and gender equality (SDG 5). The results highlight persistent structural inequalities, uneven improvement across regions, and clear relationships between broader socio-economic factors and educational outcomes.

Introduction

This report presents an initial data-driven analysis for WFoundation, focused on improving global educational access. In preparation for the Board's strategic planning meeting, our team analysed international education data aligned with Sustainable Development Goal 4 (Quality Education), drawing on additional indicators from SDG 1 (Poverty) and SDG 5 (Gender Equality). Using officially reported UN SDG datasets, we examine global patterns in educational access, identify regions where children are most at risk of being left behind, and explore disparities linked to poverty, gender, and other demographic factors. Our analysis combines exploratory data visualisation, cross-country comparisons, and trend evaluation using the most recent available data for each nation. Particular attention is given to continental and subregional inequalities, temporal progress, and structural barriers affecting completion rates. The findings lay the groundwork for evidence-based recommendations and highlight priorities for deeper stage-two analysis.

Methodology and Data

In this analysis, box plots provided a comprehensive overview of data distributions for SDG 1 and SDG 5 relative to SDG 4, yielding valuable insights into poverty and gender inequalities. For analytical clarity, poverty and marriage rates were categorised into three primary levels, allowing for an examination of patterns across these variables alongside education completion rates. In addition, Duncalfe (2024) provided external country codes to further develop the report, by translating Country codes to the country's respective proper name, continent, and sub-region within the continent.

Moreover, mean values were calculated by education level. A threshold equal to the mean was set for enhanced spatial analysis visualisation, with only data below it highlighted. The worst completion rates and their corresponding countries were closely examined, followed by an analysis of continental trends over the years, in which the mean completion rate for each continent was computed and visualised.

Both the median and the mean values were instrumental in addressing disparities in educational attainment rates. This was effectively illustrated through bar and box plots depicting completion rates at various wealth levels across educational strata, and through a table showcasing completion rates by location and education level. Series descriptions were applied to filter out disparities for more precise analysis, while the facet_grid() function enhanced visualisation by educational level, proving practical for analysing access to education. Dashed lines were added to plots to clearly demarcate thresholds.

For comparison, the units were standardised to percentages or ratios, ensuring uniform evaluation across data points. The mean was calculated from summarised questions to support the conclusions. To enhance interpretation, geographic area codes were integrated into the country data, aiding in both plots and analysis deliverables. The RStudio platform was utilised for model implementation, with essential packages, including tidyverse, rio, dplyr, knitr, kableExtra, and readxl, imported as needed. To streamline the analysis, filtering functions were employed to eliminate unnecessary data and focus on relevant records. The ggplot() function produced visual representations, while the Kable() function generated tables to summarise key findings.

Chapter 1

Spatial Analysis

1.1 Comparing Sub-Regions

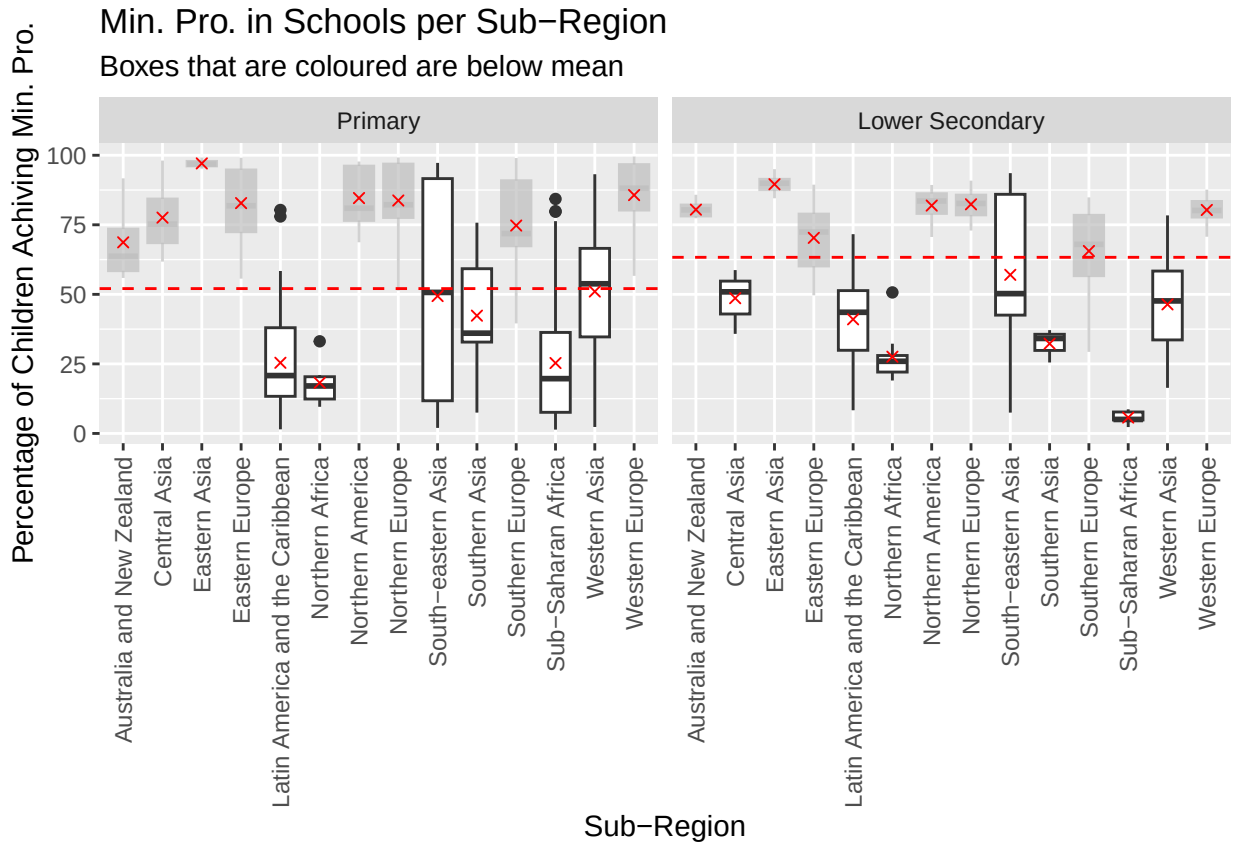

Figure 1.1: Sourced From SDG4 Global Database (Indicator 4.1.1)

Within Figure 1.1, the highlighted box plots show each Sub Region's mean being less than the mean for the overall Education Level – for clarity the red crosses are the means for each Sub Region, whilst the black points are the outliers.

Within the Primary section, outlier are shown in Latin America and the Caribbean, Northern Africa, and Sub-Saharan Africa. This aligns with the findings discussed later in Section 1.2. Additionally, South-east Asia shows an incredible spread of data, with the IQR being 61.23.

Within the Lower Secondary section, only one Sub-Region displays an outlier, being Northern Africa. Interestingly,

this outlier is still below the mean for lower secondary schools, displaying that Northern Africa is an area of concern. Additionally, South-east Asia is the only Sub-Region where the mean falls below the grand mean, but the third quartile is higher. This shows much more spread across the Sub-Region.

Whilst the Lower Secondary mean, being 63.32, is higher than the Primary's mean, being 52.07, it is important to consider the two means are not independent of another. In other words, in order to get into secondary school one must pass primary, thus the grand mean of the Primary schools would affect the mean of the Lower Secondary schools.

South-east Asia also demonstrates the most spread across the sub-regions. Contextually, this aligns with the general developmental growth of the region, and educational access within the region. For instance, Singapore is often credited of being within the top ten countries for their education system; however, other countries within the region usually fall behind (The World Top 20 Project 2025).

Table 1.1: Worst 10 countries for Indicator 4.1.2 (Completion Rate)

GeoAreaName	Continent	SubRegion	TimePeriod	Value
Côte d'Ivoire	Africa	Sub-Saharan Africa	2016	0.0
Nepal	Asia	Southern Asia	2019	0.0
Qatar	Asia	Western Asia	2012	0.0
Turks and Caicos Islands	Americas	Latin America and the Caribbean	2019	0.0
Angola	Africa	Sub-Saharan Africa	2015	1.5
Chad	Africa	Sub-Saharan Africa	2019	2.0
Malawi	Africa	Sub-Saharan Africa	2015	2.4
Madagascar	Africa	Sub-Saharan Africa	2018	2.5
Mali	Africa	Sub-Saharan Africa	2018	2.7
Rwanda	Africa	Sub-Saharan Africa	2015	3.6

1.2 Lowest Performing Countries

Using the latest available values for each country, we extracted the ten lowest performers. All ten countries fall within low-income or lower-middle-income regions, and eight of the ten are located in Sub-Saharan Africa, including Côte d'Ivoire, Angola, Malawi, Madagascar, Mali, and Rwanda. This strongly suggests that educational access continues to be highly constrained in African regions, where systemic barriers such as poverty, conflict, and limited infrastructure are well-documented.

A notable methodological limitation arises from the fact that countries have uneven reporting years. For example, Qatar's most recent observation is from 2012, whereas others have data from 2018–2019. As a result, some "low-performing" countries may have improved since their last measurement. This highlights a broader challenge in using SDG datasets for cross-country comparisons: data recency varies significantly.

1.3 Continental trends in school completion

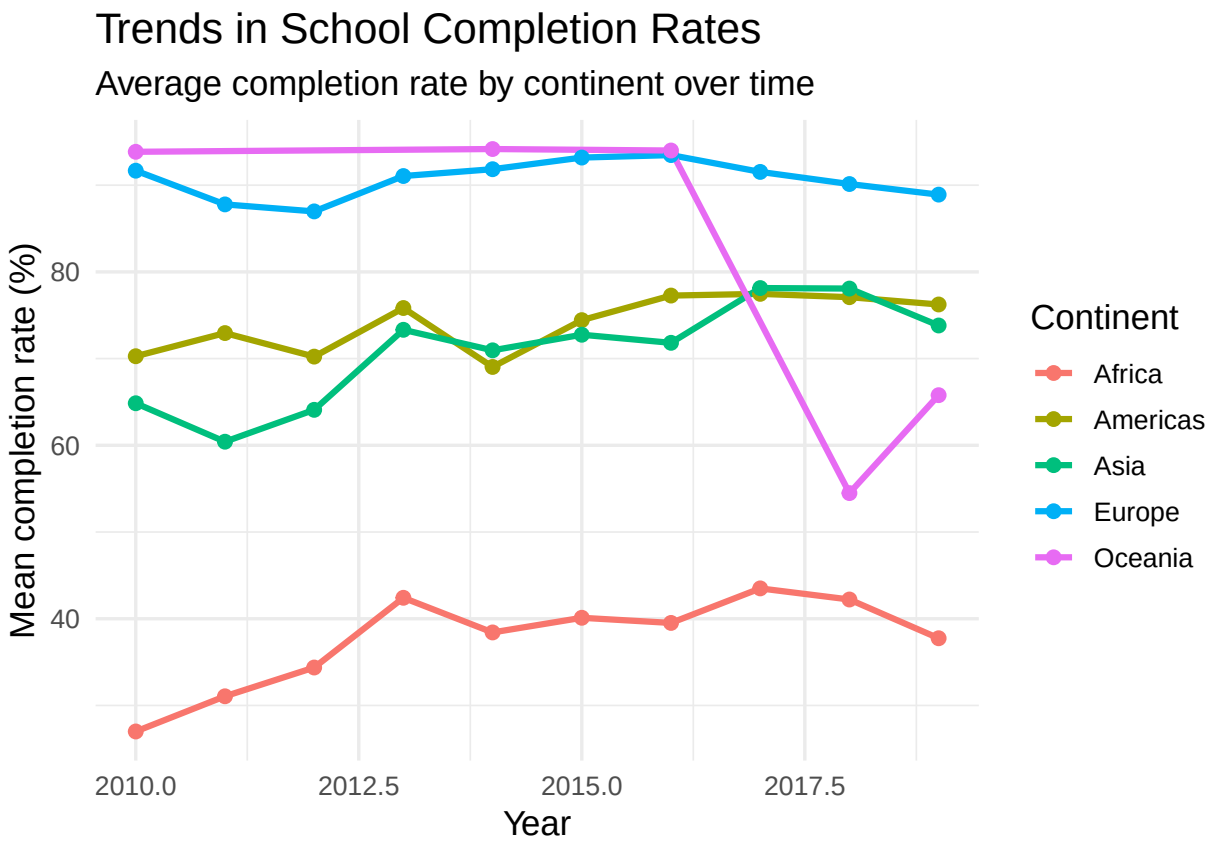

Figure 1.2: Sourced From SDG4 Global Database (Indicator 4.1,2)

To reduce noise arising from irregular reporting and to understand broader patterns, we computed average completion rates over time for each continent. The resulting plot (Figure 1.2) reveals several key insights:

Clearly, as shown previously, we notice African countries struggling with school completion rates. Not only are their school completion rates currently significantly lower than other continents, but their trend over the last 5 years does not look promising. Asia and the Americas show higher completion rates with stable increasing trends throughout the timeline. Europe reports the highest overall completion rates, with minimal variation over time and near-universal completion for primary and lower secondary education.

Oceania displays a sharp and irregular decline in completion rates, which appears misleading at first glance. This pattern could well be driven by the dominance of data from Small Island Developing States (SIDS), such as Tuvalu and Samoa, whose extremely small populations make their indicators statistically volatile. For example, despite having a population over 2,000 times smaller than Australia, Tuvalu contributes nearly half as many data points (380 vs 899). As a result, small fluctuations in enrolment or reporting can disproportionately shift regional averages.

This highlights a key limitation: regional aggregates for Oceania should be interpreted cautiously, as they are highly sensitive to small-island reporting and do not reliably reflect the trend for the region's largest country (Australia). Analysts should consider weighting by population or examining Australia separately if a stable trend is required.

1.4 Recommendation

The analysis of Indicator 4.1.1 highlights Sub-Saharan Africa as the region most in need of targeted educational interventions. Completion rates in several African sub-regions remain far below the global average, with large spreads indicating persistent inequality within the regions. Hence, the main focus of a stage two analysis should hone in on this region.

Oceania's apparent decline should be interpreted cautiously. Thus, separating SIDS from larger countries – e.g. Australia and New Zealand – in stage-two analysis to avoid misleading regional averages.

For the next analytical phase, more robust continental and sub-regional comparisons should include population-weighted averages and temporal smoothing. This would offer clearer insight into where investments would have the greatest impact.

Chapter 2

Temporal Trends

Building on the regional inequalities identified in Question 1, this section examines how key SDG4 indicators have evolved over time to assess whether progress is accelerating, stabilising, or slowing. While spatial patterns highlight where access is weakest, temporal trends reveal whether these gaps are closing or becoming increasingly entrenched. To provide this context, we analyse two indicators with consistent long-term coverage: completion rates (4.1.2) and teacher qualification (4.c.1).

2.1 Completion Rates per Education Levels

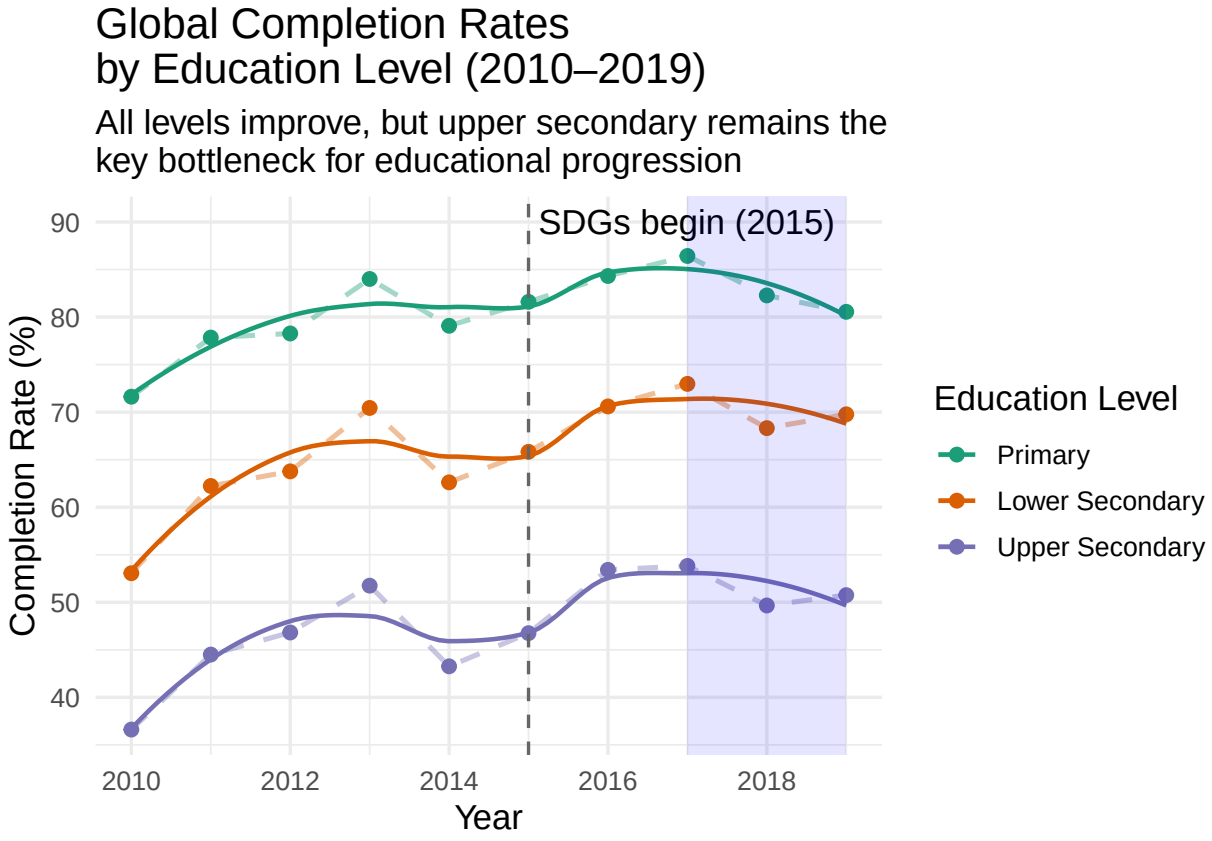

Figure 2.1: Sourced From SDG4 Global Database (Indicator 4.1.2)

Figure 2.1 presents global completion rates for primary, lower secondary and upper secondary education from 2010

to 2019. All three levels show steady improvement, with primary rising from about 72% to 80% and lower secondary from roughly 53% to 70%—the largest absolute gain. Upper secondary remains the lowest-performing stage but still increases from approximately 37% to 50%, reflecting progress at the most challenging transition point in the education pipeline.

A clear acceleration follows the introduction of SDG4 in 2015, with upper secondary showing the steepest single-year rise. This suggests early SDG-related reforms may have strengthened transitions beyond lower secondary, complementing the patterns highlighted in Question 1. However, from 2017 to 2019 all three levels display a noticeable plateau, potentially reflecting structural barriers as systems approach higher coverage or early vulnerability prior to the COVID-19 pandemic. Because upper secondary completion critically shapes tertiary access and labour-market outcomes, this persistent gap remains a strategic concern.

However, global aggregation and the smoothing line obscure substantial country-level variation, meaning sharp fluctuations and inequalities are not fully captured. Limited post-2019 data restricts assessment of COVID-19 impacts, and the absence of uncertainty intervals reduces confidence in interpreting the strength of these trends.

2.2 Qualified Primary School Teachers over Continents

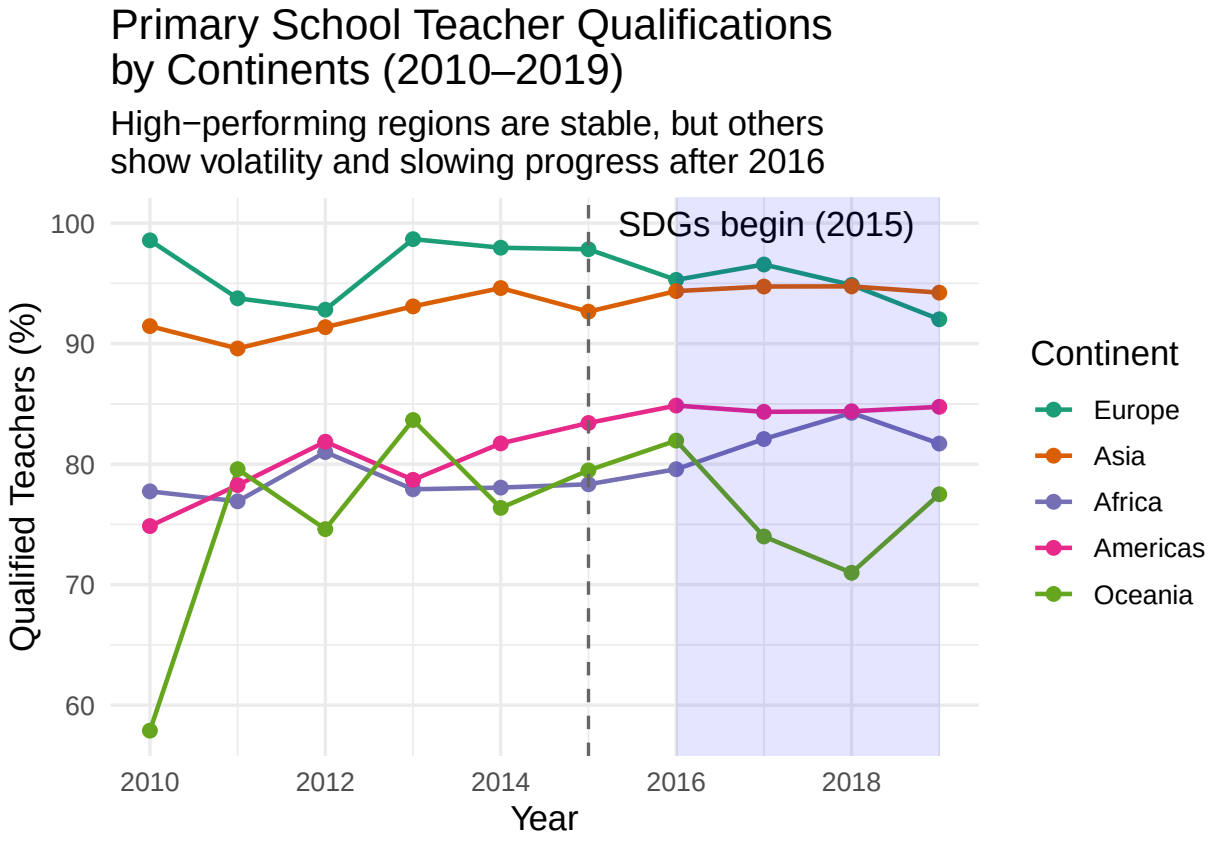

Figure 2.2: Sourced From SDG4 Global Database (Indicator 4.c.1)

Figure 2.2 examines primary teacher qualification rates across continents between 2010 and 2019. Europe and Asia maintain the highest levels, typically above 90%, while Africa and the Americas show moderate but consistent gains. Oceania exhibits sharp fluctuations—including a decline after 2016—echoing the volatility observed in its completion rates. Across most continents, progress slows after 2016, mirroring the inflection points noted in Figure 1 and emphasising the close link between a stable, well-trained workforce and sustainable expansion in educational access.

Continental averages mask significant within-region disparities, particularly in Oceania where small-island states dominate the dataset and distort regional trends—a limitation also noted in the spatial analysis. As with Figure

1, the absence of uncertainty intervals and truncated time coverage constrain interpretation of systemic workforce pressures.

Table 2.1: Annual Rates of Change for 4.1.2 and 4.c.1

Indicator	Group	Slope
Completion	Lower Secondary	1.47
Completion	Upper Secondary	1.25
Completion	Primary	0.94
Teacher Qualification	Americas	1.00
Teacher Qualification	Oceania	0.67
Teacher Qualification	Africa	0.59
Teacher Qualification	Asia	0.48
Teacher Qualification	Europe	-0.26

2.3 Slopes From Both Trends

Table 2.1 summarises the annual rates of change for both indicators. Lower secondary completion improves the fastest (slope roughly 1.47), followed by upper secondary (1.25) and primary (0.94). This suggests that although upper secondary remains the most challenging stage, its trajectory is increasingly positive. For teacher qualifications, the Americas show the strongest improvement, while Africa, Asia and Oceania grow more modestly. Europe's slight negative slope aligns with the decline observed in Figure 2, signalling that even high-performing regions face emerging challenges.

2.4 Recommendations

These temporal trends highlight several strategic priorities for the WFoundation. First, the slowdown in progress after 2016 suggests that education systems remain vulnerable to external shocks, indicating a need for investments that strengthen long-term system resilience rather than short-term gains. Second, the persistent bottleneck in upper secondary completion and the volatility observed in teacher qualification trends—particularly in parts of Africa and Oceania—point to structural constraints that require targeted, multi-year support aimed at improving both student retention and workforce stability. Third, the differing rates of progress across regions underline the importance of ensuring that future gains are equitable; without focused action, global disparities risk widening rather than narrowing. Finally, the strong alignment between shifts in completion rates and teacher qualification signals that interventions should be coordinated across indicators, emphasising integrated strategies that simultaneously enhance teaching capacity, learning environments and pathways through the education system.

Overall, integrating the spatial disparities from Question 1 with these temporal patterns shows that although global education outcomes are improving, progress is uneven and increasingly fragile. Understanding why these disparities persist—and how factors such as wealth, gender and location shape them—provides the essential next step. Question 3 explores these underlying inequalities in greater depth to inform where targeted interventions can be most effective.

Chapter 3

Disparities Within Educational Access

3.1 Wage

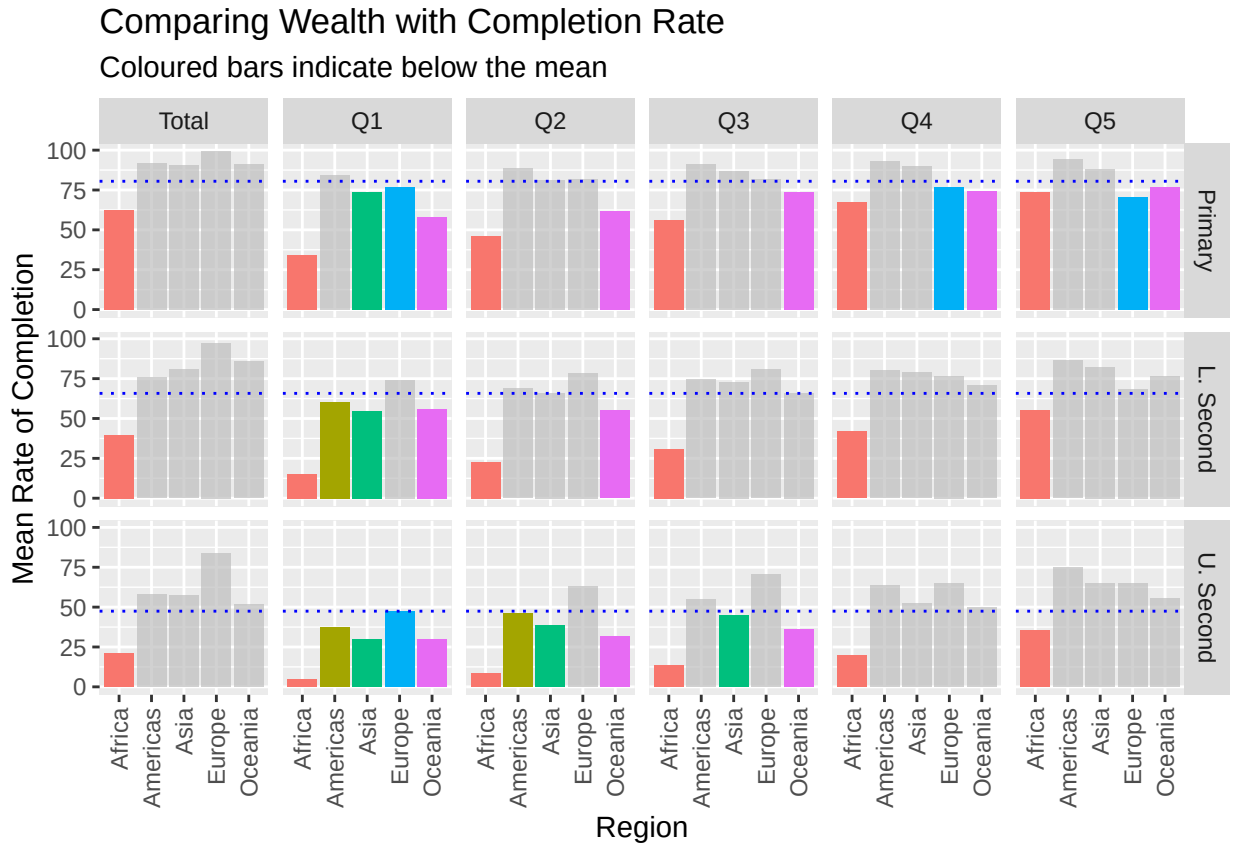

Figure 3.1: Sourced From SDG4 Global Database (Indicator 4.1,2)

In Figure 3.1, blue dotted lines mark the global means for Primary (80), Lower Secondary (66), and Upper Secondary (47) education. Coloured bars indicate continents performing below these means.

Africa consistently falls below the mean across all wealth quantiles and education levels. Notably, in Primary education, the wealthiest and poorest quantiles show similar regional trends – this is the only instance where this occurs. For Secondary levels, only Africa remains below the mean in the wealthiest quantiles (Q4–Q5), whereas nearly all regions (excluding Europe in Lower Secondary) fall below it in the poorest. Oceania generally trails the mean in Q1–Q3, though for Primary schooling, it is below average in all quantiles.

When looking across the different wealth quantiles, it is important to account for multiple things; for instance, when looking at the different education levels they are not independent of another. Education levels are sequential; lower completion rates at higher levels reflect the requirement to pass previous stages

Another factor is informal education, defined by Weinland (2023) as "learning about cultural values, norms, and expected behaviours by participating in a society", this affects the quantiles as when a child engages within their respective culture they may find a shift away from education towards something more culturally important – e.g. working within the family farm, supporting their parents or grandparents, etc.

Finally, Figure 3.1 is not a perfect representation of the wealth, as it only captures the mean rate of completion. One cannot see the spread of information or outliers which may affect the mean, thus changing the information of the plot; however, this may be accounted for using weighted means instead.

3.2 Gender Parity Analysis

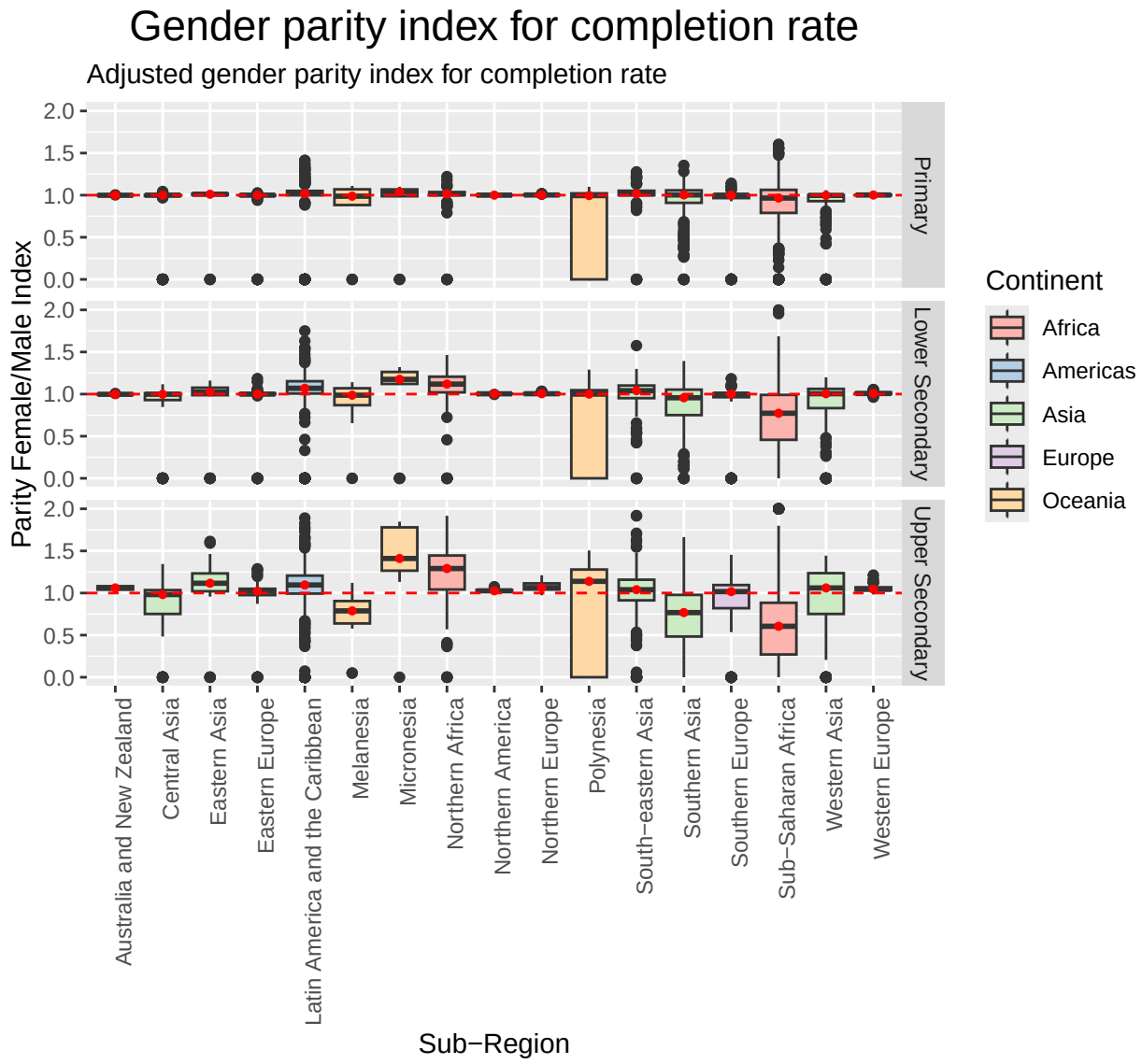

Figure 3.2: Sourced From SDG4 Global Database (Indicator 4.5.1)

Figure 3.2 illustrates the Gender Parity Index (GPI), where a red dashed line at 1 represents equality and red points denote median completion rates.

In Oceania, Melanesia maintains parity in primary and lower secondary education but shifts to favour males in upper secondary. Micronesia consistently favours females, while Polynesia – despite a wide range of values – also shows a median preference for females across all levels. African sub-regions exhibit contrasting trends: Northern Africa increasingly favours females as education levels rise, whereas Sub-Saharan Africa sees a steady decline in parity at higher levels. This is explained further in section 1.

Table 3.1: Location parity index (Rural/Urban) for education completion rate

GDB indincator 4.5.1				
Education level	Continent	Median	Mean	IQR (Q1-Q3)
Primary	Africa	0.74	0.64	0.4 - 0.95
	Americas	0.97	0.78	0.85 - 1.01
	Asia	0.99	0.83	0.86 - 1.01
	Europe	1.00	0.70	0 - 1
	Oceania	0.72	0.51	0 - 1
Lower Secondary	Africa	0.55	0.53	0.15 - 0.85
	Americas	0.84	0.69	0.5 - 0.98
	Asia	0.95	0.77	0.62 - 1.02
	Europe	0.99	0.73	0 - 1
	Oceania	0.00	0.48	0 - 0.97
Upper Secondary	Africa	0.35	0.50	0 - 0.83
	Americas	0.71	0.64	0.39 - 0.95
	Asia	0.83	0.73	0.43 - 1.02
	Europe	0.92	0.69	0 - 1
	Oceania	0.33	0.46	0 - 0.89

3.3 Location Parity Analysis

Similar to Figure 3.2, Table 3.1 presents the Location Parity Index, where a value of 1 represents rural-urban equality. Darker cell shading indicates greater deviation from this threshold

Africa and Oceania demonstrate a consistent urban advantage across all education levels, with rural completion rates dropping further as education levels rise. In contrast, the Americas and Asia show a mixed distribution: roughly half the regions achieve parity – with medians near 1 – while the other half favour urban areas. Europe follows a similar split pattern; however, the group failing to reach parity is characterized by notably lower means and wider IQRs, indicating significant inequality within those specific regions.

3.4 Recommendations

Through the analysis of wealth, gender, and location disparities Africa consistently lags behind other regions. Consequently, looking towards including a thorough audit of educational resources and the implementation of specific equality strategies within Northern and Sub-Saharan Africa. Furthermore, rural areas require targeted training to strengthen learning environments. Disparities are also evident in Oceania. In Polynesia, mentorship and community awareness initiatives are recommended to address declines in female enrolment. Finally, broad investment in rural infrastructure – specifically transportation and digital tools – is essential to improve educational access.

Chapter 4

Poverty and Gender Inequality: Alignment with the Sustainable Development Goals

4.1 Poverty in Relation to SDG 1

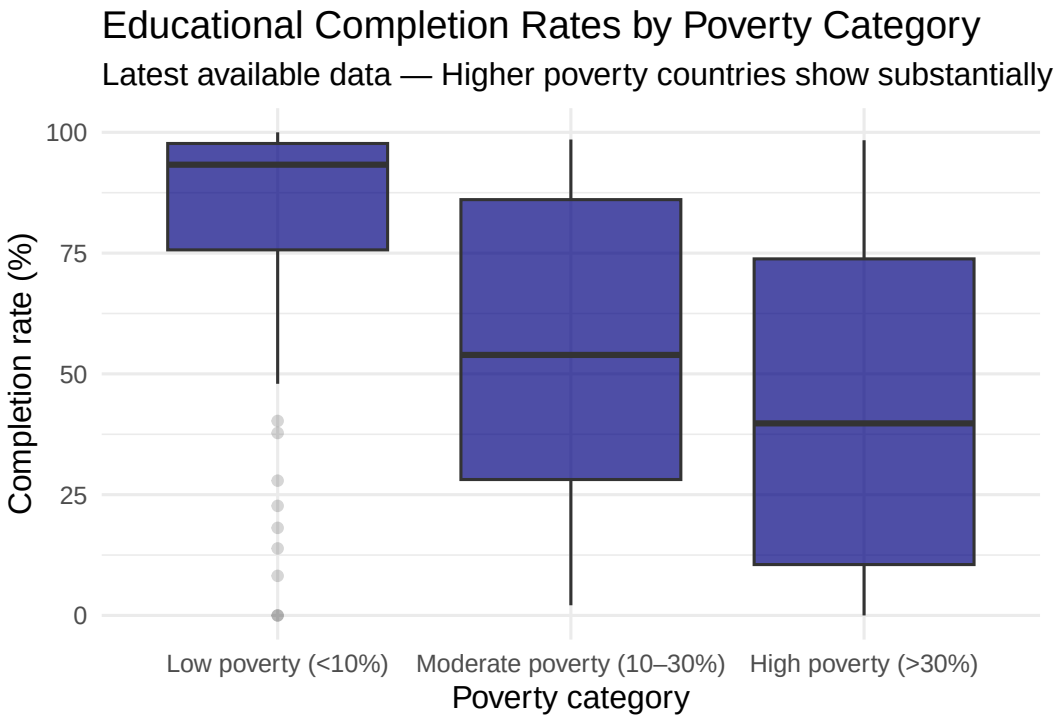

Figure 4.1: Sourced From SDG4 Global Database (Indicators 1.1.1 and 4.1.2) based on a joint database of SDG1 and SDG4 databases

Figure 4.1 illustrates the relationship between national poverty levels (SDG 1.1.1: proportion of population below the international poverty line) and school completion rates (SDG 4.1.2). The pattern is clear: higher poverty is strongly associated with lower educational completion.

Low-poverty countries (<10%):

Display the highest completion rates, typically between 85–100%, with very little variation. This suggests that once

extreme poverty is minimised, education systems tend to operate with stable, near-universal completion.

Moderate-poverty countries (10–30%):

Show significantly more variation, with completion rates ranging from 30% to 90%. The wide spread indicates inconsistent education performance despite similar poverty levels—reflecting differences in governance, conflict, rural access, and policy investment.

Finally, high-poverty countries (>30%):

Exhibit the lowest median completion rates, often below 50%, and include many observations near zero. This highlights a cycle where extreme poverty directly suppresses school participation, especially in regions affected by food insecurity, child labour, and limited infrastructure.

Overall, these results provide evidence of a strong and systematic linkage between SDG 1 (poverty reduction) and SDG 4 (quality education). Countries struggling with high poverty are disproportionately unable to sustain educational progress, reinforcing the idea that SDG targets cannot be pursued in isolation.

4.1.1 Recommendations

Stage two analysis should incorporate longitudinal analysis to assess whether improvements in poverty translate into educational gains. We would also recommend looking into joint modelling of poverty, gender, and location to address SDGs 1, 4, and 5 together for a strong stage 2 analysis.

4.2 Gender Inequality in Relation to SDG 5

Sustainable Development Goal 5 (SDG 5) explicitly addresses gender equality and emphasizes the inequalities faced by women. For instance, target 5.3 identifies barriers that limit women's educational opportunities. These barriers can impact SDG 4, which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

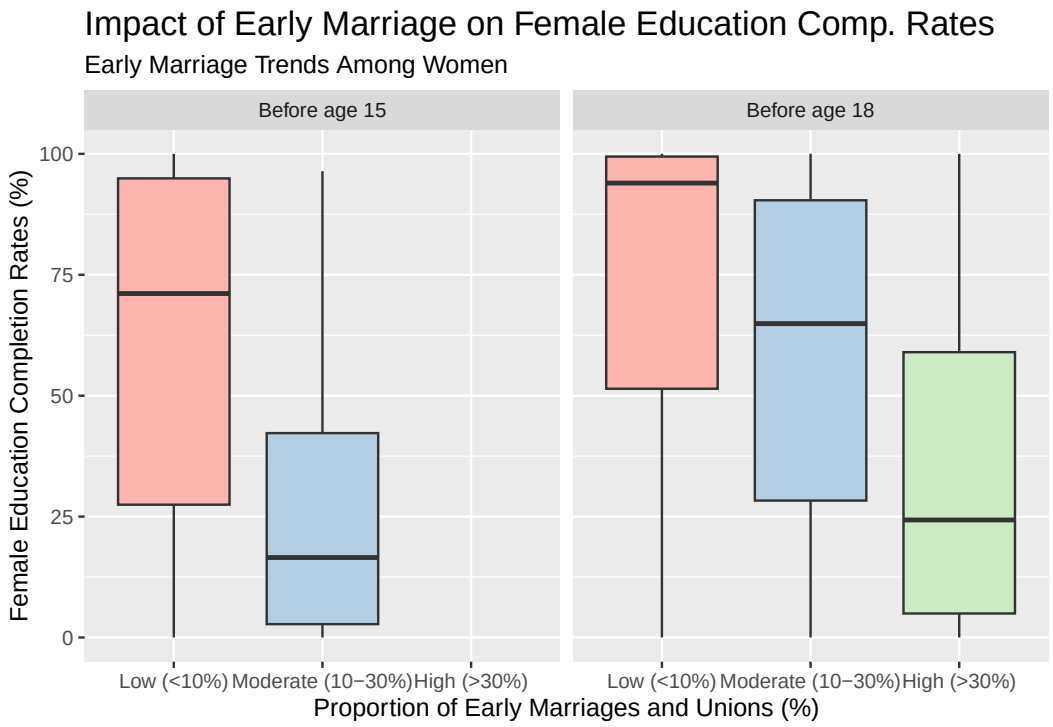

Figure 4.2: Sourced From SDG4 Global Database (Indicator 4.1.2 and 5.3.1) based on a joint database of SDG4 and SDG5 databases

Figure 4.2 illustrates the relationship between educational completion rates (Indicator 4.1.2) and early marriage (Indicator 5.3.1). The data reveals a clear negative trend: as early marriage rates increase, educational completion significantly decreases for both age groups. While the range of completion rates varies, the median values confirm that early marriage acts as a barrier to educational attainment, reinforcing gender inequality in outcomes.

This visual trend is supported by literature. Postponing marriage by a single year is associated with an increase in schooling attainment of nearly 0.5 years in Sub-Saharan Africa and approximately 0.33 years in South-West Asia (Delprato et al. 2015). Furthermore, delaying marriage improves educational perseverance, reducing the likelihood of secondary school drop-out by approximately 5.5%. This confirms that later marriage contributes to both higher attainment and greater academic stability.

In terms of specific age demographics, the rate of marriage for those under 15 does not exceed 30%. Comparing the two groups reveals that women married between ages 15 and 18 demonstrate substantially better completion rates—evident in both the median and box range—than those married by age 15. (Note that the under-18 dataset cumulatively includes those married by age 15).

Finally, a key limitation of this plot is its exclusive focus on female data. The absence of equivalent information on early-married men prevents a comparative analysis, leaving a gap in our understanding of how early marriage differentially affects educational attainment across genders.

4.2.1 Recommendations

- Provide support for young married women by ensuring access to nursery facilities, mentorship initiatives, a supportive community, and specialized supervision.

- Conduct further research on young married men and analyze the impact of marriage on their educational status, comparing this data with that of early married women.

Addressing the challenges faced by young married women alongside poverty in lower-income countries is essential for promoting gender equality and educational outcomes. This approach can create a more equitable and inclusive educational environment.

Conclusion

The findings across all sections indicate that the WFoundation should prioritise strengthening upper secondary progression, improving teacher workforce stability, and expanding access for disadvantaged groups across wealth, gender and rural–urban divides. A second phase of analysis should incorporate additional SDG4 indicators—such as literacy and numeracy skills (4.6.1) and basic school services (4.a.1)—and explore country-level variation to better diagnose barriers to learning quality. Forecasting methods could further assess whether current trajectories align with SDG4 targets, requiring well-developed computational resources and around 30–40 hours of analysing. Together, these steps will support more targeted and resilient long-term intervention planning.

(3362)

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