ST344 - Group ROC Report

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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 sub-regional 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

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. 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 weighted mean values (segregated by educational level, supregion, and quantile) 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.

Data

Through the data United Nations (2023) provided, the report was generated by looking through the SDG goals pertaining to the issues at hand, in particular SDG goals number four, five, and one. This was filtered by indicators 4.1 through 4.5. These indicators are further analysed within the report, but the data that coincide with them represents each countries reported proportion, rate, or parity ratio – with each unit dependant on the SDG goal.

In order to conduct analysis for the organisation's targets, data cleaning was required. This was done via R, a statistical coding language, to not only change the format of the data from a Microsoft Excel document to something more analysable within R, but also to select variables which were needed. Through the use of the `dplyr` package through the `tidyverse` suite, the data was cleaned by selecting the variables deemed needed for analysis, and transforming such variables into their appropriate classes. 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.

Chapter 1

Spaical analysis

1.1 Comparing Sub-Regions

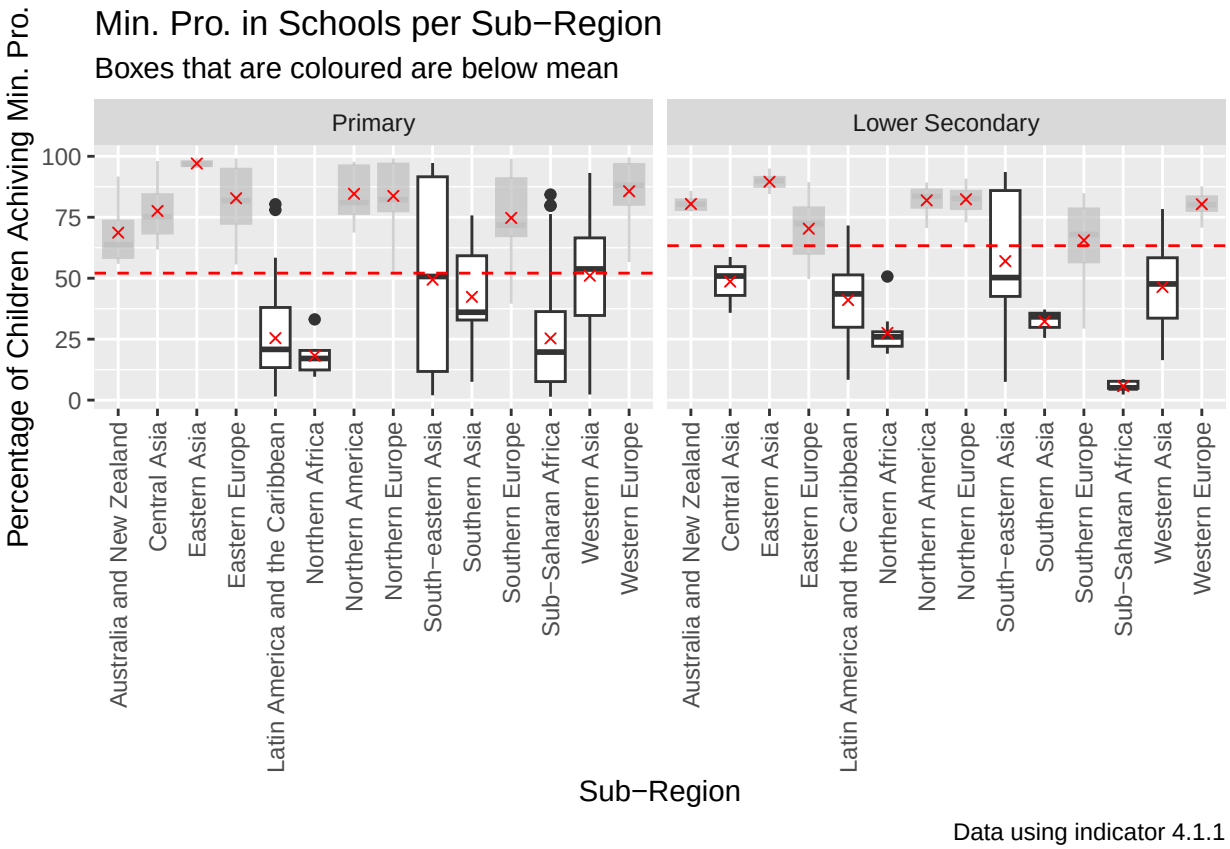

Figure 1.1:

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 well with Lowest Preforming Countries talked later in the report. 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 Preforming Countries

This analysis examines global variation in educational access using several SDG 4 indicators, with a primary focus on Indicator 4.1.2 (completion rate across primary, lower secondary, and upper secondary levels). By extracting the most recent available data for each country, we identify those lagging furthest behind and assess how completion rates differ across continents. The findings highlight persistent regional inequalities and reveal where progress has been slow or stagnant.

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.

Now, looking at each continents development from their earliest datapoint to their most recent:

1.3 Continental trends in school completion

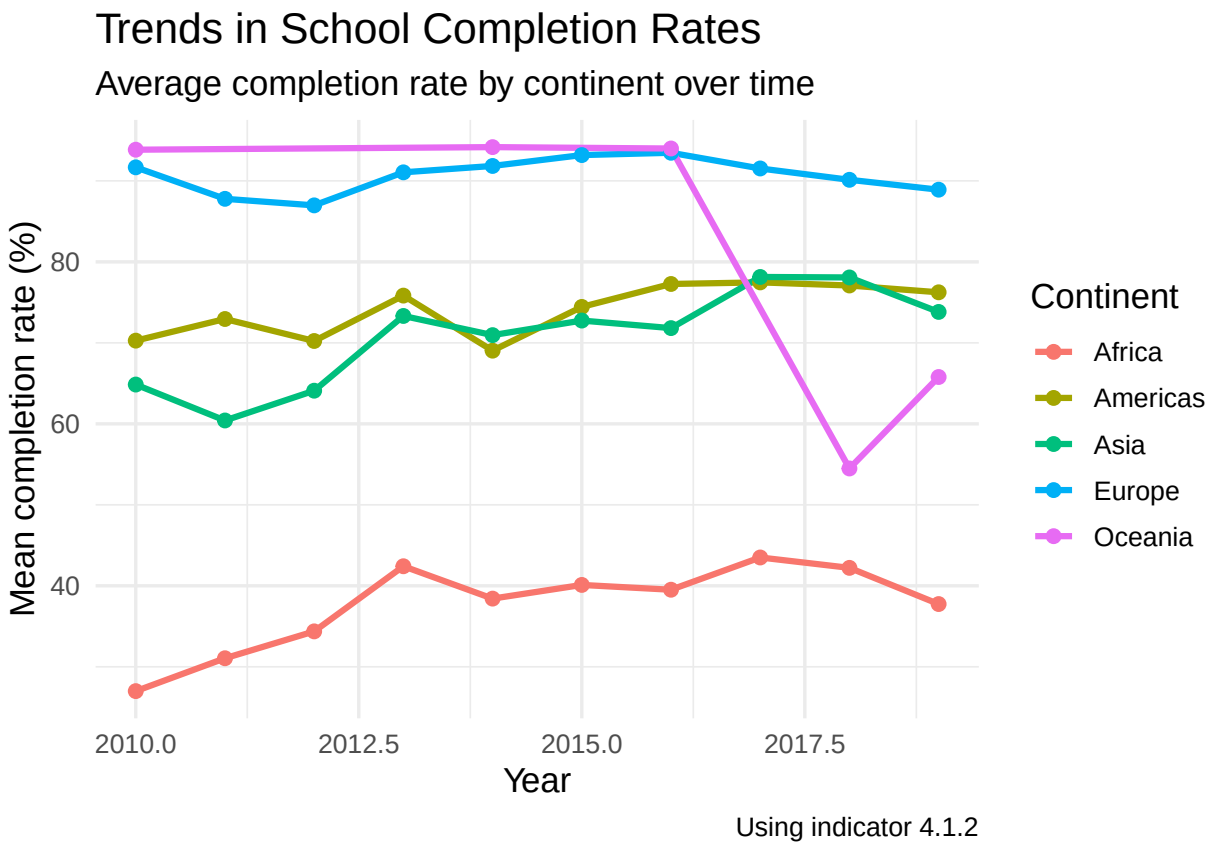

Figure 1.2:

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

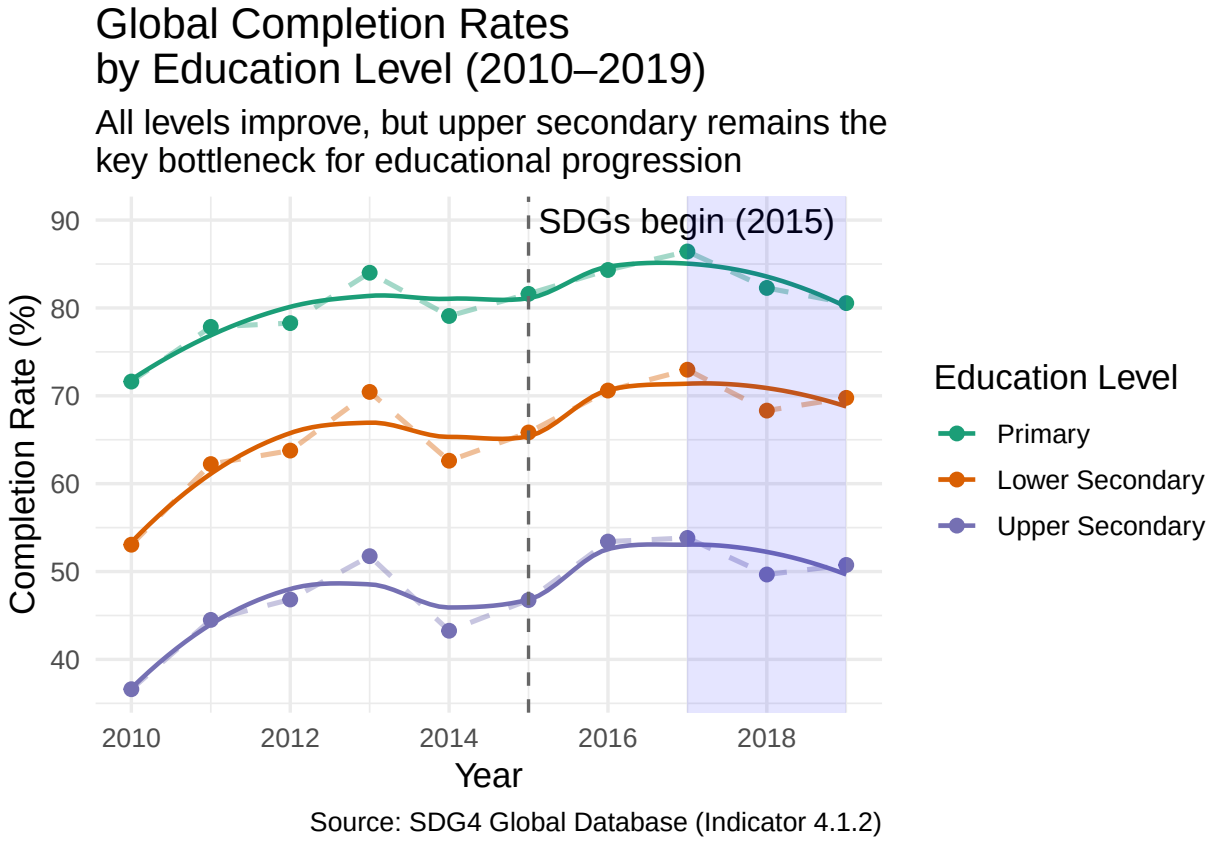

Figure 2.1:

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

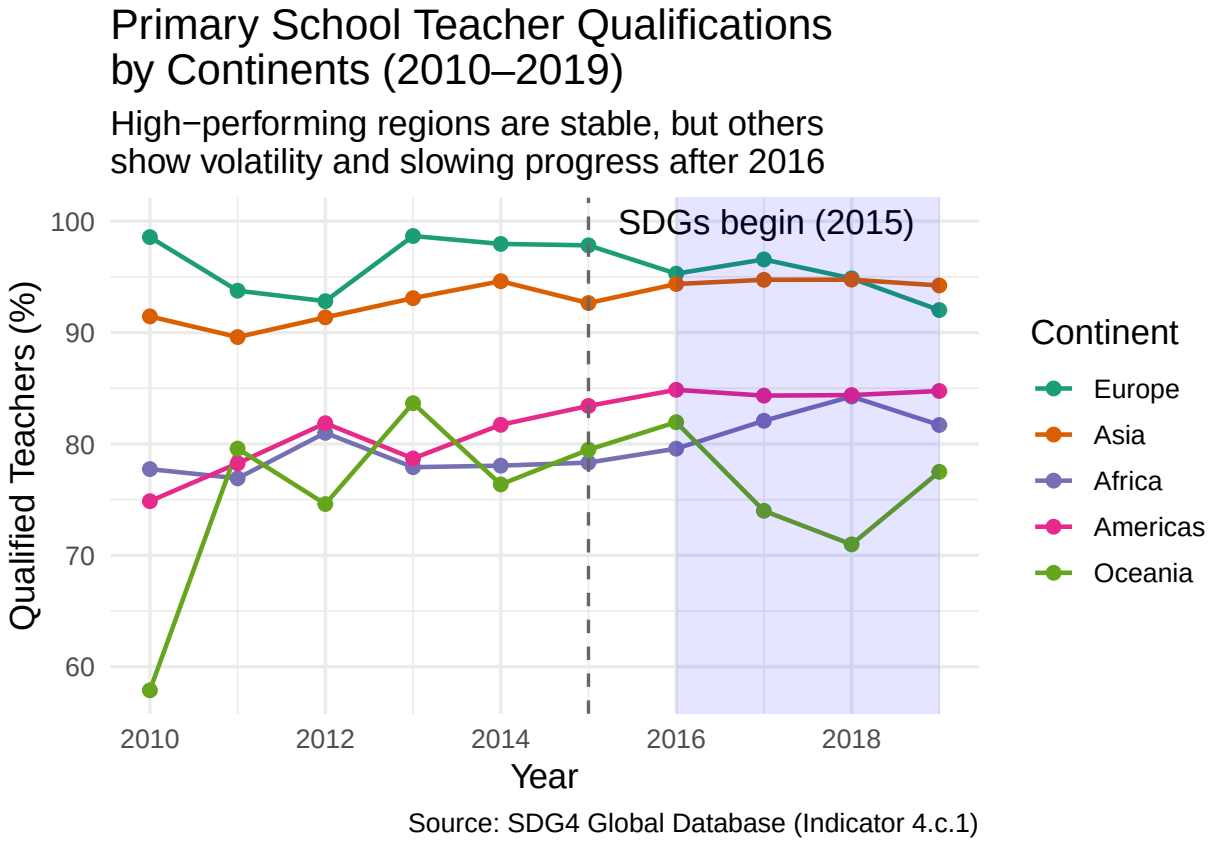

Figure 2.2:

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

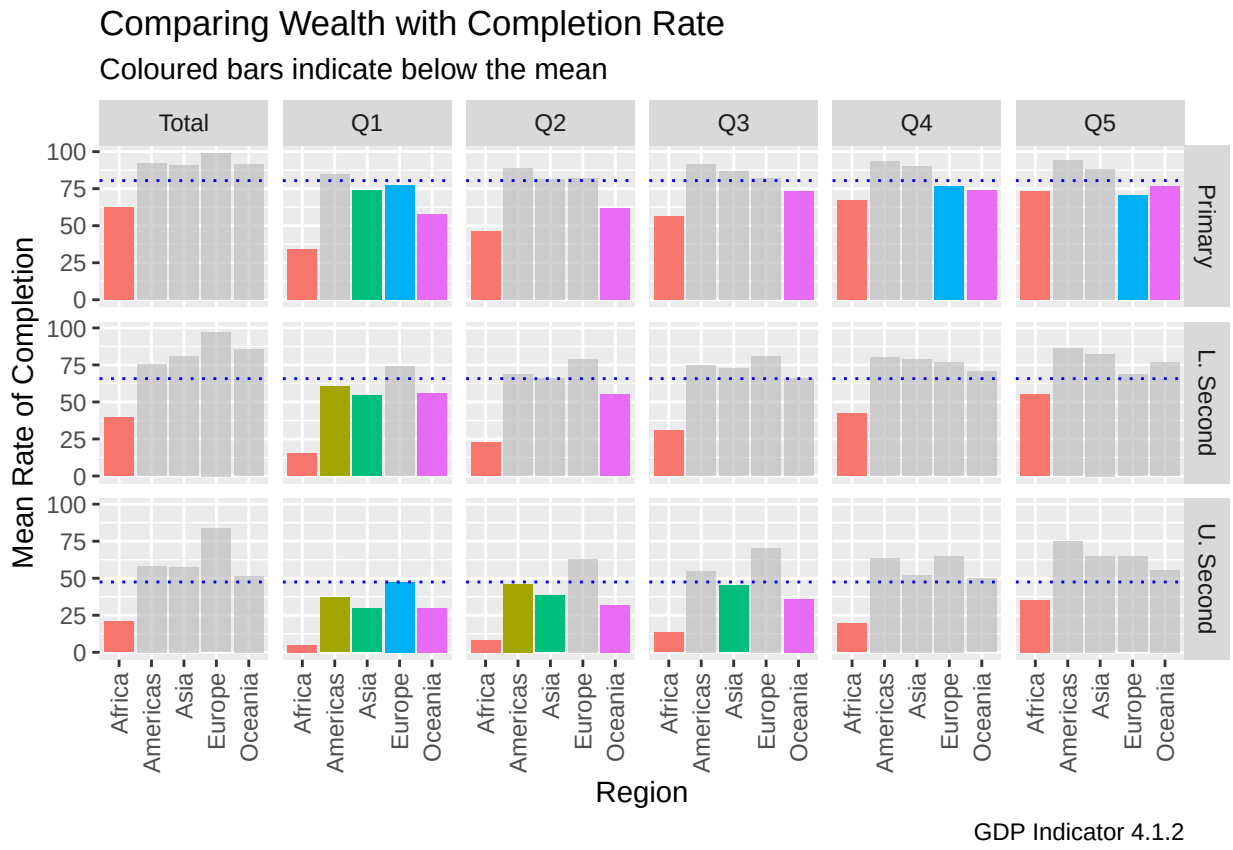

Figure 3.1:

Within the Figure 3.1, the blue dotted lines are the mean for the level of education, i.e. for primary, lower secondary, and upper secondary. Furthermore, when a bar is coloured this indicates that the region's mean is below the mean of the education level. The means for each the primary, lower secondary and upper secondary are 80, 66, and 47, respectively.

When comparing the coloured bars, Africa noticeably is is under the mean is all wealth quantiles, and all education levels. Comparing the wealthiest quantile to the poorest quantile, in primary education all three countries in the wealthiest quantile also show in the poorest quantile. Interestingly, this is the only instant where this happens.

When looking at the two different secondary levels, in both wealthiest quantiles – Q5 and Q4 – only Africa is below the mean; however, when comparing that to the poorest quantile, nearly all regions show – bar Europe in the lower secondary category.

In addition, Oceania is often under the mean in the Q1-Q3 range, with the exception of Primary Schooling whereby it is under the average for 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. In order to progress to from Primary to Lower Secondary, you must complete and pass Primary education, the same goes for Upper Secondary with lower secondary. This is shown in the data with the lower rates of completion as the education level increases.

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, this plot is not a perfect representation of the wealth between the regions, 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

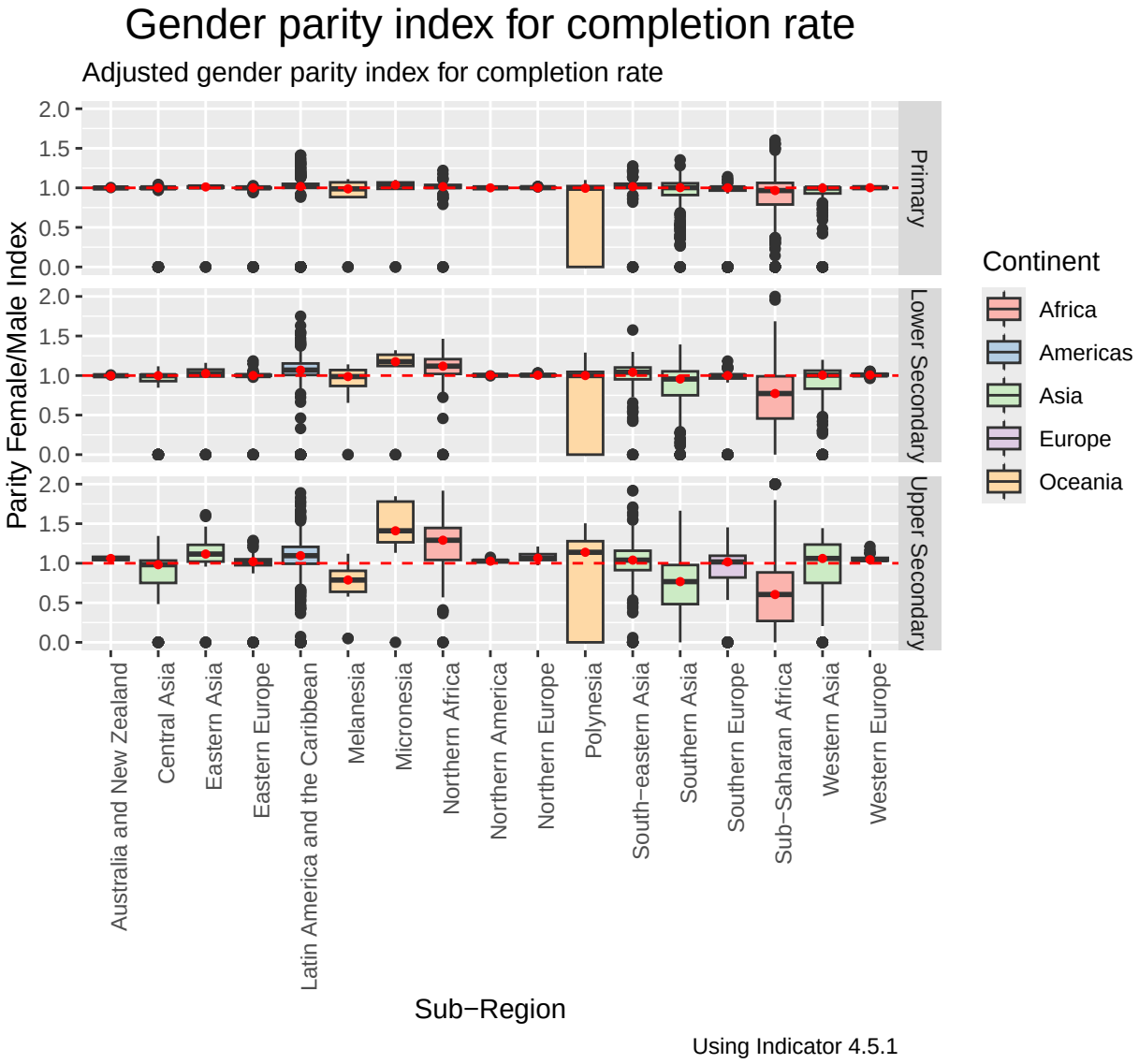

Figure 3.2:

Figure 3.2 analyses the gender parity index for education completion rates across various continents and sub-regions. The key focus is on a red-dashed threshold line representing equality at a value of 1, indicating that female and male completion rates are equal. Each education level's median completion rates are highlighted by a red point, with box plots colour-coded by continent to trace patterns.

In Oceania, distinct trends emerge among its sub-regions. Melanesia reaches gender parity in primary and lower secondary education, with medians positioned at the equality point. This indicates that the genders are similarly distributed across these regions. However, this trend shifts when Melanesia displays a decline in favour of males in higher education. Conversely, Micronesia starts with a slight median advantage for females and has steadily maintained this preference. Moreover, Despite Polynesia having a large range of gender parities, the analysis reveals that more than half of these participants have a gender parity index, based on median values, indicating a preference for females in all education levels.

In Africa, Northern Africa and Sub-Saharan Africa exhibit contrasting trends. The data indicates that Northern Africa shows an increasing favourability toward females as education levels rise, while Sub-Saharan Africa displays trends in the opposite direction, reflecting a decline in gender parity. This analysis underscores varying patterns of

gender equality in educational attainment across different regions.

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

Table 3.1 above displays the location parity index for completion rates across various education levels and continents. The main focus is on a threshold of equality set at 1, which indicates the point at which rural and urban educational completion rates are equal. For this analysis, the median, mean, and interquartile range (IQR) of completion rates for each education level were measured. The highlighted cells become darker as they deviate from the value of 1.

In Africa and Oceania, a clear trend emerges where participants generally demonstrate lower location parity, showing a strong preference for urban areas across all education levels. This results in lower completion rates in rural areas as educational levels increase. In contrast, the Americas and Asia present a more mixed situation: about half of the participants achieve parity in completion rates, with the parity threshold aligned around the median and within the IQR. However, the other half still exhibits a preference for urban education access.

Europe presents a unique case. Approximately half of the participants achieve equal completion rates, as indicated by the median values, but the other half consistently favors urban education. This is evidenced by both lower means and wider IQRs. Overall, these patterns indicate varying levels of educational equity across different regions and education levels.

3.4 Recommendations

When looking at the disparities between the wage, gender, and location, all three indicate that Africa usually lacks behind. This leads to a recommendation of a more thorough analysis of educational resources within the region, and programmes within Northern-Africa and Sub-Saharan Africa to identify effective strategies in enhancing gender and wealth equality. Additionally, look for more targeted training within the rural areas of Africa to better strengthen the learning environment.

Apart from Africa, disparities in wage, gender, and location also show up in Oceania. Thus, programmes to address the decline in female enrolment in all levels in Polynesia may be beneficial – some examples include mentorship initiatives and community awareness efforts aimed at empowering girls towards education. Finally, look to investments of resources to enhance educational access in rural areas, such as: transportation options for students, digital tools for online learning, etc.

Chapter 4

Poverty and Gender Inequality: Alignment with the Sustainable Development Goals

Tackling gender and poverty inequalities is crucial for promoting equity and improving educational outcomes, leading to a more inclusive and fair society.

4.1 Poverty in Relation to SDG 1

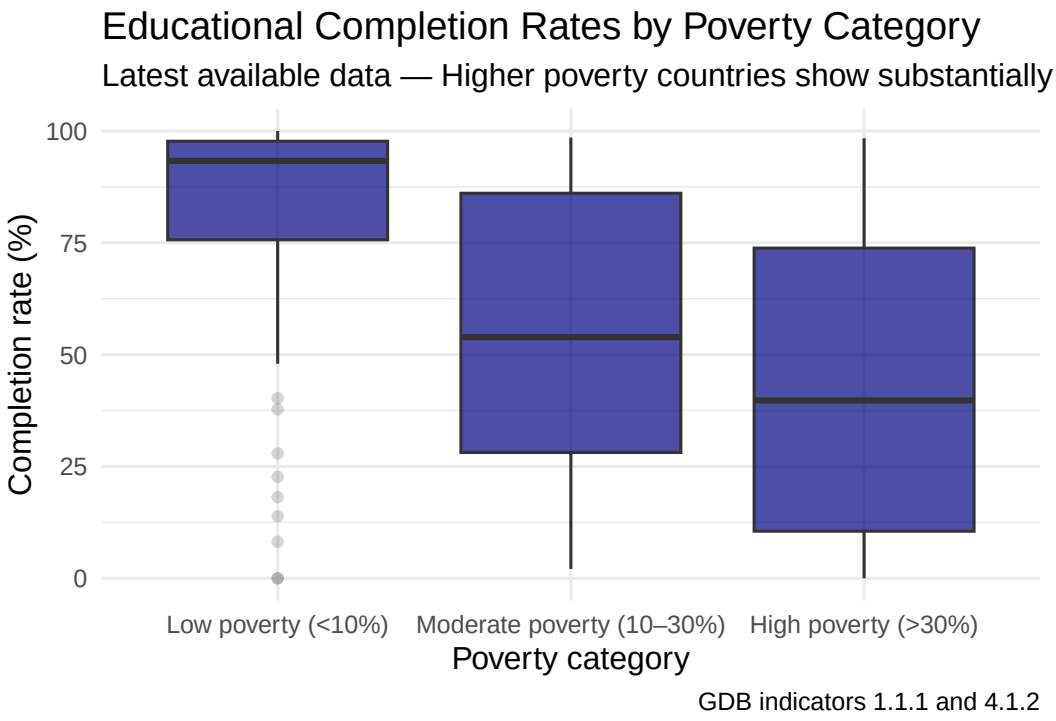

Figure 4.1:

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.

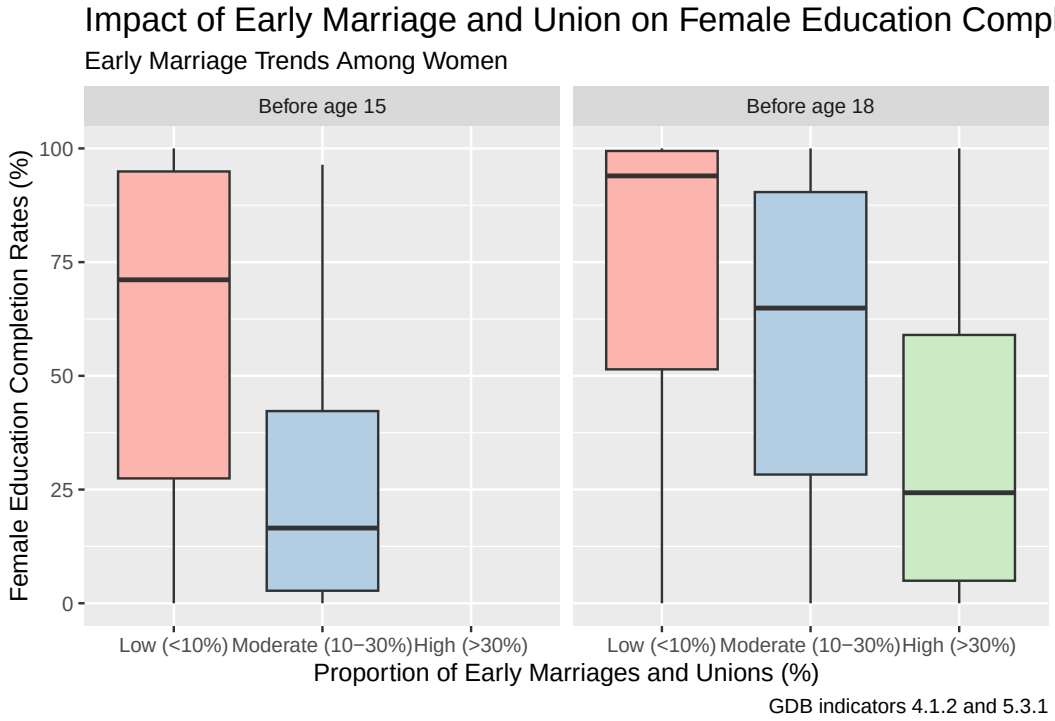

Figure 4.2:

Figure 4.2 illustrates the completion rates (indicator 4.1.2) for women who were married or in a union before the ages of 15 and 18 (indicator 5.3.1). In this analysis, the median serves as the comparison measure. The plot indicates that, as the rates of early marriage increase, the completion rate significantly decreases for both age groups. Although there is a wide range of completion rates for each age group, this trend suggests that women's educational attainment is negatively affected by their marital status, highlighting a factor that supports gender inequality in educational outcomes.

Postponing marriage by a single year is associated with an increase of nearly 0.5 years in schooling attainment in Sub-Saharan Africa (Delprato et al. 2015). Similarly, in South-West Asia, the increase is approximately 0.33 years. Furthermore, delaying marriage has a positive impact on educational perseverance, reducing the likelihood of students dropping out of secondary school by approximately 5.5%. This suggests that later marriages can contribute to higher educational attainment and greater stability in academic pursuits.

Upon closely examining the plot, it is evident that the early marriage rate for women married at age 15 or younger does not exceed 30%. Additionally, comparing the completion rates across different early marriage age ranges reveals that women married between the ages of 15 and 18 demonstrate a substantial improvement in their educational completion rates compared to those married at age 15 or younger. This improvement is evident in both the box range and median of completion rates for low and moderate early marriage rates, which increased from age 15 to age 18. It is important to note that data for women married at age 15 or younger are included in the data for those married at age 18 or younger.

Furthermore, the figure presents data collected exclusively from females, focusing on factors affecting their education. Importantly, data on early-married men is not available, highlighting a gap in the analysis. To enhance our understanding, it would be beneficial to compare the available information on early-married women with other relevant data. This comparison could reveal significant insights and highlight any disparities between 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

This report has shown that progress toward SDG4 remains highly uneven, shaped by regional disparities, structural constraints, and wider social conditions. Spatial analysis highlighted Sub-Saharan Africa and parts of Oceania as the weakest performers, while temporal trends revealed a slowing of progress after 2017, particularly in completion and teacher qualification rates. Disparity analysis demonstrated widening wealth, gender and rural–urban gaps at higher education levels, and the cross-SDG investigation confirmed that poverty and early marriage continue to suppress educational outcomes. These findings suggest that the WFoundation should prioritise strengthening upper secondary progression, improving teacher workforce stability, and expanding access for disadvantaged groups. A further phase of analysis should examine country-level variation and integrate additional SDG4 indicators—such as literacy and numeracy skills (4.6.1) and access to essential school services (4.a.1)—to better understand barriers to learning quality. Incorporating forecasting methods would also help assess whether current trajectories align with SDG4 targets. Overall, the report provides a coherent evidence base to guide targeted, resilient and long-term interventions in global education.

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