From Education to Well-Being

Analyzing the Impact of Education on Key Development Indicators

A Data-Driven Project presented by Valerio Quaranta

Project Objective

Evaluating the Impact of Education

The objective of this project is to explore the relationships between **education**, **economic development**, and **health** outcomes using World Bank data. By integrating multiple indicators across countries and over time, the analysis aims to identify structural patterns, long-term trends, and key leverage points where educational policies may contribute to broader socio-economic and demographic improvements.

Methodology

Analyzing Education's Impact on Development

The study combines multiple **World Bank datasets** covering education, economic, and health indicators from 2000 to 2023. After data cleaning and harmonization, the datasets are merged into a unified panel structure. Missing values are addressed through linear interpolation followed by forward and backward filling. The analysis relies on descriptive statistics, correlation analysis, and visual exploration to support an interpretable, data-driven assessment of cross-domain relationships.

Dataset Core: **EdStats**

Dataset Integrativi: **GDP per cap, Infant Mortality, Life Expectancy**

Countries Analyzed

Comparing Advanced and Emerging Economies

Italy

Australia

Germany

USA

Canada

China

India

Brasil

South Africa

Kenya

Characteristic

Established education systems, high public spending, service-based economies.

Rapid expansion of schooling, structural challenges, demographic growth.

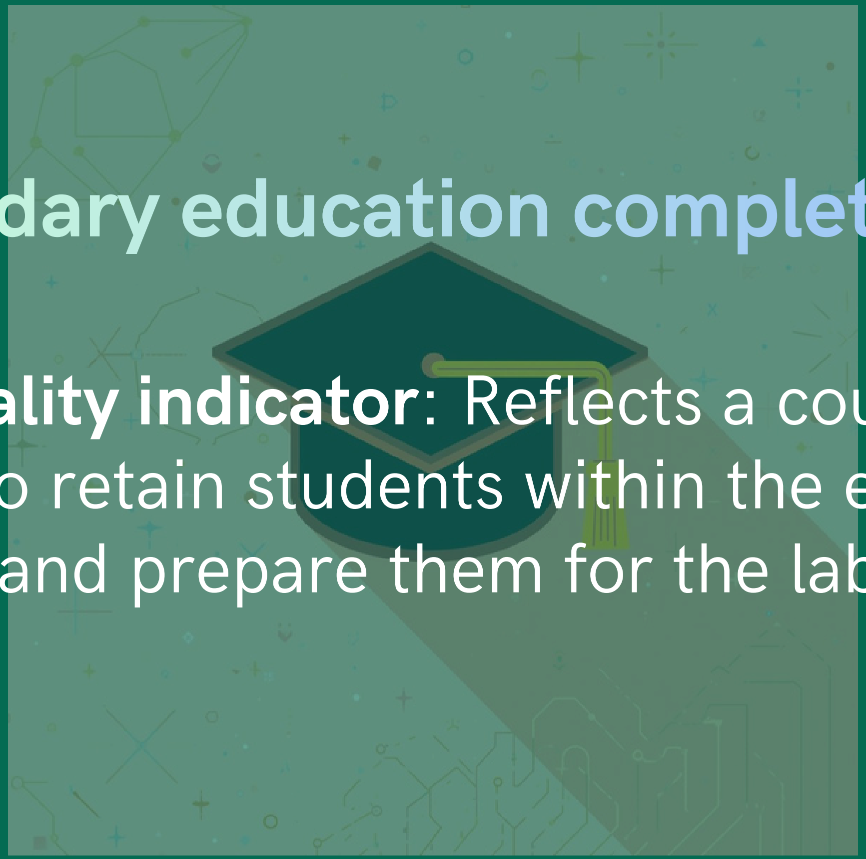
A heterogeneous sample representing diverse regional contexts to identify successful models that can be replicated at a global level.

Key Indicators

Essential Metrics for Education

Primary school enrollment rate

The starting point: Measures basic access to education and the system’s capacity to accommodate new generations.



Secondary education completion rate

The quality indicator: Reflects a country’s ability to retain students within the education system and prepare them for the labor market.

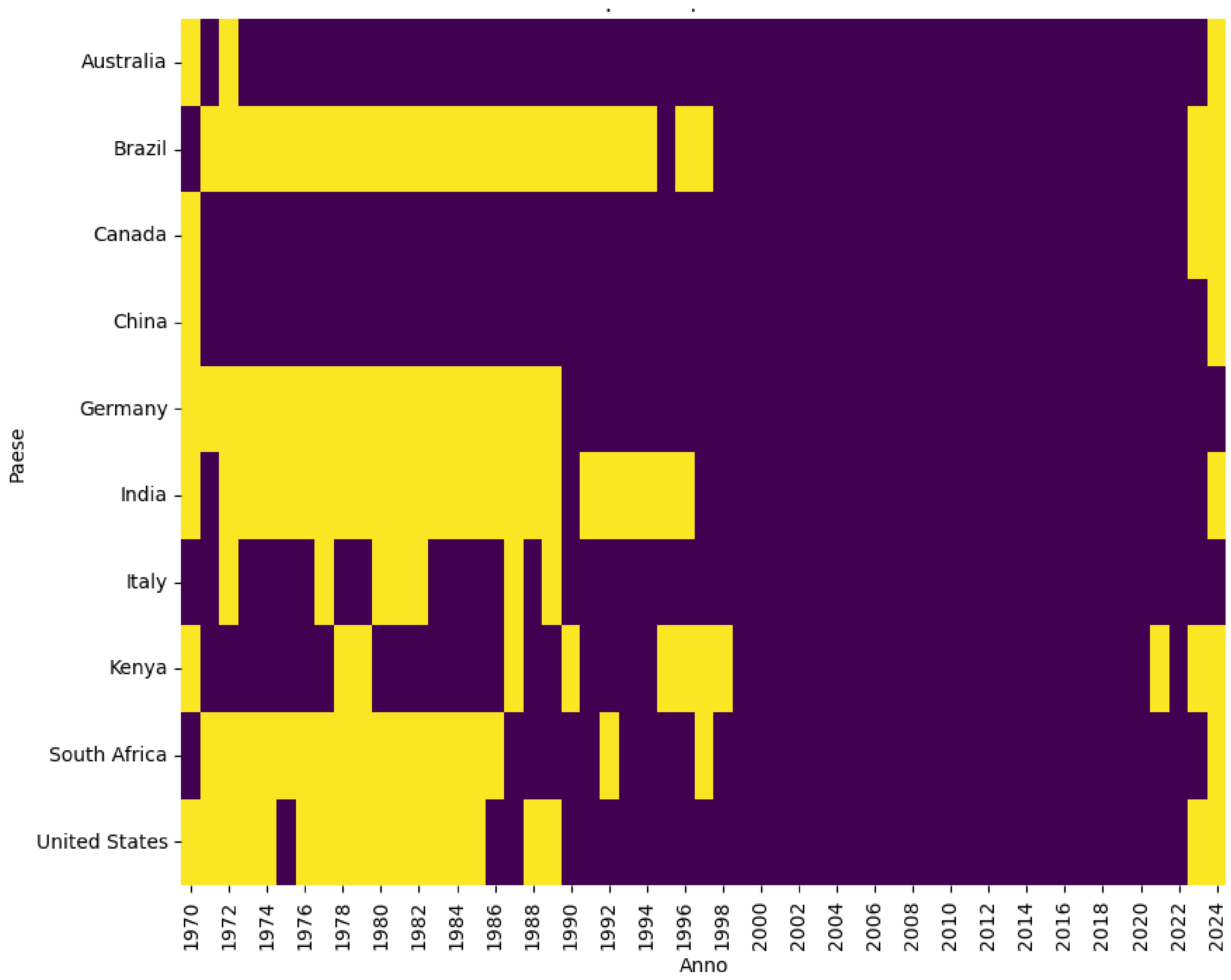
Public expenditure on education

Political commitment: Indicates how much the state concretely invests in the future, linking financial resources to achieved outcomes.

Data coverage and baseline differences

Uneven data coverage across countries

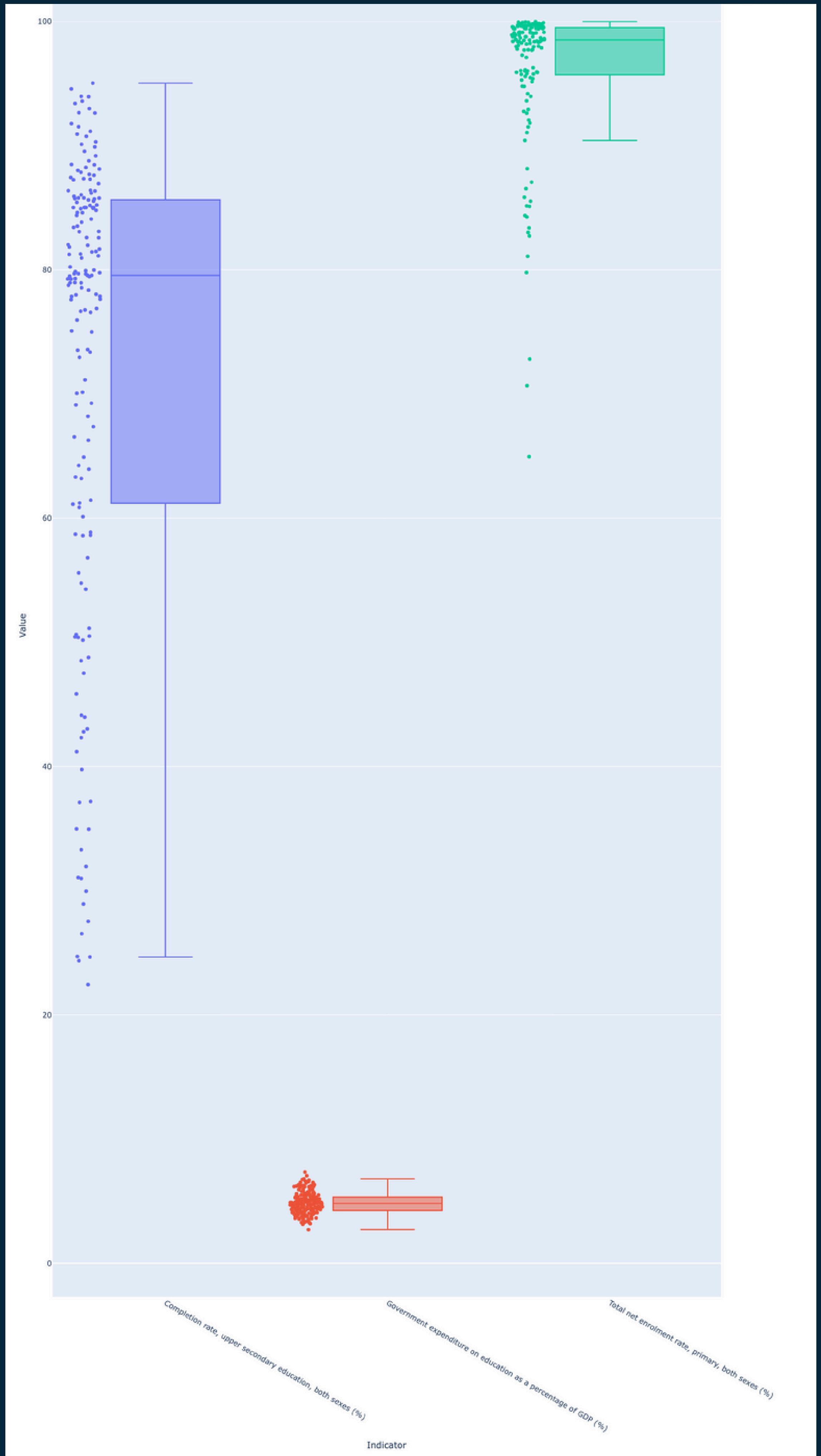
markedly across countries and years, reflecting **structural gaps** in data collection and reporting. This uneven coverage directly influences the scope and reliability of comparative analyses.



Early differences in education systems

arities in enrolment, completion rates, and public education spending, highlighting **diverse starting conditions** before any temporal or relational analysis.

Temporal dynamics and structural variability



Heterogeneous paths and structural outliers

Enrolment rates and education expenditure show more heterogeneous and often stagnant patterns, particularly in high-income countries.

The distribution of indicators reveals significant variability and outliers, pointing to country-specific dynamics and suggesting that education outcomes are shaped by more than investment levels alone.

Outlier Analysis

Identifying structural deviations

Outliers were identified using the **Interquartile Range** (IQR) method, allowing for a robust detection of atypical values while limiting the influence of extreme observations.

South Africa

South Africa emerges as an outlier primarily due to **discontinuous secondary completion rates**. These deviations are consistent with the country’s pronounced internal inequalities, where access to education and learning outcomes vary sharply across socio-economic groups and regions

India

India stands out as an outlier in **both enrolment and completion indicators**, reflecting significant temporal variability. This pattern can be attributed to the country’s vast territorial scale and strong regional heterogeneity, where national averages mask substantial differences in access, quality, and educational infrastructure.

Case Study: Kenya

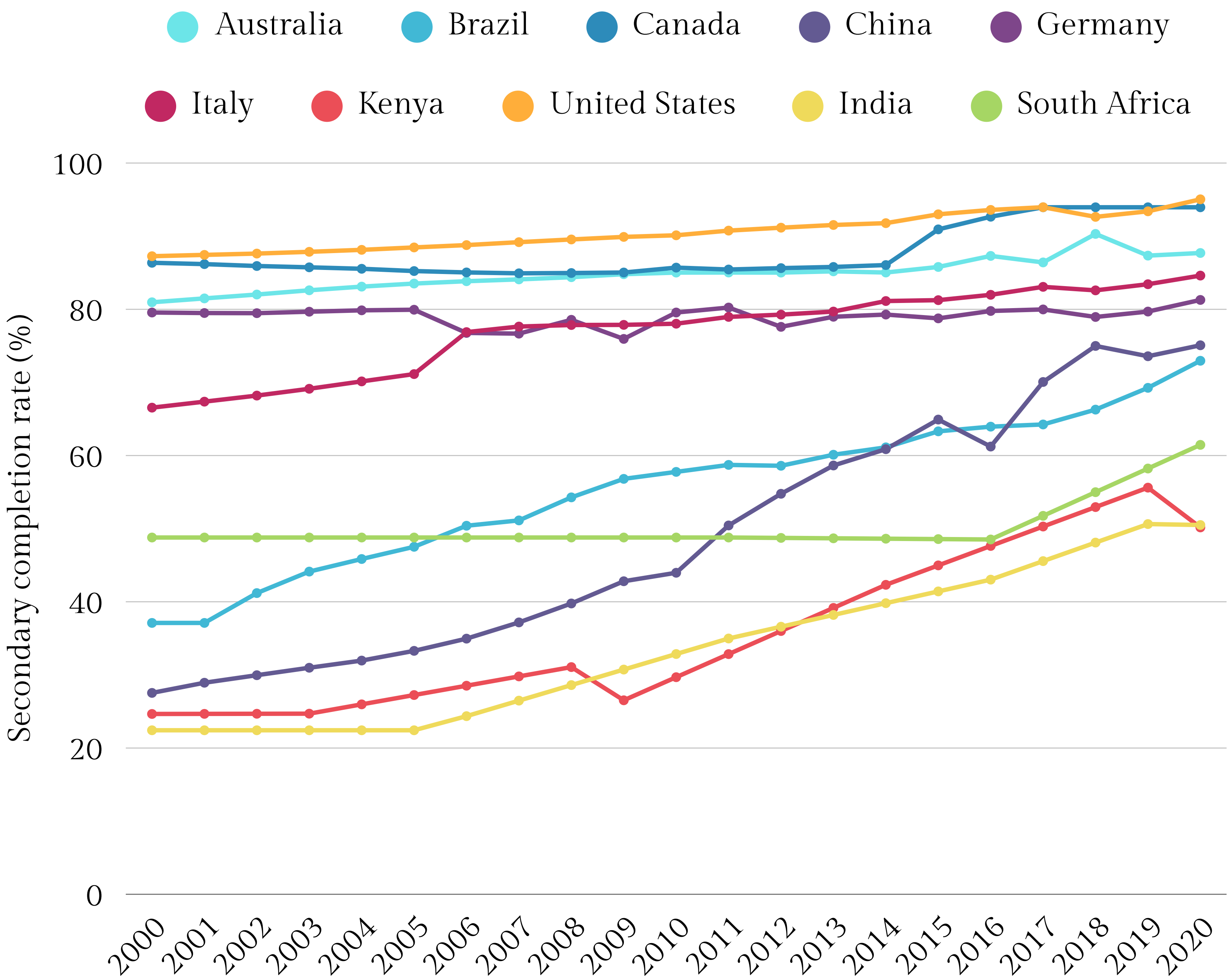
Kenya stands out as an outlier both in **enrollment rates** and **education spending**.
Years marked by significant increases in public investment in education are followed by sharp cuts, creating a jagged trend that directly affects enrollment rates.

Despite these fluctuations, the country demonstrates **notable educational commitment** during certain periods, reflected in temporary increases in enrollment before the subsequent decline.

This dynamic highlights how **fluctuations in spending can have a direct and immediate impact** on student engagement within the education system.

Global Trend

Despite economic disparities, the **completion of upper secondary** education remains the most resilient and consistent indicator.



Divergence from traditional Inputs

In more developed countries, education spending and enrolment rates remain largely flat over time, while secondary completion continues to improve.

Beyond Spending and Access

The widespread growth in completion rates suggests that progress in education is not solely driven by higher spending or broader access, but also by institutional effectiveness, policy design, and system-level improvements.

Expanding the Analysis: Key Socioeconomic Indicators

Integrating Infant Mortality, GDP per Capita, and Life Expectancy to Contextualize Educational Outcomes

Infant Mortality Rate

This dataset captures the number of infant deaths per 1,000 live births and serves as a key indicator of health conditions, social stability, and access to essential services. It helps assess how educational outcomes relate to broader human development factors.

fonte

GDP per Capita

GDP per capita provides a measure of economic prosperity and living standards across countries. Including this indicator allows the analysis to contextualize educational performance within different levels of economic development.

fonte

Life Expectancy

Life expectancy reflects long-term population health and quality of life. By linking this indicator to education metrics, the analysis explores how educational attainment correlates with overall societal well-being.

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Dataset Integration

Dataset Merging Strategy

To enable a comprehensive analysis, all datasets were merged into a single unified dataframe using **Country** and **Year** as common keys.
This step allowed education indicators to be jointly analyzed alongside economic and health variables, ensuring temporal and cross-country consistency.

Step 1: Interpolation

Linear Interpolation

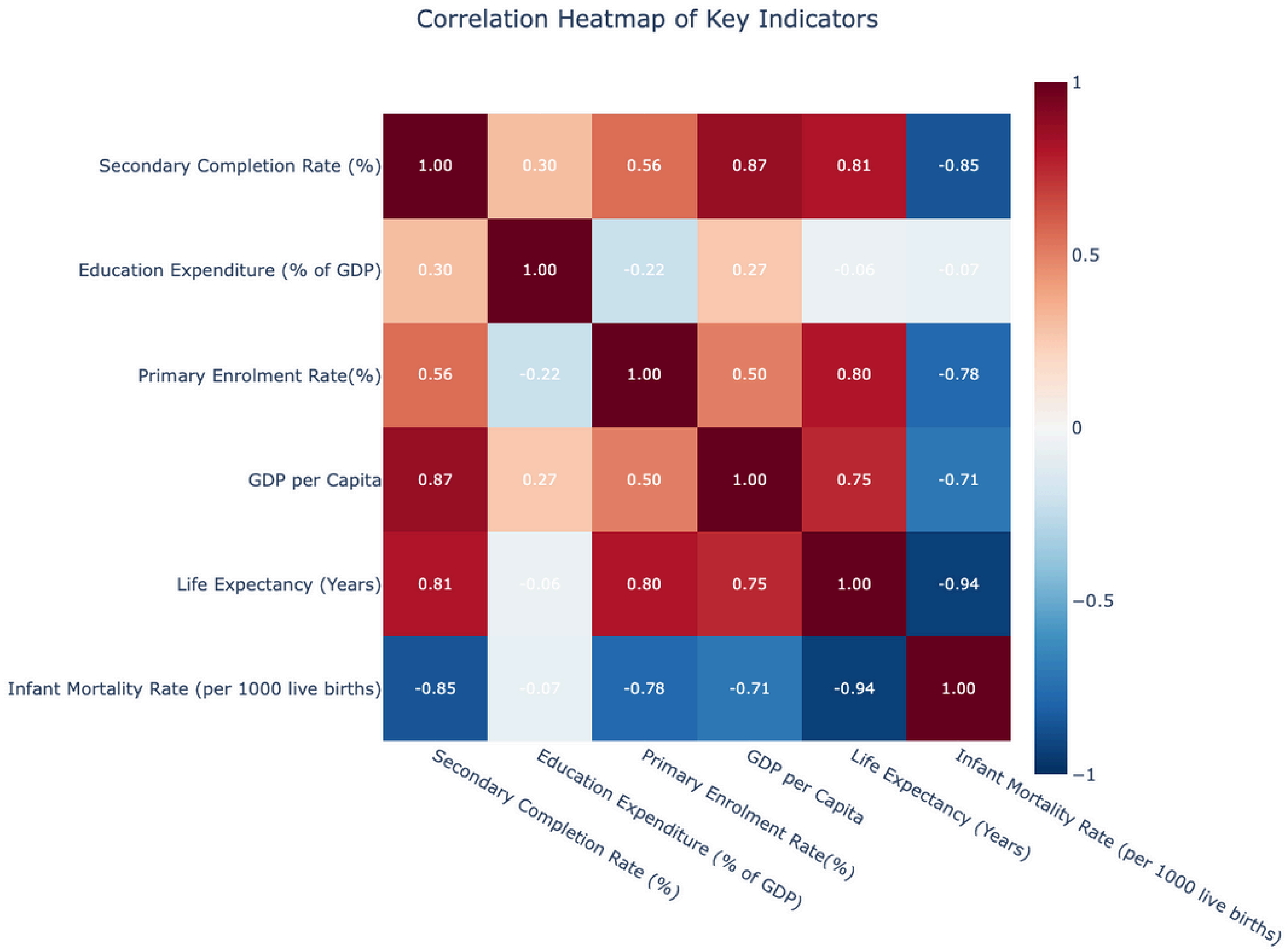
Missing values were first addressed using linear interpolation, preserving the temporal structure of the data and ensuring smooth transitions between observed years without introducing abrupt artificial changes.

Step 2: Forward & Backward Fill

Forward & Backward Filling (ffill / bfill)

Remaining gaps at the beginning or end of time series were filled using forward and backward propagation, ensuring dataset completeness while maintaining realistic value continuity.

Exploring Relationships Through Correlation Analysis



Merging heterogeneous datasets enables the exploration of cross-domain relationships.
The correlation heatmap offers an initial, data-driven overview of how key variables relate to one another, guiding subsequent analytical steps.

Education, Health and Economic Development: A Correlation-Based Synthesis

Education as a Core Driver of Development

The **Secondary Completion Rate** stands out as the most strongly connected indicator, showing a very high correlation with **GDP per capita (0.87)** and strong links with health outcomes. Countries with higher completion rates typically exhibit more stable economies, stronger institutions, and broader access to social services.

Education and Population Health

Both **secondary completion** and **primary enrolment** are closely associated with health indicators. Higher educational attainment corresponds to **longer life expectancy** and **lower infant mortality**, confirming education as a central pillar of human development and social resilience.

Beyond Spending: Quality over Share of GDP

Education Expenditure (% of GDP) shows relatively weak correlations with educational and health outcomes. This suggests that development depends less on the share of spending and more on how resources are allocated, managed, and translated into effective educational systems.

Key Finding #1

Education demonstrates **significant returns** after 8–12 years, reinforcing its role as a vital investment in human capital.
Data from 2000 to 2023 show that improvements in education and social outcomes occur gradually over time. The **Secondary Completion Rate** increases on average by **~0.7%** per year, while gains in life expectancy and reductions in infant mortality emerge steadily, especially in countries with sustained economic growth.
These patterns indicate that educational investments generate **structural benefits** rather than immediate results.

Education and Health

Quality primary education is crucial; it directly correlates with reduced infant mortality rates and improved health outcomes.

The **Primary Enrolment Rate**, with an average of **95.9%** but a wide range (**64.9%-99.9%**), shows a strong correlation with **Life Expectancy (0.80)** and a moderate association with **Secondary Completion (0.56)**.

This pattern highlights the central role of **early educational access**: countries that ensure widespread primary schooling tend to build more resilient trajectories in both **educational attainment** and **population health** over the following decades.

Policy Recommendations

- **Prioritize secondary education completion**

Strong correlations with GDP per capita, life expectancy, and infant mortality indicate that strengthening secondary education yields broad socio-economic and health benefits, especially in middle-income countries.

- **Focus on the quality, not just the volume, of education spending**

Higher public expenditure alone does not guarantee better outcomes; targeted investments in teaching quality, essential infrastructure, and system efficiency deliver higher returns.

- **Ensure universal and stable access to primary education**

High primary enrolment acts as a foundation for long-term gains in secondary completion and population health, particularly in countries with uneven access.

- **Integrate education and health policies**

Improvements in life expectancy and reductions in infant mortality are closely linked to sustained educational development, calling for coordinated cross-sector strategies.

Conclusions

This analysis demonstrates that educational outcomes cannot be interpreted in isolation, but rather as part of a broader development ecosystem in which economic performance and health conditions evolve in strong interdependence. While global averages suggest gradual improvement, substantial structural differences persist across countries, highlighted by outliers and extreme case studies. The results emphasize the central role of primary and secondary education as long-term drivers of human development, and show that policy effectiveness depends less on aggregate spending levels than on strategic, sustained, and well-targeted investments over time.

Thank You

Fonts (World Bank)

EdStats
Infant Mortality Rate
GDP per Capita
Life Expectancy

Code

Github