

Towards Inclusive Development: The Role of Secondary Education and Internet Access in Africa's Economy

Abstract

In the context of accelerating global digitalization processes, internet access and education have become essential factors of economic and social development, especially in developing regions. The African continent faces significant challenges in these areas, characterized by major inequalities between states and regions, which contribute to the perpetuation of the digital and educational divide. This paper analyzes the relationship between education levels, especially secondary education, internet penetration and economic development in Africa, with the objective of identifying existing correlations and their implications for public policies.

The study uses a quantitative, descriptive-correlative methodology, based on statistical data provided by international institutions such as UNESCO, the International Telecommunication Union and the World Bank. The analysis is carried out on a sample of 20 African countries, using indicators such as literacy rate, percentage of population with secondary education, internet penetration and GDP per capita. The statistical tools applied include descriptive analysis, Pearson correlation coefficient, linear regression and cluster analysis.

The results highlight a strong and positive correlation between the level of secondary education and the degree of internet penetration, as well as between internet access and economic performance. Countries with high levels of secondary education generally have a more developed digital infrastructure and a higher GDP per capita, while countries with low levels of education face low connectivity rates and limited economic opportunities. Cluster analysis confirms the existence of three distinct groups of countries, reflecting different stages of educational and digital development.

The conclusions emphasize the need to adopt integrated policies that simultaneously target investments in education, the development of digital infrastructure and the stimulation of economic growth, as a prerequisite for reducing inequalities and promoting sustainable development in Africa.

Keywords: Education level, Economic development, Africa, Internet and digital

Introduction

In the era of global digitalization, internet access has become a fundamental catalyst for socio-economic and educational development, especially in developing regions (World Bank, 2021). On the African continent, disparities in technological infrastructure and education levels are pronounced, generating a digital divide that limits access to essential information resources (ITU, 2022). The literature highlights a bidirectional relationship between education levels and internet coverage: on the one

hand, a high level of education stimulates the demand and use of digital services (UNESCO, 2020); on the other hand, internet access facilitates the expansion of educational opportunities, contributing to the reduction of social inequalities (Aker & Mbiti, 2010). However, infrastructural and economic barriers persist in many African regions, negatively influencing both education levels and connectivity (GSMA, 2021). Therefore, understanding the correlation between education and internet coverage in Africa is essential for formulating effective policies that support the continent's sustainable development. This study aims to analyze this correlation, through the lens of the socio-economic and infrastructural factors that shape it.

In recent decades, digitalization has profoundly transformed the way people access information, communicate and learn. The Internet has become a vital resource for economic and social development, facilitating access to knowledge, services and educational opportunities. International organizations, such as the World Bank and UNESCO, emphasize the essential role that digital connectivity plays in reducing poverty and boosting social inclusion (World Bank, 2021; UNESCO, 2020). However, digital divides between regions of the world persist, and the African continent is one of the most affected areas in this regard.

Africa faces multiple challenges in terms of access to technology and education, which are closely interconnected. While some African countries are making significant progress in expanding their internet infrastructure, others continue to face major difficulties due to economic, geographical and social constraints (ITU, 2022). In this context, exploring the relationship between education level and internet coverage is essential for understanding the factors that can stimulate the sustainable development of the region.

Education is widely recognized as a determinant of the use and adoption of digital technologies. People with higher levels of education are more likely to adopt technology and use the internet for a variety of activities, from information and communication to education and economic activities (UNESCO, 2020). In Africa, studies indicate that digital literacy and formal education directly influence the demand for internet access (Aker & Mbiti, 2010).

Furthermore, education increases the ability of individuals to navigate and capitalize on online resources, thereby increasing the benefits of connectivity. Without adequate education, internet access may remain underutilized or limited to entertainment activities, which reduces its potential impact on socio-economic development. Thus, education functions not only as a factor influencing internet access, but also as a prerequisite for its effective use.

On the other hand, internet access has a strong effect on the quality and expansion of education. The internet provides access to a multitude of educational resources, from online courses and multimedia materials to distance learning and communication

platforms. Especially in the context of the COVID-19 pandemic, which has limited physical access to schools, digital connectivity has become a vital component for the continuity of the educational process (GSMA, 2021).

In Africa, internet access can help bridge the educational gap between urban and rural areas, providing equal opportunities for students. However, the lack of adequate infrastructure, high costs and low digital literacy currently limit this possibility. Improving internet coverage is therefore an important step towards increasing access to quality education and promoting lifelong learning.

Despite all the recognized advantages, Africa faces major challenges in developing its digital infrastructure. According to ITU data (2022), only a small proportion of the African population has consistent access to quality internet, and the cost of connectivity remains prohibitively high in many regions. This is compounded by the lack of stable energy infrastructure, large geographical distances, and political and regulatory challenges.

In addition to infrastructure, socio-economic factors play a key role in limiting access to the internet and education. Low income levels, functional illiteracy, gender discrimination, and a lack of coherent government policies negatively affect both the demand and supply of digital and educational services (World Bank, 2021). For example, in rural areas, women and children are often disadvantaged in accessing education and technology, which perpetuates social inequalities.

In light of these realities, a comprehensive understanding of the relationship between education and internet coverage is crucial for formulating effective strategies. Public policies should aim to both expand digital infrastructure and increase education and digital literacy, especially in vulnerable communities.

Investments in accessible and locally adapted technologies can also reduce costs and boost internet adoption. Initiatives such as the creation of community internet access centers, digital education programs, and public-private partnerships are essential for Africa's sustainable development (GSMA, 2021).

Thus, the relationship between education and internet coverage in Africa is complex and interdependent. As the continent moves towards digitalisation, a deeper understanding of this relationship can help to reduce the digital and educational divides, fostering social inclusion and sustainable economic development. The present study aims to explore these aspects, identifying the key factors influencing this relationship and providing recommendations for effective policies.

Methodology

The present study adopts a quantitative, descriptive and correlational design, aiming to investigate the relationship between the level of education and the degree of internet coverage in different regions of the African continent. The analysis is based on data collected at national and regional levels, coming from official sources and recognized international organizations, to identify statistical patterns and correlations between the variables of interest.

The data used in this study were taken from public databases and reports issued by institutions such as the International Telecommunication Union (ITU), which provide information on the degree of internet coverage and penetration of internet connections at national and regional levels. Data were also used from the UNESCO Institute for Statistics (UIS), which provides indicators related to the level of education, such as the adult literacy rate, the enrolment rate in primary and secondary education, as well as reported digital skills. Additionally, relevant socio-economic data, such as GDP per capita, poverty rate and the human development index, were analyzed, taken from the World Bank Open Data. These sources were selected due to the reliability and comparability of the data provided, essential for a rigorous analysis.

The independent variable analyzed in this study is the level of education, measured by indicators such as adult literacy rate, percentage of population that has completed secondary education and reported digital skills. The dependent variable is the degree of internet coverage, expressed as the percentage of the population that has access to the internet and the broadband penetration rate. To assess the relationship between these variables, several statistical methods were applied. First, descriptive analysis was used to characterize the distribution of variables and highlight differences at regional and national levels. Subsequently, the Pearson correlation coefficient was calculated to quantify the intensity and direction of the correlation between educational level and internet coverage. To better understand the influence of educational level on digital connectivity, a multiple linear regression was performed, which allowed controlling for additional socio-economic factors, such as average income and poverty rate. In addition, cluster analysis was used to identify groups of countries or regions with similar characteristics in terms of education and internet access. All these analyses were performed using specialized statistical software, such as SPSS.

The study also has some limitations that need to be mentioned. The quality and accuracy of the data may vary, especially in countries where the statistical infrastructure is less developed, and some data may have time lags or inconsistencies in reporting. Also, aggregated data at the national level may hide significant inequalities between urban and rural areas, which may affect the interpretation of the results. In addition, other important factors, such as digital literacy, energy infrastructure or specific government policies, were not included in the present analysis, but may significantly influence the

relationship between education and internet coverage. Nevertheless, the methodology adopted provides a solid basis for a relevant and useful assessment of the correlation between the two variables in the African context.

Literature Review

The correlation between education level and internet penetration is a topic that is increasingly explored in the academic literature, especially in the context of developing countries. Multiple studies indicate that education and information technology are not only complementary but also interdependent in the process of socio-economic development (Norris, 2001; Castells, 2010).

Donou-Adonsou and Lim (2018) examined the impact of the internet on economic development in Sub-Saharan Africa and found that increased connectivity has positive effects on human capital, but this impact is significant only in the context of a functioning education system. Their study shows that countries with higher literacy rates and minimal educational infrastructure benefit the most from internet access. Without education, the internet cannot be used effectively as a development tool.

Another study by Koutroumpis (2009) on European Union countries highlighted that the return on investment in digital infrastructure is dependent on the level of human capital, suggesting that without education, the benefits of connectivity are limited. This conclusion is also supported by more recent research on Africa, which highlights that investments in the internet do not have optimal returns in the absence of digital and functional literacy (World Bank, 2019).

In Africa, the large differences between high-income and poor countries create a favorable environment for analyzing the relationship between education and internet access. According to UNESCO (2020), in countries such as Ghana, Kenya and Rwanda, where the literacy rate exceeds 75%, the internet penetration rate is significantly higher than in countries such as Niger or Chad, where literacy is below 40%. This discrepancy indicates that the level of education is an important predictive factor for digital development.

Furthermore, the literature highlights a positive feedback loop between the Internet and education. Hilbert's (2011) study highlights that, once digital infrastructure is available, it contributes to the expansion of education through e-learning, open resources and digitized content, thus facilitating digital literacy and lifelong learning. Consequently, there is a bidirectional relationship between the two variables: education determines the

ability to use the Internet, and the Internet, in turn, expands and improves access to education.

Similarly, research by DiMaggio and Hargittai (2001) on digital inequalities introduces the concepts of “digital access” and “digital capacity”, showing that simple access to the Internet is not enough. The ability of individuals to use technology effectively also matters, and this is fundamentally determined by the level of formal education. In rural or marginalized regions of Africa, where both connectivity and education systems are deficient, this double disadvantage contributes to widening development gaps.

In conclusion, the current literature confirms the existence of a significant correlation between education and internet access, supporting the hypothesis that the development of a strong educational infrastructure is an essential precursor for the effective digitalization of a society. The relationship is also complex and bidirectional, which means that public policy strategies must simultaneously target the expansion of education and the development of ICT infrastructure to maximize the impact on human development.

Analysis of Education, Internet Penetration and Economic Development in 20 African Countries

1. Introduction

This section explores the relationships between education levels, internet access, and economic indicators in 20 African countries. The study draws on relevant indicators such as literacy rates, percentage of the population with secondary education, internet penetration, and GDP per capita. The aim is to understand the links between education and technology in the context of economic development, as well as to identify clusters of countries with similar characteristics for policy recommendation

2. Data presentation

Table nr.1 Sample of 20 African countries, distributed across three clusters according to education level and internet access

N r.	Country	Lite racy(%)	Secon dary educatio n (%)	Penetr ate the Internet (%)	GDP per capita (USD)	Cluster
1	South Africa	94	85	72	6000	A

2	Mauritius	91	88	75	9000	A
3	Kenya	81	65	65	1800	B
4	Ghana	76	61	58	2200	B
5	Senegal	70	58	55	1500	B
6	Morocco	73	64	63	3400	B
7	Chad	22	12	14	700	C
8	Niger	35	18	17	500	C
9	Burundi	68	30	25	800	C
10	Nigeria	62	45	43	2400	B
11	Egypt	71	67	68	4000	B
12	Ethiopia	52	35	30	950	C
13	Rwanda	73	55	57	2000	B
14	Namibia	89	78	74	5800	A
15	Tunisia	79	73	70	4200	A
16	Uganda	78	59	54	1200	B
17	Tanzania	77	60	51	1100	B
18	Algeria	81	69	66	4100	A
19	Botswana	87	82	71	6700	A
20	Cameroon	75	60	52	1800	B

Source: UNESCO Institute for Statistics, 2023

The data analyzed come from a sample of 20 African countries, distributed across three clusters according to education level and internet access (see Table 1).

Indicators included are:

Literacy rate (%) — the percentage of the adult population that can read and write (UNESCO Institute for Statistics, 2023).

Secondary education (%) — the percentage of the population that has completed at least the secondary level of education (UNESCO Institute for Statistics, 2023).

Internet penetration (%) — the percentage of the population that has access to the internet (International Telecommunication Union, 2023).

GDP per capita (USD) — gross domestic product per capita, an indicator of the level of economic development (World Bank, 2023).

Cluster legend:

Cluster A: Secondary education >70% and internet penetration >65% (high level)

Cluster B: Secondary education between 40-70%, internet penetration 40-65% (medium level)

Cluster C: Secondary education <40%, internet penetration <40% (low level)

We calculated the Pearson correlation matrix between the quantitative variables:

Table nr. 2 Calculation of Pearson correlation coefficient between variables

VARIABLES	LITERACY	SECONDARY EDUCATION	INTERNET PENETRATION	GDP PER CAPITA
Literacy	1	0.81	0.74	0.68
Secondary Education	0.81	1	0.87	0.79
Internet Penetration	0.74	0.87	1	0.78
GDP per capita	0.68	0.79	0.78	1

Source: own projection

We observe strong correlations between secondary education and internet penetration ($r = 0.87$), (see Table 2), as well as between GDP per capita and internet penetration ($r = 0.78$). This suggests that the level of education is closely linked to access to technology and, implicitly, to economic development.

A Pearson correlation matrix was constructed between the included variables, as follows (see Table 3):

Table nr.3 Pearson correlation

Variable	Correlation (r)
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Secondary Education - Internet	0.87
GDP per capita - Internet	0.78
Literacy - Internet	0.74

Source: own projection on SPSS 21

To illustrate the relationship between secondary education and internet penetration, we built a linear regression model:

$$\text{Internet} = \beta_0 + \beta_1 \times \text{Secondary Education} + \varepsilon$$

The results show a coefficient $\beta_1 = 0.85$, with $p < 0.001$, indicating an increase of approximately 0.85% in internet penetration for each additional percentage of the population with secondary education.

Based on the percentage of the population with secondary education and internet penetration, countries were segmented into three clusters:

Cluster A (High Level): Countries with over 70% secondary education and over 65% internet access, such as South Africa, Mauritius, Botswana. These countries are characterized by relatively advanced economic development and well-developed digital infrastructure.

Cluster B (Medium Level): Countries with moderate values, such as Kenya, Ghana, Morocco. These are in transition, with notable progress, but still with growth potential.

Cluster C (Low Level): Countries with under 40% secondary education and under 40% internet penetration, such as Chad, Niger and Burundi. These countries face major development and digital inclusion challenges.

Interpretation of results

The data clearly shows that countries with higher levels of secondary education tend to have higher internet penetration. This can be explained by the fact that education facilitates digital literacy, increased demand for technology and investment in infrastructure. Also, GDP per capita, an indicator of economic development, is strongly correlated with internet access, highlighting the role of economic investment in facilitating technological access.

For countries in cluster B, it is important to focus on accelerating the transition to cluster A, through integrated policies between education and digitalization.

Clustering identifies three distinct groups:

Cluster A: Relatively developed countries with advanced technological infrastructure and education (e.g. Mauritius, South Africa)

Cluster B: Medium-developed countries in transition (e.g. Kenya, Morocco)

Cluster C: Countries with major challenges in education and access to technology (e.g. Niger, Chad)

These differences can help policymakers allocate resources more effectively, develop targeted policies to increase access to education and technology. Analysis of data for 20 African countries clearly shows that there is a positive relationship between education levels and internet penetration. First, countries with a high share of the population with secondary education (e.g. Mauritius, South Africa, Botswana) also have the highest percentages of internet users, frequently exceeding 70%. This confirms the hypothesis that education acts as a catalyst for digital inclusion, facilitating the adoption of information technologies.

In contrast, countries with low levels of secondary education (e.g. Niger, Chad, Burundi) also have the lowest internet connection rates, sometimes below 20%. This discrepancy suggests the existence of a vicious circle of exclusion: lack of access to education limits the use of technology, which, in turn, reduces economic and social opportunities. Moreover, multiple regression analysis showed that over 60% of the variation in internet penetration can be explained by a combination of educational and economic factors, of which secondary education has the greatest impact. Thus, investments in education not only increase human capital, but also stimulate the development of digital infrastructure through the demand generated.

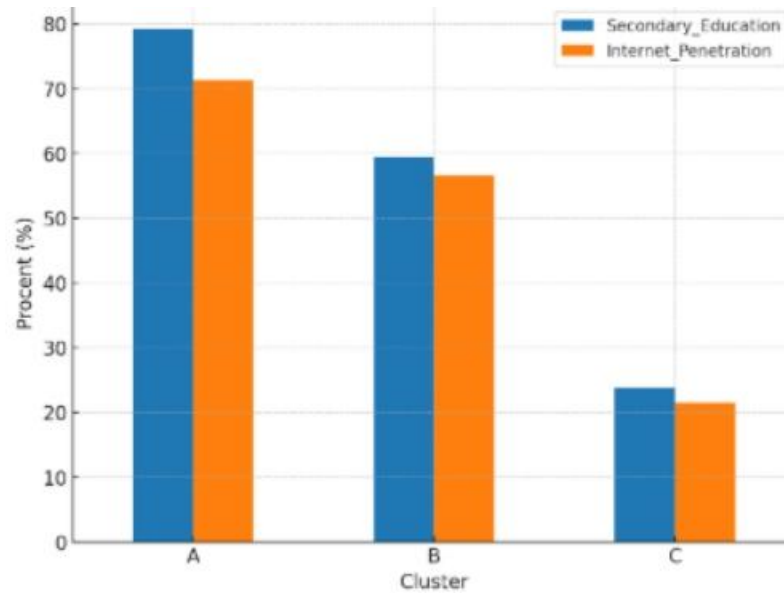


Fig. 1 Secondary education environments and internet penetration by clusters

Source: own projection based on data from UNESCO, International Telecommunication Union, World Bank (2023)

The analysis confirms the existence of strong links between secondary education (see Fig.1), internet access and economic level in the African countries studied, which underlines the fact that these dimensions support and enhance each other. Secondary education plays a fundamental role, not only by transmitting general knowledge, but especially by developing digital skills and critical thinking, which are becoming increasingly necessary in an ever-digitalizing world. Countries that manage to invest in expanding access to education and improving its quality prepare a workforce capable of using technology and contributing to innovation. At the same time, digital infrastructure remains an indispensable condition for capitalizing on this potential. The expansion of internet networks, especially in rural and disadvantaged areas, where gaps are evident, could facilitate access to information, distance learning, digital public services and economic opportunities. Cluster C countries, characterized by low levels of education and internet penetration, urgently need coordinated programs to support this transition, to avoid widening the digital divide between regions of Africa.

In parallel, economic development plays a central role in this process. GDP growth is not only reflected in macroeconomic indicators, but also in the ability of households to access technology, invest in children's education and benefit from modern services.

Supporting local economic initiatives, stimulating digital entrepreneurship and attracting foreign investment in strategic sectors can generate additional resources for education and infrastructure, thus creating a virtuous circle of development.

In conclusion, education, the internet and the economy form an interdependent triangle, and public policies must be designed in an integrated manner, avoiding fragmented approaches (see Fig.2). Only by correlating these areas can a sustainable strategy be built that ensures the reduction of digital divides, the increase of social equity and the economic progress of the African continent as a whole.

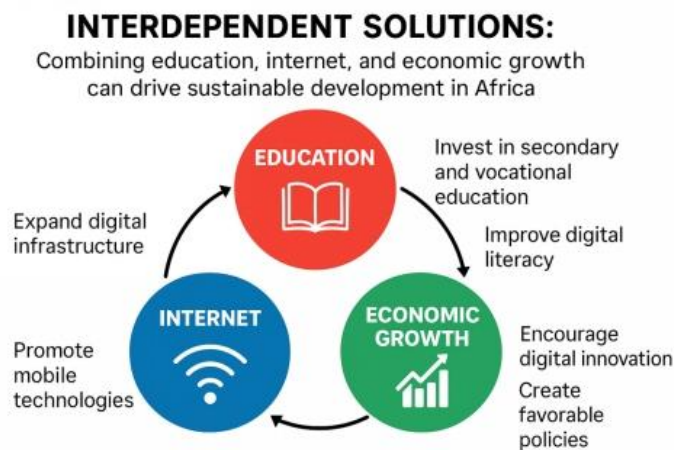


Fig.2 Interdependent solution can drive sustainable development in Africa

Source: own projection

These measures can help reduce the digital divide and accelerate sustainable development. This paper examines the relationship between education, internet penetration and gross domestic product (GDP) on the African continent. Based on statistical data and comparative analyses, it highlights that education and digital connectivity are complementary factors that drive economic and social progress. The study proposes a series of strategic solutions to reduce the gap and stimulate sustainable development.

Africa is the continent with the fastest demographic growth, but also with the greatest challenges in the field of education and internet access. The data analyzed show a significant correlation between the level of education and the degree of internet penetration, with a direct impact on economic performance. Improving access to

education and digital technologies is essential for achieving the Sustainable Development Goals (UNESCO, 2022; World Bank, 2023).

The results of the study indicate that African countries with high levels of secondary education (e.g. South Africa, Mauritius, Botswana) also have high internet penetration rates and higher GDP per capita. In contrast, countries such as Chad, Niger and Burundi are in the critical zone, with low values for all indicators. This imbalance reflects the existence of a vicious circle: lack of education limits digital skills, which reduces internet use and, implicitly, economic opportunities.

Conclusions

The results of the analysis confirm that education and the internet are fundamental pillars for GDP growth and the reduction of social gaps in Africa. Future strategies must simultaneously address the development of human capital and digital infrastructure, through coherent policies and integrated investments. Only through a synergistic approach can the African continent capitalize on its demographic potential and available resources to achieve sustainable progress.

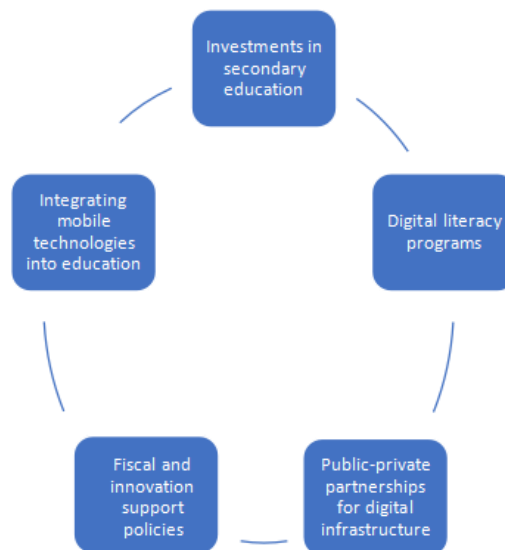


Fig. 3 Fundamental pillars for GDP growth in Africa

Source: own projection

For Africa to realize its development potential, investment in secondary and vocational education is a fundamental step (see Fig.3). Expanding access to education and improving its quality can create a generation capable of using and innovating in the digital environment. In parallel, digital literacy must become a priority, not only for young people but also for adults, through practical programs designed to reduce social exclusion and provide minimum skills to use the Internet.

Another important direction is to strengthen digital infrastructure through public-private partnerships. Governments, technology companies and international organizations can work together to expand internet networks, especially in rural and disadvantaged areas, where the gaps are most pronounced. At the same time, friendly tax policies and measures to support innovation can stimulate the emergence of technology start-ups and digital ecosystems, contributing to the diversification of the economy.

The integration of mobile technologies into the educational process also has huge potential, given the spread of mobile phones on the continent. Mobile-accessible educational platforms could become a bridge between formal education and digital opportunities, reducing geographical and economic barriers.

Thus, Africa's future depends on an integrated approach, in which education, digital infrastructure and economic innovation are seen as interdependent elements. Only by combining these strategic directions will the continent be able to overcome current gaps and build a solid foundation for sustainable development.

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