A Multi-Indicator Data-Driven Framework for Benchmarking Education Systems: Evidence from Morocco and South Korea

Tarik El Moudden[1]*, Lachgar Noureddine[3], Bahaa Eddine Elbaghazaoui[2], and Mohamed Amnai[1]

[1] Computer Science Research Laboratory, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco
tarik.elmoudden@uit.ac.ma, mohamed.amnai@uit.ac.ma

[2] National School of Applied Sciences, Sultan Moulay Slimane University, Beni Mellal, Morocco
b.elbaghazaoui@usms.ac.ma

[3] Laboratory of Studies and Research in Human Beings, Societies and Values, Ibn Tofail University, Kenitra, Morocco
noureddine.lachgar@uit.ac.ma

Abstract. Many international rankings place Morocco low, relying on studies that may be riddled with unfair data preparation processes. These indicators often combine disparate variables into a single index, heavily dependent on imputation missing data algorithms, which can obscure recent progress and bias assessments of reform efforts. This imbalance poses a problem for governments, who may embark on successive waves of reform without a clear understanding, thus undervaluing their efforts. To address this gap, the current study develops a comparative data analysis framework that compares Morocco with South Korea, a widely recognised educational success story, using nine World Bank indicators grouped into benefit (GEE-GDP, LSCR, PCR, PSE, and SSE) and cost (AOS-Sec, COSP, PTR-P, and PTR-S) dimensions. The indicators are treated as time series data. The results generally showed that there has been tangible progress in the education system in Morocco, while highlighting the structural distance that still separates it from an integrated, high-performing system like the one in South Korea.

Keywords: Multi-indicator analysis, Data-Driven Educational Governance, World Bank Education Data, Benchmarking Morocco and South Korea,Evidence-Based Education Reform

1 Introduction

No one disputes that education is the engine of sustainable development. All democratic countries rely on it and have allocated all logistical, human, and financial resources to its development. Furthermore, education plays a vital role in

* Corresponding author.

C. Jerry et al. (eds.), *Proceedings of the Conference Morocco-Korea Cooperation: A Lever for Afro-Asian Development (MKC 2025)*, Atlantis Highlights in Social Sciences, Education and Humanities 50,
https://doi.org/10.2991/978-94-6239-680-7_22

all sectors; for example, it contributes to economic development [1], strengthens social and political stability, and produces highly skilled professionals needed in the health, technology, and scientific research sectors [2,3].

1.1 Assessment of Educational Reforms in Morocco

Several reports have examined the state of education in Morocco. These reports, issued by institutions known for their credibility, objectivity, and intellectual integrity, generally employ numerous quantitative indicators. Unfortunately, many of these reports paint a poor picture of the educational situation in Morocco, ranking it low in indices such as the "Global Education Index 2025" (64th place) and the "Global Justice Index 2024" (110th place globally).

Regarding the Moroccan educational context, which has undergone repeated reforms, some remedial and others urgent, for example:

- In the 1990s, following a World Bank report and the 1997 reforms, the Special Committee for Education and Training was established. In 1999, it drafted the National Charter for Education and Training, which emphasised diversifying funding sources and strengthening the role of stakeholders and partners in education and training. However, before the end of the charter's "decade of reform," reports emerged ranking Morocco among the lowest in education [4,5].
- Then, the Ministry of National Education launched Strategic Vision of 2015-2030, which has two phases of reform projects. The first one was the Emergency Program for Education in Morocco, a new reform" or a reform of the reform" without evaluating the initial reform. Among the objectives of the Emergency Program were supporting private investment in the education sector and developing a new model for educational offerings in the private sector. The second phase involved priority measures to implement the strategic vision and address shortcomings, including school dropout (absenteeism, grade repetition, and failure to complete studies), the increasing number of multi-grade classes, incomplete infrastructure, and weak language proficiency. Unfortunately, the Strategic Vision has not achieved its goals so far, and several studies have already highlighted clear signs of its limited effectiveness [6].

1.2 Educational Reform in South Korea

The Republic of South Korea, a relatively small country (approximately 100,000 km^2) with a population of over 51.7 million, has achieved remarkable success in education. This success, according to the World Bank, has paralleled the country's achievement in combining rapid economic growth with a significant reduction in poverty. South Korea's GDP grew at an average annual rate of 5.7% between 1980 and 2023. Per capita GNI in South Korea rose rapidly, from US$67 in the early 1950s to US$33,745 in 2023.

Having previously received aid from international development institutions, South Korea became a member of the Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD) in 2010. Today, South Korea offers lessons to developing countries in sustainable development, infrastructure development, improving services to enhance people's lives, and how to transition to a dynamic knowledge-based economy[4]. For example, in the health sector, South Korea has achieved a remarkable 100% child survival rate up to age five. The survival rate of adults from the age of fifteen to the age of sixty is 94%, which is an indicator of the quality of health services and an indicator of the range of health risks that a child born today may face as an adult under the current conditions.

In contrast, a child who starts school at age four is expected to complete 13.6 years of schooling by their eighteenth birthday. Regarding standardised test scores, students in the Republic of Korea average 537 points, with 625 representing advanced levels and 300 representing lower levels [7]. According to the World Bank, South Korea spent 4.6% of its GDP on education in 2016, which is lower than the regional average of 4.7%. Furthermore, according to the 2015 Learning Poverty Index, only 3% of ten-year-olds could not read and understand a simple text by the end of elementary school, which is also lower than the regional average.

These results were not straightforward to achieve, as the path to education reform was difficult. It witnessed a series of programmes and interventions. Despite ranking first in science and second in mathematics in the PISA program, the state school system was heavily criticised [8,9]; expressions such as "school collapse," "classroom collapse," and "school system crisis" became common from 1999 onwards, as critics focused on student disobedience, teachers' loss of self-esteem, and their lack of passion for teaching [10].

As part of the education reform process that South Korea will experience, there were two main reforms, with some initiatives associated with them; the first was known as the Free Classroom Program for first-year junior high school students, which aims to reduce the pressure associated with exams and promote creativity, problem-solving skills, and career exploration, as shown by multiple policy analyses and national assessments [11]. Second, there was the "SMART Education" initiative, which was launched as a national initiative in 2011 with the goal of digitising all educational content by 2015 and making information and communication technology a primary means of learning and personalising education [12].

Overall, numerous previous studies and contrasting educational reforms in Morocco and South Korea demonstrate the impact of this on national trajectories. While Morocco is undergoing multiple reforms that could be derailed without evaluation, South Korea has implemented coherent, long-term strategies that have transformed its education system into a global benchmark. These two cases together highlight the crucial impact of governance, political transparency, and investment efficiency on educational outcomes and sustainable development.

[4] https://www.worldbank.org/en/country/korea/overview

Given the problem of missing information in global rankings—which can introduce bias through the imputation of missing data—this study adopts a more transparent, indicator-based approach to benchmarking education system performance over time. The research question is: **Can a multi-indicator time-series framework provide a more accurate assessment of Morocco's education system progress compared to composite global rankings?**. To answer this question, we compare South Korea and Morocco using nine annual indicators drawn from World Bank datasets–selected for data availability, policy relevance, and coverage of access, progression, and learning conditions–analysed as time series and interpreted from a cost–benefit perspective.

2 Background and Methodology

Morocco is consistently ranked very low by many studies in the education sector, such as the 2025 Global Education Index (ranked 64^{th}) and the 2024 Global Justice Index (ranked 110^{th} globally) [13]. However, these rankings generally rely on algorithms that compress numerous indicators into a single index, obscuring the individual improvements or declines of each indicator and resulting in a loss of valuable information [14]. Furthermore, the problem of relying on missing data remains a significant issue, potentially introducing bias into national results and systematically undervaluing recent reforms [15]. Consequently, countries like Morocco may find themselves trapped in a cycle of successive reforms without clear evidence of the measures' actual effectiveness in improving educational outcomes. Therefore, a more targeted and data-driven approach is needed, one that thoroughly analyses the evolution of the Moroccan education system, rather than simply relying on aggregated rankings that manipulate missing data and compress indicators into a single index.

To address this problem, We propose and apply a transparent, indicator-level benchmarking framework that avoids aggregation bias through a comparative data-analysis approach, benchmarking Morocco's educational performance against South Korea, a widely recognised success case in education. Instead of depending on imputed missing values, the analysis is based on observed data for nine carefully selected indicators, grouped into two categories. The first group, named "Benefit indicators", includes government expenditure on education, the lower secondary completion rate, the primary completion rate, primary school enrolment, and secondary school enrolment. The second group, named "Cost indicators", comprises adolescents out of school, children out of school (primary age), pupil–teacher ratio in primary education, and pupil–teacher ratio in secondary education. These dual-group indicators make it possible to identify both strengths and weaknesses in Morocco's education system across access, progression, and learning conditions, while using South Korea as a benchmark trajectory.

3 Matherial and Methods

The data analysis in this study is based on nine education indicators provided by the World Bank. The first operation consists of downloading each indicator as a separate `.xls` file containing time series data, with columns for country name, country code, indicator name, indicator code, and annual values for each year. All files were saved and loaded into `pandas` DataFrames using Python, ensuring uniform and repeatable processing for each indicator. Second, the nine indicators for South Korea (KOR) and Morocco (MAR) were filtered to retain only these two country codes, and at most one row per country was preserved. Non-pertinent descriptive columns such as “Country Name”, “Indicator Name”, and “Indicator Code” were then removed to keep only the country codes and numerical year columns, resulting in a harmonised set of `*_KOR_MAR` DataFrames ready for comparative analysis, as ploted in Fig. 1.

Finally, nine key indicators were divided into two analytical groups reflecting the "benefit" and "cost" dimensions of educational performance. These were then merged using a custom Python function to identify the common set of years across the indicators in each group, and the data was transferred so that the years formed the horizontal axis, with South Korea and Morocco appearing as separate series. The resulting multi-indicator time series graphs were exported as scalable vector graphics (SVG) files and serve as the graphical basis for the analysis presented in the Results section; consequently, the analysis focuses on trend comparison rather than inferential statistical testing.

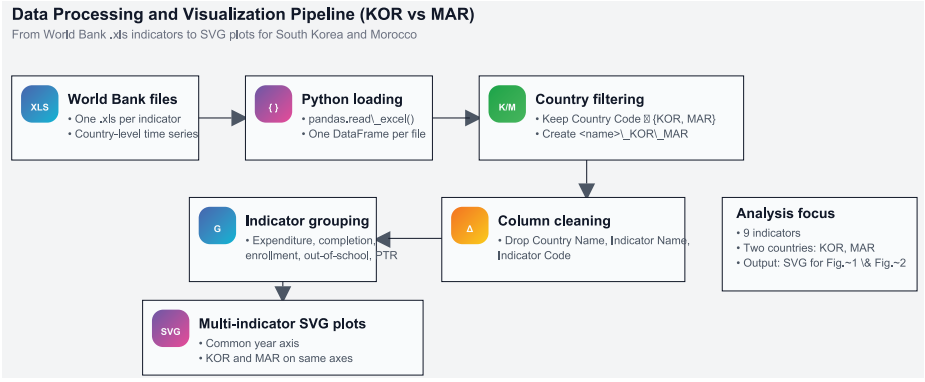

Fig. 1: Data processing pipeline from World Bank `.xls` files to SVG plots for South Korea (KOR) and Morocco (MAR).

4 Results and discussions

This section analyses the nine indicators selected to provide a coherent comparative picture of the education systems of South Korea and Morocco across access, progression, learning conditions, and public investment at both primary and secondary levels. For clarity, each indicator is presented with its corresponding graphical representation and marker style in Fig. 2 and Fig. 3, allowing a direct comparison between the trajectories of both countries. The following subsections provide a detailed interpretation of each indicator.

4.1 Adolescents Out of School(AOS-Sec)

AOS-Sec indicator [16], measures the percentage of middle- and high-school-aged adolescents who are not enrolled in any level of education. As a cost indicator, high values reflect weaknesses in the education system because they correspond to increasing exclusion and school dropout rates driven by various factors, including family and social conditions, societal norms, and economic circumstances [17]. World Bank data show that South Korea maintains a near-zero rate of AOS-Sec throughout the observed period, as ploted by —●— in Fig. 2, indicating universal or near-universal participation in secondary education with a relatively stable trend at the bottom of the curve.

Morocco, however, begins with a much higher level of adolescent exclusion in 1999, although the rate declines over the years, particularly during periods of educational reform, as ploted by —●— in Fig. 2. In some cases, this decline is followed by relative stability, even though certain groups such as rural populations, low-income families, and often girls continue to be disproportionately excluded. This pattern indicates a persistent transitional bottleneck between primary and secondary education. While Morocco has made significant progress in access to primary schooling, the proportion of students who continue into secondary education remains unsatisfactory.

4.2 Children Out of School Primary (COSP)

South Korea has a very low COSP indicator [18], often between 0 and 2 percent, as ploted by —■— in Fig. 2, which is consistent with near-universal primary school enrollment despite the country's rugged terrain. In contrast, Morocco has historically started at a much higher level, as ploted by —■— in Fig. 2 , then steadily declined over the years. However, during the years 2020–2021–2022, Morocco temporarily surpassed South Korea, a development that may be attributed to the COVID-19 pandemic, during which Morocco successfully implemented distance learning [19]. It must be noted that any changes in data during the pandemic period should be treated with caution, as they may be temporary fluctuations or the result of exceptional circumstances and not a permanent natural trend.

Overall, trend patterns indicate that South Korea achieved universal primary education early, while Morocco follows a more gradual and dynamic path

of improvement driven by educational reforms whose effects take time to materialize. This slower decline leaves rural families, low-income groups, and, in some regions, girls at a disadvantage, as they are less affected by the reform measures.

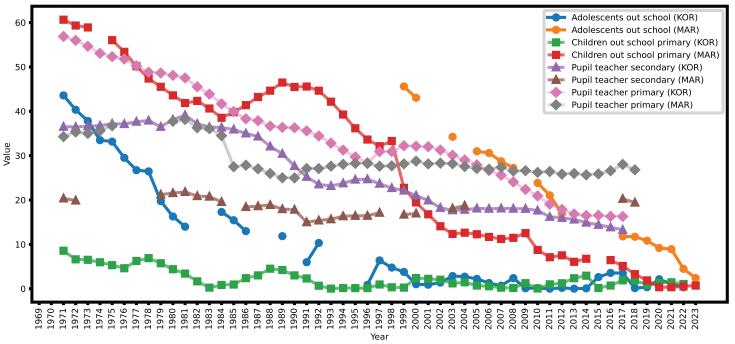

Fig. 2: A combined visualisation of AOS-Sec, COSP, PTR-P, and PTR-S for South Korea and Morocco as a time series from 1969 to 2023.

4.3 Pupil–Teacher Ratios in Primary and Secondary Education (PTR-P and PTR-S)

The PTR–P and PTR–S indicators measure the average number of pupils per teacher in primary and secondary education [20], respectively, serving as key factors that reflect classroom density and the teacher's capacity to provide effective instruction. Lower values on these indicators generally indicate more favourable learning conditions, with smaller class sizes and greater opportunities for individualised support, while higher values correspond to overcrowded classrooms that may hinder teaching and learning. When comparing South Korea and Morocco, in Fig. 2, shows that South Korea performs significantly better, maintaining PTR–P levels in the low twenties or below, reflecting a long-standing investment in sufficient teacher supply to sustain mass enrolment. In Morocco, by contrast, PTR–P values remain consistently higher than those of South Korea, as in Fig. 2, indicating structural pressures linked to financial constraints, rapid enrolment growth, and the persistent difficulty of deploying enough qualified teachers, particularly in rural areas. Alongside this, the PTR–S indicator is also represented by for South Korea and for Morocco in Fig. 2, illustrating corresponding differences in classroom conditions at the secondary level.

4.4 Government Expenditure on Education (GEE-GDP)

The GEE–GDP indicator represents the percentage of national income allocated to a country's education system annually. A comparison between South

Korea and Morocco shows that Morocco allocates a relatively higher share than South Korea, as ploted by —●—, and —●— in Fig. 3 . This suggests that the key challenge is not merely how much the government spends, but how effectively resources are allocated and reforms are governed—meaning governance efficiency and program quality matter more than spending levels alone. It is also worth noting that Korea's spending stabilizes at a relatively high level, indicating continuity in its investment base, while Morocco exhibits fluctuations in this indicator, reflecting the country's economic conditions and policy cycles [21].

4.5 Lower Secondary Completion Rate (LSCR)

LSCR measures the percentage of adolescents who successfully complete lower secondary education [22]. Comparing South Korea and Morocco, World Bank data indicate that South Korea maintained very high completion rates, often between 80% and 100%, as ploted by —■— in Fig. 3 ,throughout the period from 1990 to 2024. Morocco, meanwhile, shows a gradual improvement driven by expanding enrollment and higher retention rates, although it remains significantly below the Korean benchmark for most of the comparison period, as ploted by —■— in Fig. 3 . These dynamics may be influenced by the proportion of government spending on education, the student–teacher ratio, and the effective use of available resources to achieve better educational outcomes.

4.6 Primary Completion Rate (PCR)

The PCR indicator measures the primary school completion rate, making it an important measure of primary education performance [23]. The graph consistently shows that South Korea maintains very high completion rates, typically between 95% and 100%, as ploted by —▲— in Fig. 3 ,reflecting a successful system in which children not only enter school but also complete the full primary cycle. Morocco, on the other hand, shows slower progress in this indicator, with negative fluctuations and declines in several years, as ploted by —▲— in Fig. 3 .This pattern points to internal challenges such as dropout, grade repetition, and a gradual deterioration in educational quality, issues that recent reforms aim to address in order to improve primary completion over time.

4.7 Primary School Enrolment (PSE)

The PSE–Net indicator measures the percentage of children of compulsory primary school age who are enrolled in primary education. This indicator is crucial for assessing the effective coverage of the school-age population and the extent to which this group is being targeted [24]. Comparing South Korea and Morocco, the figure shows that South Korea's PSE–Net remains close to 100% with only minor fluctuations, as ploted by —◆— in Fig. 3 . Morocco's PSE–Net, on the other hand, has been slowly improving from much lower enrolment levels, rising steadily over the years, with recent sharp increases indicating the beginning of benefits from reform and expansion efforts, as ploted by —◆— in Fig. 3.

The correlation of PSE–Net with other primary indicators—such as the decline in the percentage of the COSP indicator, the gradual increase in PCR, and the development of PTR–P and PTR–S—confirms that Morocco has made remarkable progress in access to early education, even though challenges remain in later stages of the education pathway.

4.8 Secondary School Enrolment (SSE)

The SSE–Net indicator represents the percentage of adolescents of official secondary school age who are enrolled [25]. This is a measure of the extent to which students continue beyond primary school and is correlated with LSCR to assess the success of learners in progressing through the system. —×— in Fig. 3 , shows that South Korea maintains very high net secondary school enrollment levels, often ranging between 80% and 95%, reflecting a massified public secondary system in which most adolescents are in school rather than dropping out.

In Morocco, the percentage of adolescents of secondary school age who are out of school has slowly decreased over the years, as shown by —×— in Fig. 3. This improvement is attributed to the establishment of vocational training institutions, the construction of collèges and secondary schools, and the implementation of reforms aimed at enhancing infrastructure, particularly in remote areas. Furthermore, an analysis of this indicator, together with AOS–Sec, LSCR, and PTR–S, shows that although Morocco is expanding enrollment, it still faces challenges in retaining students and strengthening system capacity.

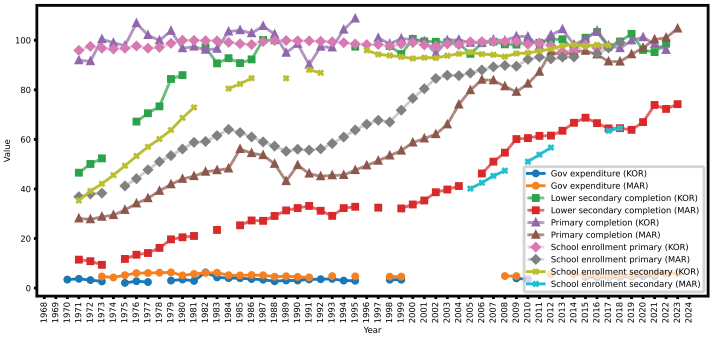

Fig. 3: A combined visualisation of GEE-GDP, LSCR, PCR, PSE, and SSE for South Korea and Morocco as a time series from 1968 to 2024.

5 Conclusions

This study proposed a comparative framework based on nine indicators: GEE–GDP, LSCR, PCR, PSE, SSE, and the cost indicators AOS–Sec, COSP, PTR–P, and PTR–S, to analyse the evolution of the Moroccan education system using South Korea as a benchmark. Instead of relying on a single composite indicator that combines heterogeneous variables into one score and uses missing-data imputation algorithms, the analysis focused on examining each of the nine direct indicators collected from the World Bank, divided into two groups.

The multi-indicator approach provides a more policy-relevant diagnostic tool than composite rankings. Through this data-driven approach, the study provided a more transparent and accurate picture of Morocco's educational performance, particularly in recent years. Therefore, This approach suggests that there is a significant improvement in primary education indicators and completion rates, a decrease in COSP and AOS–Sec, and an increase in secondary school enrolment, especially during reform phases. However, the high PTR–P and PTR–S values reflect persistent gaps in adolescent participation, lower secondary completion, and classroom conditions. Overall, the multi-indicator approach confirms that recent reforms have produced measurable progress, despite the bleak picture painted by many existing studies and reports. Furthermore, this study underscores the structural gap that still exists between Morocco and a fully massified and high-performing system such as that of South Korea.

6 Limitations and future work

While the proposed multi-indicator, World Bank-based time-series benchmarking framework improves transparency and policy interpretability, it remains subject to several limitations that follow directly from its indicator-level and descriptive trend-comparison design.

- The absence of qualitative indicators (learning outcomes): The study did not directly address detailed learning outcomes (competencies and core skills). Future research could complement these approaches with learning outcome datasets, such as international achievement measures, to better link system expansion with the quality of learning.
- The absence analyse régionale interne: Indeed, The indicators are analysed at the national level, which can mask within-country disparities (regional, urban–rural, and socio-economic gaps). Extending the same multi-indicator logic to subnational data would make the diagnostic more actionable by identifying where progress concentrates and where bottlenecks persist.
- The absence of economic causality: Because the study focuses on trend comparison (rather than inferential testing), it does not estimate causal effects of reforms or spending changes. Future research could add econometric designs to test whether specific policy phases plausibly drove observed indicator changes.

References

1. Pelinescu, E. The impact of human capital on economic growth. *Procedia Economics And Finance*. **22** pp. 184-190 (2015)
2. Raghupathi, V. & Raghupathi, W. The influence of education on health: an empirical assessment of OECD countries for the period 1995–2015. *Archives Of Public Health*. **78**, 20 (2020)
3. Cloete, A. Technology and education: Challenges and opportunities. *HTS: Theological Studies*. **73**, 1-7 (2017)
4. Sassi, M., Chaibi, A. & Najbi, M. The Kingdom of Morocco. *TIMSS 2011 Encyclopedia*. pp. 605 (2015)
5. Mansouri, Z. & Moumine, M. Primary and Secondary Education in Morocco: From Access to School into Generalization to Dropout.. *International Journal Of Evaluation And Research In Education*. **6**, 9-16 (2017)
6. Berrada, K., El Kharki, K. & Ait Si Ahmad, H. Science Education in Morocco. *Science Education In Countries Along The Belt Road: Future Insights And New Requirements*. pp. 93-112 (2022)
7. Avitabile, C., D'Souza, R., Gatti, R. & Chapman, E. Insights from Disaggregating the Human Capital Index. (World Bank Group,2020)
8. Kim, W. Educational psychological analysis of classroom collapse. *Korean Journal Of Anthropology Of Education*. **3**, 79-138 (2000)
9. Kim, M. School collapse, a myth or a reality. *Educational Anthropology*. **3** pp. 1-29 (2000)
10. Kim, J. Education reform policies and classroom teaching in South Korea. *International Studies In Sociology Of Education*. **14**, 125-146 (2004)
11. Jeong, E. Education Reform for the Future: A Case Study of Korea.. *International Journal Of Education And Development Using Information And Communication Technology*. **16**, 66-81 (2020)
12. Lee, S. & Lee, K. Smart teachers in smart schools in a smart city: teachers as adaptive agents of educational technology reforms. *Learning, Media And Technology*. **49**, 456-477 (2024)
13. Gu, Y., Guo, S., Gan, Y., Qin, X., Qu, W. & Wang, Z. Global justice index report 2024. *Chinese Political Science Review*. pp. 1-100 (2025)
14. Kordzadeh, N. & Ghasemaghaei, M. Algorithmic bias: review, synthesis, and future research directions. *European Journal Of Information Systems*. **31**, 388-409 (2022)
15. Lin, W. & Tsai, C. Missing value imputation: a review and analysis of the literature (2006–2017). *Artificial Intelligence Review*. **53**, 1487-1509 (2020)
16. Mahoney, J., Vandell, D., Simpkins, S. & Zarrett, N. Adolescent Out-of-School. *Handbook Of Adolescent Psychology, Volume 2: Contextual Influences On Adolescent Development*. **2** pp. 228 (2009)
17. Ibourk, A. & Raoui, S. Territorial obstacles causing early school dropout in Morocco: Multivariate spatial analysis. *Heliyon*. **11** (2025)
18. Henriksson, A. Primary School Teachers' Perceptions of Out of School Learning within Science Education.. *LUMAT: International Journal On Math, Science And Technology Education*. **6**, 9-26 (2018)
19. Belamghari, M. Emergency remote learning in Morocco as a response to the Covid-19 pandemic: students' perspectives. *Learning: Research And Practice*. **9**, 39-56 (2023)
20. Ikediashi, N. & Amaechi, O. Pupil–Teacher Ratio: Implication for Quality Education in Nigeria Primary Schools. *AFRREV IJAH: An International Journal Of Arts And Humanities*. **1**, 257-264 (2012)

21. Bahaddi, T. & Karim, M. Impact of public expenditure on the growth in Morocco: Role of governance. *International Journal Of Economics And Finance*. **9**, 12-19 (2017)
22. Imbova, M., Mackatiani, C., Getange, K. & Bogonko, S. Students' completion rates: implications for teaching and learning Resources in Secondary Schools in Kenya. *Journal Of Education And Practice*. **9**, 38-43 (2018)
23. Cameron, L. Primary completion rates. *Technical Paper WP-09*. **1** (2005)
24. Handa, S. Raising primary school enrolment in developing countries: The relative importance of supply and demand. *Journal Of Development Economics*. **69**, 103-128 (2002)
25. Asante, G. The effects of cost elimination on secondary school enrolment in Sub-Saharan Africa. *Educational Review*. **76**, 561-585 (2024)