

Statistical Literacy and Research Capacity in Moroccan Higher Education: A Critical Review and Research Agenda

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ABSTRACT: This critical review examines statistical literacy and research capacity in Moroccan higher education within the context of the ESRI 2030 reform initiative. Drawing on scientometric analyses, qualitative research with Arab scholars, and statistical literacy frameworks, the article synthesizes evidence on Morocco's research infrastructure, productivity patterns, and methodological competencies. Morocco's tertiary system has expanded dramatically to 1.35 million students across 13 public universities by 2022, supported by unprecedented governmental investment of 14 billion dirhams (2023) and a 3 billion dirham World Bank loan targeting higher education transformation. Despite producing 1,574 scientific articles annually and ranking fourth in Africa for total output, Morocco's per capita productivity of 47 publications per million inhabitants places it in the lower tier of Arab countries. Scientometric analyses reveal that mid-2000s stagnation in research productivity coincided with structural policy challenges including teaching pressure, promotion system reforms, language policy inconsistencies, and complex research bureaucracy. Qualitative studies document that Arab researchers, including Moroccan participants, face insufficient methodological training, limited institutional support, and heavy workloads constraining research engagement. Applying Gal's (2002) multidimensional framework and Callingham and Watson's (2017) developmental perspective, the review identifies critical gaps in current knowledge: no systematic assessment of statistical literacy among Moroccan educational researchers exists despite its foundational importance for evidence-based policy development. The article proposes a comprehensive research agenda addressing doctoral curriculum reform, institutional support infrastructure, professional development programs, and cultural transformation valuing rigorous quantitative research. While recent financial investments create necessary conditions for research excellence, translating infrastructure into capacity requires strategic attention to methodological training and evidence-informed policy implementation. The review concludes that statistical literacy represents a critical yet underexamined dimension of Morocco's research transformation agenda under ESRI 2030.

KEYWORDS: statistical literacy, research capacity, Moroccan higher education, ESRI 2030, quantitative methods, Arab researchers, scientometric analysis, educational research

1. INTRODUCTION

Statistical literacy defined by Gal (2002) as the ability to "interpret and critically evaluate statistical information, data-related arguments, or stochastic phenomena" and to "discuss or communicate their reactions to such statistical information" (p. 2) which represents a foundational competency for educational researchers in the contemporary evidence-based research environment. The development of robust statistical literacy is particularly critical in higher education systems undergoing rapid transformation, where research quality determines both institutional competitiveness and the capacity to address societal challenges through evidence-informed policy and practice.

Morocco's higher education system presents a compelling context for examining statistical literacy and

research capacity. Since independence in 1956, the system has expanded from a handful of institutions to encompass 13 public universities serving over 1.35 million students as of 2022 (Statista, 2024). This represents remarkable quantitative growth, with an average annual expansion rate of 11% during the post-colonial period (StateUniversity.com, 2000). Recent governmental initiatives signal renewed commitment to research excellence: the Ministry of Higher Education, Scientific Research, and Innovation allocated 14 billion dirhams (MAD 14 billion, approximately USD 1.4 billion) to support research and education in 2023 (Bedraoui, 2024; Royaume du Maroc, 2023), supplemented by a 3 billion dirham (MAD 3 billion, approximately USD 300 million) World Bank loan specifically targeting higher education transformation.

However, quantitative expansion has not translated uniformly into research quality or international visibility. As Jaida and Haoucha (2025) document in their comprehensive analysis: "only one Moroccan public university appeared in the 2025 QS World University Rankings, namely Mohammed V University of Rabat, being ranked in the 1001-1200 range" (p. 468). This gap between enrollment growth and research competitiveness motivates critical examination of the factors including methodological capacity and statistical literacy that constrain research development in the Moroccan context.

1.1. Purpose and Scope

This article pursues three integrated objectives. First, it synthesizes published research on statistical literacy frameworks and their application in educational research contexts, establishing theoretical foundations for understanding methodological competencies. Second, it critically reviews empirical evidence regarding research practices and challenges among Moroccan and Arab researchers, drawing on recent qualitative studies (Elgamri et al., 2024) and scientometric analyses (Bouabid et al., 2014; Kabba & Ejbari, 2021). Third, it identifies critical knowledge gaps and proposes a systematic research agenda to inform Morocco's ESRI 2030 reform implementation, with specific attention to evidence needs for policy development. Throughout, the article maintains focus on educational research specifically, while acknowledging broader patterns across social science disciplines.

2. THE MOROCCAN HIGHER EDUCATION CONTEXT: INFRASTRUCTURE AND REFORM

2.1. System Structure and Enrollment Patterns

Morocco's contemporary higher education system comprises two primary sectors, which are public and private. The public sector serves the vast majority of students, includes 13 universities and 145 higher education establishments, divided into 61 open-access and 84 limited-access institutions (Moroccan Ministry of Higher Education, 2019). The private sector includes over 200 institutions, though these require program accreditation for state recognition -a process formalized through Ministry decree in 2012. The educational qualifications of Moroccan researchers have increased significantly since the early 1990s, though challenges in research training infrastructure persist (Wikipedia, 2024).

Enrollment has grown substantially over recent decades. From approximately 100,000 students in the 1980s and 250,000 by the late 1990s (StateUniversity.com, 2000), tertiary enrollment reached approximately 1.35 million by 2022 (Statista, 2024). This growth reflects expanded access but also creates challenges for maintaining educational quality and research mentorship ratios. Historical data from 2000 indicated that approximately 7,000 faculty members (assistants, lecturers, professors, researchers) worked across Moroccan higher education institutions, yielding a professor-to-student ratio of approximately 1:27 in general colleges and 1:6 in technical institutes (StateUniversity.com, 2000). By 2022, the number of teaching staff at the tertiary level had grown to approximately 39,000 (12,900 women and 26,100 men), though the student-to-faculty ratio has remained challenging given enrollment expansion (Statista, 2024).

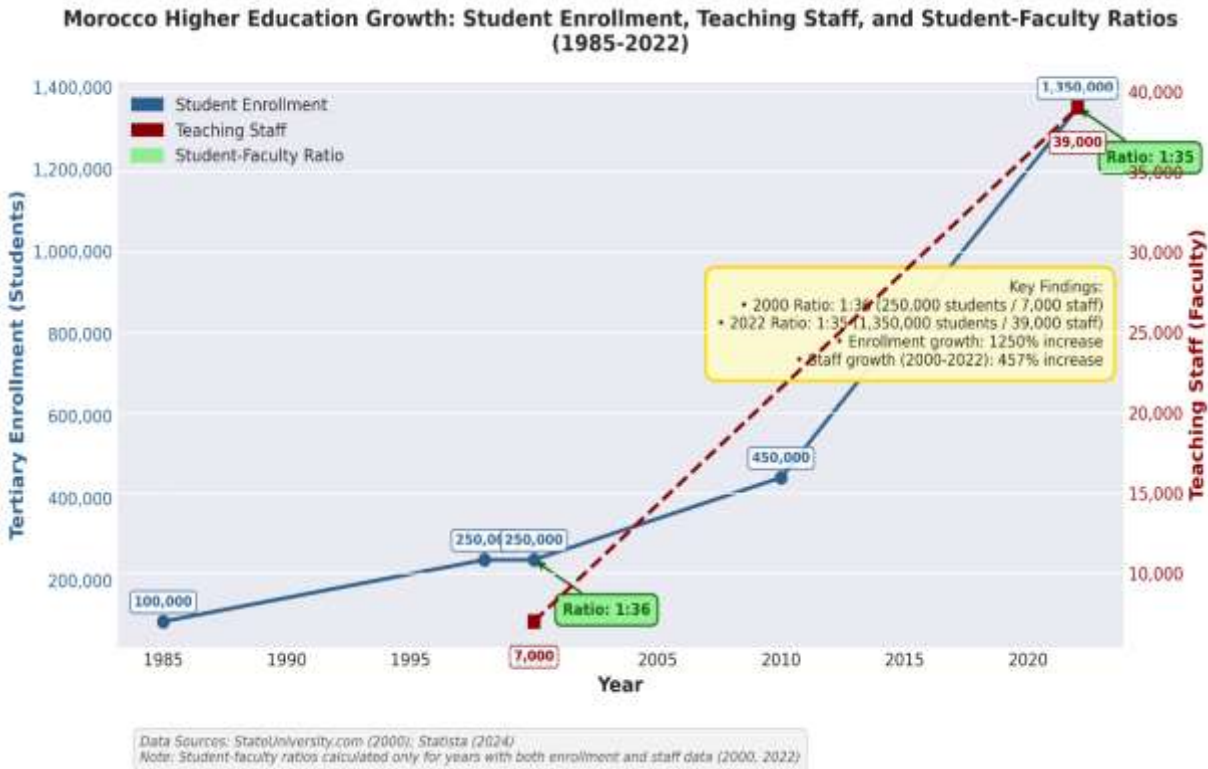


Figure 1: Tertiary Enrollment Growth, Teaching Staff Expansion, and Student-Faculty Ratios in Moroccan Higher Education (1985-2022).

Figure 1 illustrates the dramatic expansion of Morocco's tertiary education system over four decades, with enrollment increasing thirteen-fold from 100,000 students in the mid-1980s to 1.35 million by 2022, while teaching staff expanded approximately five-fold from 7,000 (2000) to 39,000 (2022). Notably, student-faculty ratios remained relatively stable between 2000 (1:36) and 2022 (1:35), suggesting that faculty hiring kept pace with enrollment growth during this period. However, this aggregate stability masks important variations: StateUniversity.com (2000) reported ratios of 1:27 in general colleges versus 1:6 in technical institutes, indicating substantial institutional heterogeneity that persists across Morocco's differentiated university system.

These patterns have direct implications for research capacity and statistical literacy development. Faculty members serving 35 students -combined with administrative duties- face substantial teaching loads that constrain time available for both conducting research and developing methodological skills. This structural reality operationalizes what Kabba and Ejbari (2021) identified as "teaching pressure in universities" (#7 in their framework of factors negatively impacting research productivity). Moreover, the rapid expansion created a system where many current faculty completed their doctoral training during periods of resource scarcity prior to recent financial investments, potentially limiting their exposure to rigorous quantitative methods training. This historical context explains why statistical literacy gaps may persist despite improved funding, and why targeted professional development represents a critical complement to financial investment in achieving ESRI 2030's research capacity objectives.

2.2. Recent Reform Initiatives: ESRI 2030 and Financial Investment

Morocco's higher education has undergone multiple reform waves, including the National Charter for Education and Training (1999) and the Strategic Vision 2015-2030. Most recently, the Pacte ESRI 2030 (Education, Scientific

Research, and Innovation Ecosystem) framework aims to "accelerate the transformation of public universities in Morocco" (Jaida & Haoucha, 2025, p. 455). This reform agenda represents a comprehensive approach to addressing systemic challenges while building on existing strengths identified in Morocco's 2003 self-evaluation, which found "a good supply of well-trained high quality human resources" and "some laboratories of very high quality" despite gaps in research-innovation linkages (Wikipedia, 2024, para. 1).

The ESRI 2030 framework is supported by unprecedented financial commitments. The Ministry of Higher Education, Scientific Research, and Innovation allocated 14 billion dirhams (MAD 14 billion) for research and education in 2023 (Bedraoui, 2024; Royaume du Maroc, 2023), while the World Bank approved a 3 billion dirham (MAD 3 billion) loan specifically for higher education and innovation transformation. These investments build on earlier commitments: in 2009, the government signed 12.6 billion dirhams (MAD 12.6 billion) in new agreements to improve university quality as part of the National Education Emergency Support Programme 2009-2012 (Wikipedia, 2024).

These investments have produced tangible changes in research conditions. As Bedraoui (2024), a PhD candidate at Mohammed VI Polytechnic University, documents: "Just a few years ago, PhD students in Morocco had to pay for conferences and publications out of their own pocket, often borrowing money, and they had to secure full-time jobs to support their research. Now, everything is changing" (p. 2). The government introduced 7,000 dirham (MAD 7,000) monthly scholarships for PhD students at public universities (Bedraoui, 2024), with some institutions offering up to 10,000 dirhams (MAD 10,000) monthly for excellence scholarships. These financial supports represent fundamental shifts in research infrastructure, enabling full-time doctoral study without external employment—a development that creates conditions for more rigorous methodological training.

Comprehensive Table of Morocco's Higher Education Financial Commitments (2009–2023)

Initiative/Programme	Amount (MAD)	USD Equivalent	Year/Period	Source/Citation
National Education Emergency Support Programme	12.6 billion	~1.26 billion	2009–2012	Wikipedia, 2024
ESRI 2030 Ministry allocation	14 billion	~1.4 billion	2023	Bedraoui, 2024; Royaume du Maroc, 2023
World Bank loan	3 billion	~300 million	2023	Wikipedia, 2024
PhD scholarships (public universities)	7,000/month	~700/month	From 2022	Bedraoui, 2024
Excellence scholarships (select institutions)	up to 10,000/month	up to ~1,000/month	From 2022	Bedraoui, 2024
UM6P funding from OCP Foundation	10 billion	~1 billion	2020–2023	Bedraoui, 2024

This table demonstrates Morocco's unprecedented escalation in higher education financial commitments since 2009, notably with large-scale government allocations,

targeted international loans, and the introduction of monthly scholarships for doctoral students and high-achievers at select institutions. Notably, the 2023 ESRI 2030 allocation

is the largest single annual investment, reflecting policy prioritization of research and capacity-building. However, as highlighted by Bedraoui (2024), such improvements are unevenly distributed, with elite institutions (like UM6P) benefiting disproportionately. While financial infrastructure is essential for research excellence, complementary reforms in training and support systems remain critical for wider impact on research productivity and statistical literacy among educational researchers.

While these financial investments represent substantial progress, important caveats merit attention. First, Bedraoui's testimony reflects experiences at Mohammed VI Polytechnic University (UM6P), which received approximately 10 billion dirhams (MAD 10 billion) from the OCP Foundation, far exceeding resources available to the 12 public universities serving the majority of Moroccan students and researchers. Whether improvements generalize beyond elite institutions requires empirical verification. Second, as Kabba and Ejbari (2021) document through scientometric analysis, funding alone does not ensure research productivity without addressing structural barriers including teaching loads, promotion systems, and methodological training gaps. Thus, while financial infrastructure improvements create necessary conditions for research excellence, they represent insufficient conditions absent complementary reforms in training, support systems, and institutional culture.

3. MOROCCO'S RESEARCH PRODUCTIVITY: THE QUANTITY-QUALITY PARADOX

3.1. Publication Output and International Positioning

Morocco's scientific output presents a paradoxical picture that reveals both achievements and limitations. According to Thomson Reuters' Web of Science, Moroccan authors produced 1,574 articles catalogued in the Science Citation Index Expanded in 2014 (Wikipedia, 2024). The number of scientific articles catalogued in international journals has risen steadily since 2006, when these numbered 990 (Wikipedia, 2024). As Hammouti et al. (2023) report "Among African countries, Morocco ranks fourth behind Egypt, South Africa and Nigeria" in total scientific production (p. 2). This represents substantial absolute output and positions Morocco as a significant contributor to African research, with Morocco home to 39 research institutions according to the Scimago database (Bedraoui, 2024).

However, adjusted for population, Morocco's productivity reveals important limitations. The 1,574 articles in 2014 "corresponds to 47 per million inhabitants, which is towards the low end of the scale in the Arab world" (Wikipedia, 2024, para. 3). The same source indicates that "only Libya, Iraq, Syria, Sudan, Yemen, Mauritania and Palestine had a lower publication intensity in 2014" among Arab countries. This per capita measure suggests that Morocco's absolute ranking reflects population size more than research intensity. In comparison, the global average for researchers per million inhabitants was 1,368 in 2018, while Morocco's research intensity remained below this benchmark (Wikipedia, 2024).

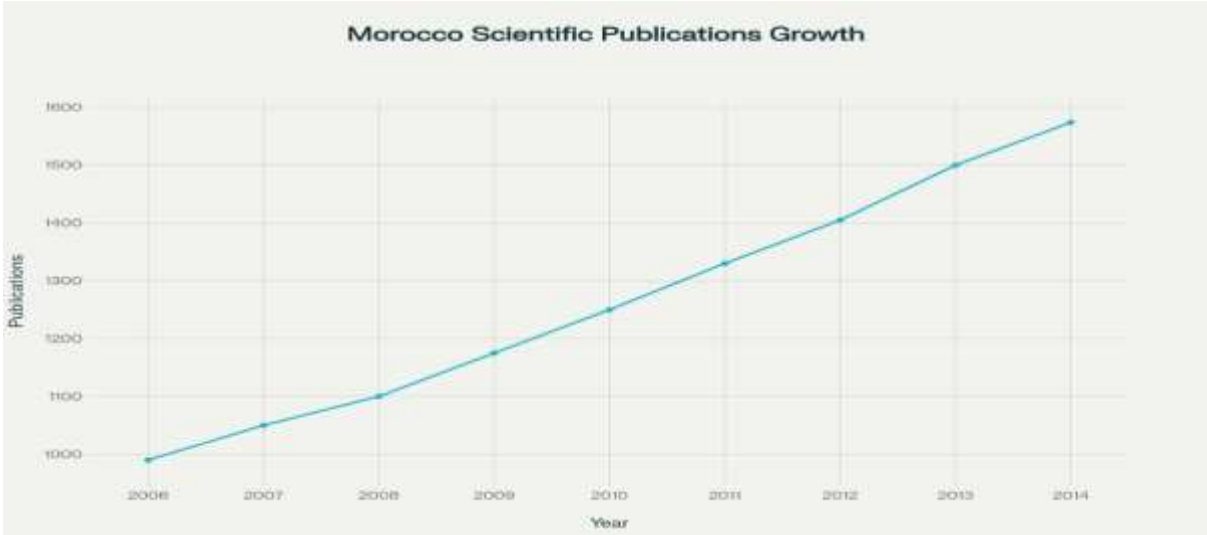


Figure 2. Comparative visualization of Morocco's scientific research output (2006-2014).

Figure 2 provides a multi-faceted view of Morocco’s place within African and Arab scientific publication landscapes. Panel A illustrates Morocco’s 4th rank in Africa for total scientific publications, trailing only Egypt, South Africa, and Nigeria (Hammouti et al., 2023). However, as Panel B demonstrates, Morocco’s per capita research productivity in 2014 was just 47 publications per million inhabitants, placing it well below the leading Arab countries and just

above the lowest-performing peers (Wikipedia, 2024). Panel C visualizes robust yet gradual publication growth from 2006 to 2014, confirming that absolute gains remain tempered by persistent capacity and structural challenges. These findings underscore that while Morocco's scientific visibility has increased, serious gaps remain in per-capita output and research intensity, necessitating targeted institutional and policy reforms for sustained advancement.

3.2. Productivity Trends and Systemic Barriers

Longitudinal analysis reveals concerning patterns beneath the surface growth. Kabba and Ejbari (2021) document that Morocco's "scientific output underwent stagnation and even decline in the mid-2000s relegating Morocco to the last rank of the Maghreb countries" (p. 3). Their rigorous scientometric analysis identifies ten governmental decisions that negatively impacted research activity, creating a comprehensive framework for understanding Morocco's research productivity challenges:

"(1) the use of different scientific languages in schools and universities, (2) abolition of the State Doctorate, (3) the promotion system of professors, (4) the complex bureaucracy of project management, (5) the Voluntary Departure initiative, (6) administrative equivalence of Master and PhD, (7) teaching pressure in universities, (8) ageing of professors and supporting administrative personnel, (9) preference given to expertise over research activity, (10) fled of PhD students" (Kabba & Ejbari, 2021, p. 3).

These structural factors illuminate why financial investment alone may prove insufficient for research development. Teaching pressure (7), for instance, directly constrains time available for both conducting research and developing methodological skills. The equivalence of

Master's and PhD degrees (6) potentially undermines incentives for advanced training in research methods. Language policy inconsistencies (1) create barriers to international collaboration and accessing methodological resources predominantly available in English, while also creating confusion about language of instruction within Moroccan institutions.

Bouabid et al. (2014), in their comprehensive scientometric analysis of Moroccan university research metrics, found that "just by setting S&T metrics as objective indicators there was an increasing research outputs: productivity, impact, and collaboration. However, overall productivity is still far low when brought to academic staff size and that a huge difference exists among universities achievements" (p. 1). This productivity gap relative to staff numbers suggests that many faculty either lack research capacity or face institutional constraints preventing research engagement, which can be considered as a pattern entirely consistent with Kabba and Ejbari's (2021) identification of structural barriers. The finding that "a huge difference exists among universities achievements" additionally highlights institutional variation in research culture and support systems that merit investigation.



Figure 3. Morocco's Research Productivity Trajectory: Trends, Institutional Variation, and Policy Challenges (2000–2020).

Figure 3 offers a focused depiction of Morocco's research productivity and policy context from 2000 to 2020. Panel A demonstrates how mid-2000s stagnation in publication output directly aligns with adverse policy shifts, including promotion system reforms and the abolition of the State Doctorate, as identified by Kabba & Ejbari (2021). Panel B exposes substantial disparities in research productivity across leading universities, signaling persistent variation in institutional resources and academic culture (Bouabid et al., 2014). Panel C details the chronology of ten major negative policy decisions, illustrating their cumulative impact on the higher education system's research performance.

Taken together, these panels reveal that Morocco's apparent research productivity is ranking fourth in Africa, and is undermined by low per-capita output and complex barriers, including underfunding, heavy teaching loads, limited training opportunities, and fragmented policy support. Improving capacity therefore demands comprehensive reforms: strengthening doctoral training, enhancing institutional research infrastructure, rationalizing workloads, implementing incentive systems for scholars, and adapting language policies to foster international engagement within a multilingual environment.

4. STATISTICAL LITERACY: CONCEPTUAL FRAMEWORK AND ASSESSMENT

4.1. Defining Statistical Literacy for Educational Researchers

Gal's (2002) comprehensive framework defines statistical literacy through two interrelated dimensions that extend beyond computational proficiency. The first encompasses "people's ability to interpret and critically evaluate statistical information, data-related arguments, or stochastic phenomena, which they may encounter in diverse contexts" (p. 2). The second addresses "their ability to discuss or communicate their reactions to such statistical information" (p. 2). This dual focus, interpretation and communication, distinguishes statistical literacy from mere computational competence or theoretical knowledge, positioning it as an integrated capability requiring both technical and critical thinking skills.

Gal (2002) identifies five knowledge components essential for statistical literacy: (1) literacy skills (ability to read and interpret text, graphs, tables), (2) statistical knowledge (understanding of key statistical concepts and terms), (3) mathematical knowledge (computational skills and understanding of mathematical relationships), (4) context knowledge (understanding of the context in which statistical information appears), and (5) critical questions (ability to formulate critical questions about statistical claims). Additionally, two dispositional components prove essential: (6) critical stance (questioning attitude toward statistical claims) and (7) attitudes and beliefs (confidence and motivation regarding statistics). This multidimensional framework recognizes that statistical literacy requires integration of technical competencies with domain knowledge and critical dispositions.

Callingham and Watson (2017) extend this framework by documenting developmental progressions in statistical literacy. Their longitudinal research demonstrates that "the development of statistical literacy at school" proceeds through hierarchical levels, from basic graph reading to sophisticated critical evaluation of statistical arguments (p. 181). This developmental perspective proves crucial for understanding how researchers acquire and refine statistical competencies through education and practice, suggesting that statistical literacy development continues throughout doctoral training and professional careers rather than representing a fixed achievement at degree completion.

CONCLUSION

This comprehensive review documents that Morocco's higher education system stands at a critical juncture of transformation. Substantial quantitative expansion (1.35 million students across 13 public universities) combined with unprecedented financial investment (14 billion dirhams governmental allocation, 3 billion dirhams World Bank support, monthly doctoral scholarships of 7,000 dirhams) creates infrastructure for research development. However,

Morocco's research productivity; while ranking fourth in Africa with 1,574 annual publications, it yields only 47 publications per million inhabitants, placing Morocco in the lower tier of Arab countries (Wikipedia, 2024; Hammouti et al., 2023).

Scientometric analyses identify structural barriers including teaching pressure, complex bureaucracy, language policy inconsistencies, and promotion system issues (Kabba & Ejbari, 2021; Bouabid et al., 2014). Qualitative research with Arab researchers, including Moroccan participants, documents insufficient methodological training, limited institutional support, and heavy workloads constraining research engagement (Elgamri et al., 2024). Yet systematic assessment of statistical literacy and methodological competencies among Moroccan educational researchers remains absent from published literature, limiting evidence-based policy development for the ESRI 2030 reform implementation.

As Jaida and Haoucha (2025) observe in their comprehensive analysis of Morocco's higher education landscape, "a steadfast commitment to world-class education standards is essential to enhancing its performance, visibility, and competitiveness on the global stage" (p. 473). Achieving this commitment requires not merely financial investment but systematic, evidence-based interventions addressing methodological capacity at multiple levels: doctoral curriculum reform, institutional support infrastructure, professional development programs, and cultural change valuing rigorous research.

Morocco's recent progress provides grounds for optimism. As Bedraoui (2024) notes: "Just a few years ago, PhD students in Morocco had to pay for conferences and publications out of their own pocket, often borrowing money, and they had to secure full-time jobs to support their research. Now, everything is changing" (p. 2). Financial infrastructure improvements create conditions for research excellence. Translating infrastructure into actual research capacity requires strategic attention to methodological training, institutional support systems, and evidence-based policy implementation informed by systematic research on statistical literacy and research practices. Statistical literacy represents one critical dimension of this broader transformation agenda -a dimension currently underexamined but essential for Morocco's research competitiveness and the success of ESRI 2030.

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