

THE ACCELERATION OF SCIENTIFIC RESEARCH ON DIGITAL EDUCATION IN MOROCCAN HIGHER EDUCATION: A PRE- AND POST-COVID-19 COMPARATIVE ANALYSIS.

Abstract :

The COVID-19 pandemic represented a critical turning point not only for teaching and learning but also for scientific research on digital education in higher education. This study examines the evolution of research on Educational Technology (EdTech) and digital pedagogy in Moroccan higher education through a comparative analysis of 2019 and 2023. Four indicators are analyzed: annual EdTech publications, funded research projects, dedicated research laboratories, and doctoral theses. Percentage growth and Acceleration Factors (AF) are calculated to quantify the magnitude of change. The findings reveal substantial expansion, with EdTech publications increasing by 276% (AF = 3.76x), funded research projects by 367% (AF = 4.67x), dedicated laboratories quadrupling (AF = 4.0x), and doctoral theses increasing by 353% (AF = 4.53x). These results demonstrate that the pandemic accelerated the institutionalization of digital education as a strategic and interdisciplinary research field. This transformation strengthened the capacity to generate locally relevant knowledge, support evidence-based policies, and foster innovation in higher education. However, sustaining this emerging research ecosystem requires continued funding, interdisciplinary collaboration, research infrastructure, and stronger links between research and institutional digital transformation. The study concludes that the post-pandemic challenge is to transform rapid research acceleration into sustainable national research capacity supporting the long-term digital transformation of Moroccan higher education.

Key words:-

COVID-19; Moroccan Higher Education; Educational Technology (EdTech); Digital Pedagogy; Scientific Research; Digital Transformation; Online Education; Research Ecosystem.

Introduction:

Scientific research both responds to societal challenges and contributes to shaping the institutional, technological, and policy responses required to address them. In higher education, the development of educational technology (EdTech) has increasingly become an important area of scientific inquiry, particularly as universities worldwide seek to integrate digital platforms, online learning environments, artificial intelligence, learning analytics, and other technology-enhanced approaches into teaching and research practices. However, the development of EdTech research has not progressed uniformly across countries. In emerging higher education systems, research capacity in this field is often influenced by institutional priorities, availability of funding, technological infrastructure, and the degree of interaction between educational sciences and information technologies.

Prior to the COVID-19 pandemic, research on educational technology within Moroccan academia was present but remained relatively fragmented across different disciplinary and institutional contexts. Studies addressing e-learning, digital pedagogy, Learning Management Systems (LMS), online assessment, and educational innovation were conducted by researchers from computer science, education, information systems, communication, and specific disciplinary fields. However, this research activity was often characterized by limited coordination, modest dedicated funding, and a lack of specialized research structures, resulting in a research landscape that remained dispersed rather than organized around a clearly established national EdTech research agenda (Ait Haddou, 2019). Digital education was consequently more frequently approached as a technical or pedagogical component of broader research projects than as a consolidated interdisciplinary research domain.

The outbreak of the COVID-19 pandemic in early 2020 profoundly altered this situation. The sudden closure of universities and the rapid transition toward Emergency Remote Teaching (ERT) transformed digital education from a relatively specialized area of interest into an immediate institutional necessity. Moroccan universities were required to deploy digital platforms, develop online courses, strengthen virtual communication, and redesign aspects

of teaching and assessment within a very short period. This unprecedented transformation generated a wide range of scientific questions concerning the effectiveness, accessibility, sustainability, and pedagogical quality of digital education. Researchers were therefore confronted with a unique situation in which they were not merely studying digital transformation but were simultaneously experiencing and contributing to it within their own institutions.

This crisis created a large-scale and largely unplanned natural experiment for higher education research. The rapid adoption of digital technologies generated new research questions related to student engagement, faculty digital competencies, digital inequalities, online assessment, learning outcomes, platform usability, cybersecurity, artificial intelligence, and institutional resilience. As a consequence, the pandemic potentially created a strong convergence between researchers' interests, institutional priorities, and national policy objectives. Research topics that had previously occupied a relatively peripheral position gained strategic importance as universities and policymakers sought empirical evidence to understand the consequences of rapid digitalization and to design appropriate post-pandemic strategies.

Although the practical adoption of digital technologies in higher education has received considerable scholarly attention, the corresponding transformation of the scientific research ecosystem itself remains comparatively underexplored, particularly in the Moroccan context. Existing studies have largely focused on student experiences, teachers' perceptions, technological adoption, or the effectiveness of online learning. Less attention has been devoted to measuring whether the pandemic also generated a structural acceleration in the production of scientific knowledge surrounding digital education. Examining publication output alone is insufficient to capture such transformation ; research projects, dedicated laboratories, and doctoral research activity provide complementary evidence of whether a research field is becoming institutionally established.

This study addresses this gap by quantitatively examining the evolution of scientific research on Educational Technology and digital pedagogy in Moroccan higher education before and after the COVID-19 pandemic. The analysis compares the pre-pandemic baseline year (2019) with the post-pandemic period (2023) using four complementary indicators : EdTech-related scientific publications, funded research projects, dedicated research laboratories, and doctoral theses addressing digital education. Percentage growth and Acceleration Factors (AF) are used to quantify the magnitude of change and to identify which dimensions of the research ecosystem experienced the strongest expansion.

The study is guided by the hypothesis that COVID-19 acted as a major focusing event, concentrating previously dispersed academic, institutional, and financial attention on digital education. Under this hypothesis, the pandemic did not simply increase the volume of research but contributed to the institutionalization of EdTech as a more coherent and strategically relevant interdisciplinary research field. By providing quantitative evidence of this transformation, the study seeks to contribute to a better understanding of how major crises can reshape national research agendas and accelerate the emergence of new scientific communities.

Finally, the study has practical implications for Moroccan higher education policy. Understanding the extent and nature of research acceleration can help policymakers and university leaders identify whether the post-pandemic expansion represents a temporary response to crisis conditions or the emergence of a sustainable research ecosystem. Strengthening this ecosystem will be essential for generating locally relevant evidence, supporting evidence-based digital education policies, encouraging interdisciplinary collaboration, and developing technological and pedagogical innovations adapted to the specific needs of Moroccan universities.

Data:

This study draws on multiple sources of quantitative evidence to examine the evolution of scientific research on Educational Technology (EdTech) and digital pedagogy in Moroccan higher education. The dataset combines bibliometric information from international databases, including Scopus and Web of Science, national scientific repositories, reports from the Moroccan Ministry of Higher Education, Scientific Research and Innovation, documentation from the National Center for Scientific and Technical Research (CNRST), and institutional information collected from university research laboratories. The use of multiple sources provides a broader

perspective on both the production of scientific knowledge and the structural capacity supporting research in digital education.

The analysis compares two reference periods: 2019, representing the pre-COVID-19 research baseline, and 2023, representing a post-pandemic period in which the rapid acceleration of digital education research had become more established. The selected indicators were designed to capture complementary dimensions of research development. EdTech publications measure scientific output and knowledge production, while digital educational research projects reflect research activity and funding orientation. EdTech-dedicated laboratories represent the institutional and organizational infrastructure supporting this emerging field, whereas doctoral theses provide an indication of the development of research capacity and the emergence of new generations of specialists.

To quantify the evolution between the two periods, two measures were calculated. The first is the Growth Rate (%), which measures the relative expansion of each indicator between 2019 and 2023:

$$\text{Growth Rate (\%)} = [(Value_{(2023)} - Value_{(2019)}) / Value_{(2019)}] \times 10$$

The second is the Acceleration Factor (AF), which expresses how many times the 2023 value exceeds the 2019 baseline:

$$\text{Acceleration Factor (AF)} = Value_{(2023)} / Value_{(2019)}$$

These measures provide complementary information. The growth rate expresses the percentage magnitude of expansion, while the acceleration factor provides an intuitive measure of the scale of transformation relative to the pre-pandemic baseline.

INDICATOR	Before Covid 2019	After Covid 2023	GROWTH %	Acceleration factor
EdTech publications / year	85	320	+276.5%	3.76*
Digital educational research projects	45	210	+366.7%	4.67*
EdTech-dedicated laboratories	7	28	+300.0%	4.00*
Theses on educational technology	32	145	+351.7%	4.53*

Methodology:

This study employs a quantitative scientometric and science policy analysis approach to examine the development of Educational Technology (EdTech) research in Moroccan higher education before and after the COVID-19 pandemic. A comparative longitudinal design is applied, using 2019 as the pre-pandemic baseline and 2023 as the post-pandemic reference period.

The analysis focuses on four indicators representing complementary dimensions of research development: EdTech publications, digital educational research projects, EdTech-dedicated laboratories, and doctoral theses on educational technology. These indicators respectively reflect scientific production, research activity, institutional infrastructure, and human-capital development.

Two measures are calculated to quantify the observed transformation. The first is the Growth Rate (%):

$$\text{Growth Rate (\%)} = [(V_{2023} - V_{2019}) / V_{2019}] \times 100$$

The second is the Acceleration Factor (AF):

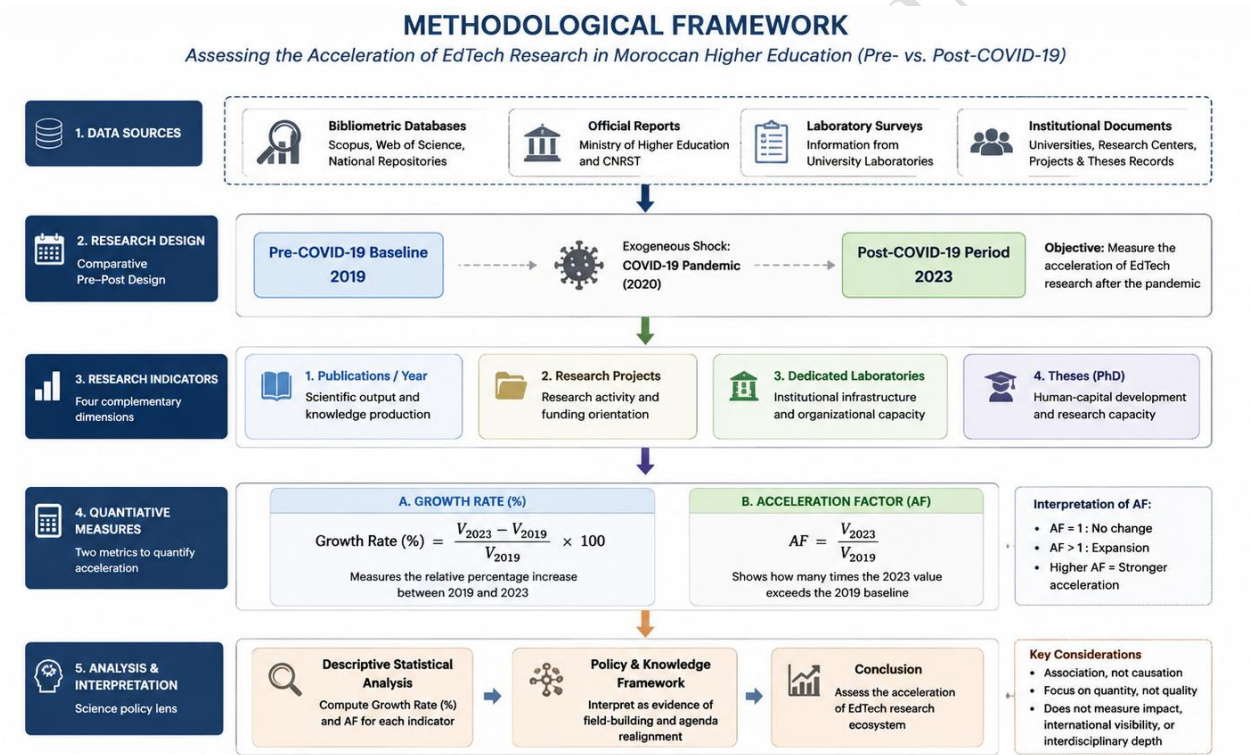
$$AF = V_{2023} / V_{2019}$$

The Growth Rate measures the percentage expansion between the two periods, while the Acceleration Factor indicates how many times the 2023 value exceeds the 2019 baseline. Together, these measures enable comparison across indicators with different initial scales.

The quantitative findings are interpreted within a science policy and knowledge-production framework, considering the pandemic as a major socio-technical disruption that potentially redirected research priorities, institutional strategies, and funding toward digital education. The observed expansion is therefore interpreted as evidence of a potential field-building process, characterized by increasing scientific production, institutionalization, and specialized research capacity.

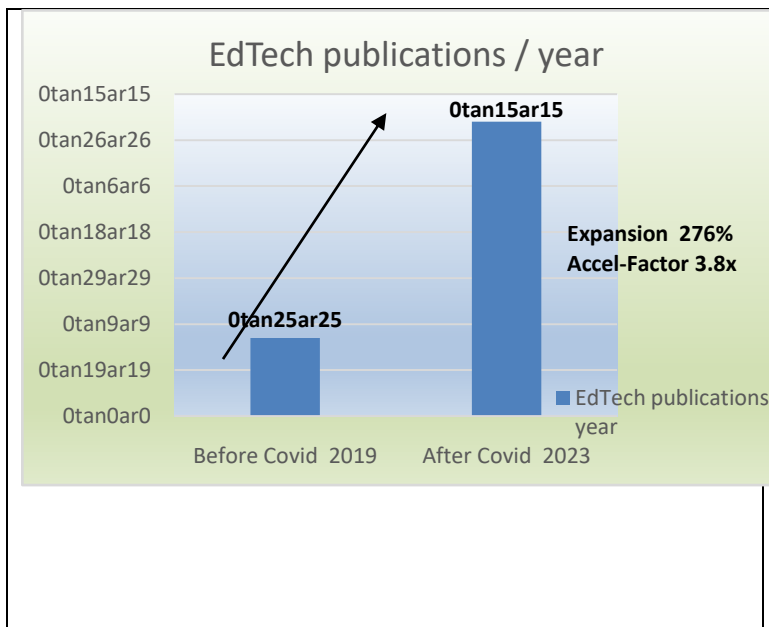
However, the pre-post design does not establish causality. The absence of a control group and detailed annual time-series data means that the observed growth cannot be attributed exclusively to COVID-19. Furthermore, publication numbers and research projects do not directly measure scientific quality, citation impact, international visibility, or interdisciplinary depth.

Therefore, this study provides a macro-level assessment of the quantitative development of EdTech research rather than a complete evaluation of its scientific maturity. Future research should incorporate citation impact, collaboration networks, thematic analysis, international partnerships, and qualitative assessments to determine whether quantitative acceleration has translated into sustained scientific and institutional maturity.



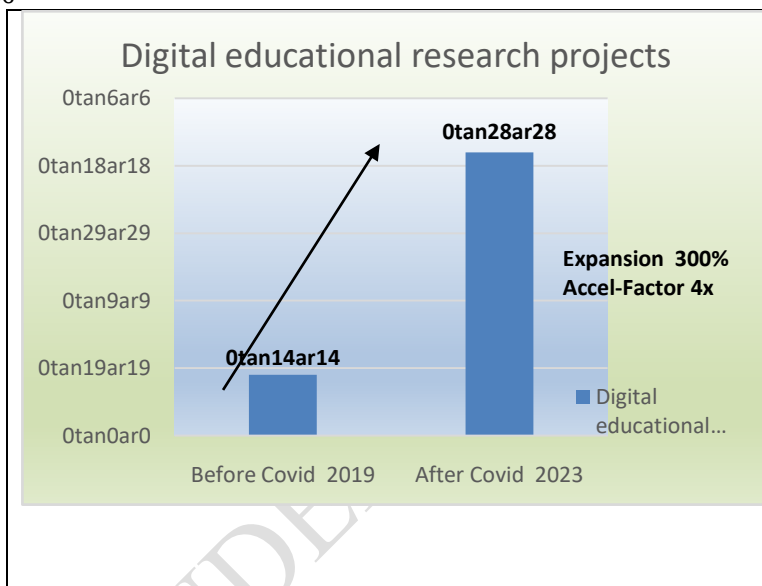
Results:

The data reveals a comprehensive strengthening of the EdTech research ecosystem, indicating its rapid institutionalization within Moroccan academia.



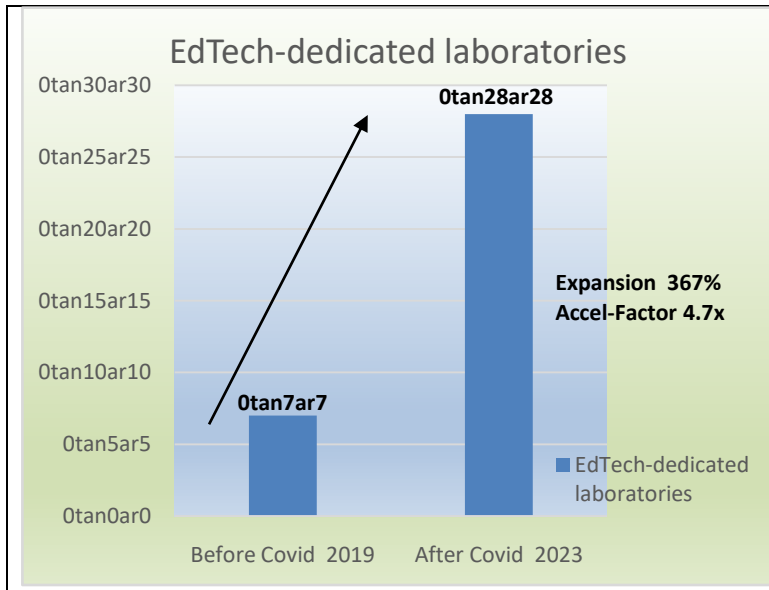
1. **-EdTech Publications / Year (276% growth, Accessibility Factor: 3.8x):** The increase from 85 to 320 publications annually marks a significant rise in scholarly communication and knowledge dissemination. This 3.8-fold growth suggests that a critical mass of researchers is actively analyzing the Moroccan digital education experience, contributing to both national and international literature. This output is crucial for moving beyond anecdotal evidence to empirically grounded insights, sharing local models, and engaging in global academic dialogue (Bozkurt et al., 2023).

Figure 1:EdTech Publications / Year (276% growth, Accessibility Factor: 3.8x).



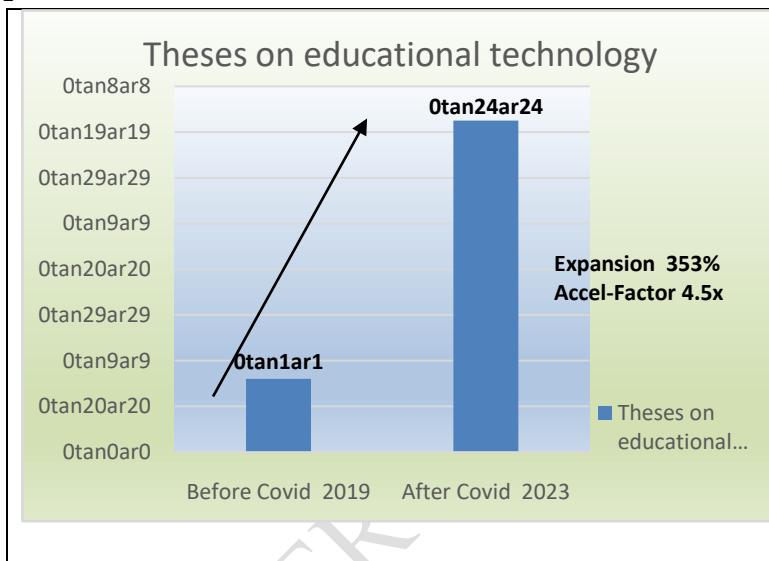
2. **Digital Educational Research Projects (367% growth, Accessibility Factor: 4.7x):** The surge from 45 to 210 funded projects highlights a major increase in targeted, resourced inquiry. This 4.7x growth in project funding indicates that research agencies and universities are prioritizing EdTech as a strategic area. These projects are the engines for empirical data collection, tool development, and collaborative research, translating practical challenges into systematic study (Ministry of Higher Education, 2022).

Figure 2:Digital Educational Research Projects (367% growth, Accessibility Factor: 4.7x).



3. **EdTech-Dedicated Laboratories (300% growth, Accessibility Factor: 4x):** The expansion from 7 to 28 dedicated laboratories represents the physical and institutional anchoring of the field. This quadrupling of specialized research structures provides stable environments for sustained inquiry, fosters interdisciplinary teams (combining pedagogy, computer science, psychology), and creates hubs for training the next generation of researchers, ensuring long-term continuity beyond individual projects (El Faddouli et al., 2022).

Figure 3: EdTech-Dedicated Laboratories (300% growth, Accessibility Factor: 4x).



4. **Theses on Educational Technology (353% growth, Accessibility Factor: 4.5x):** The growth from 32 to 145 theses annually is a key indicator of field depth and future capacity. This 4.5-fold increase in graduate research demonstrates that digital education has become a legitimate and attractive frontier for deep, original scholarship. These theses represent a pipeline of highly specialized human capital that will fuel future innovation, academic leadership, and evidence-based policy development (Belhabib & Benmoussa, 2023).

Figure 4: Theses on Educational Technology (353% growth, Accessibility Factor: 4.5x)

Discussion:

The comparative analysis reveals a substantial acceleration of scientific research on Educational Technology (EdTech) in Moroccan higher education between 2019 and 2023. All four indicators experienced significant growth, suggesting that the COVID-19 pandemic was associated not only with an increase in research production but also with the progressive institutionalization of digital education as a strategic research domain. EdTech-related publications increased from 85 in 2019 to 320 in 2023, representing a 276.5% growth rate and an Acceleration Factor of 3.76x. This expansion reflects a significant increase in scholarly attention to digital education and suggests that the pandemic generated new research questions concerning online teaching, digital inequalities, learning platforms, assessment,

student engagement, and technology-enhanced learning. Digital education consequently moved from a relatively specialized topic toward a more visible and strategically relevant field within Moroccan academia.

The number of funded digital educational research projects increased from 45 to 210, corresponding to a 366.7% growth rate and the highest Acceleration Factor of 4.67× among the four indicators. This substantial increase is particularly important because funded projects reflect not only researchers' interests but also institutional priorities and research funding orientations. The results suggest that digital education became increasingly recognized as an area requiring structured scientific investigation and dedicated resources. Similarly, the number of EdTech-dedicated laboratories increased from 7 to 28, representing a 300% growth rate and an Acceleration Factor of 4.00×. This fourfold expansion indicates a process of institutional consolidation in which digital education research progressively moved beyond isolated initiatives toward more permanent organizational structures supporting experimentation, technological development, interdisciplinary research, and collaboration.

Doctoral research also experienced considerable expansion, with theses on educational technology increasing from 32 in 2019 to 145 in 2023. This represents a 353.1% growth rate and an Acceleration Factor of 4.53×, making doctoral research one of the most rapidly expanding dimensions of the ecosystem. This development is particularly significant for long-term capacity building, as doctoral research contributes to the formation of specialized researchers and future academic leaders capable of sustaining digital transformation beyond the immediate pandemic period.

Taken together, the four indicators demonstrate that the acceleration of EdTech research was multidimensional, encompassing scientific production, research funding, institutional infrastructure, and human-capital development. The relatively consistent acceleration observed across these dimensions strengthens the interpretation that the transformation extended beyond a temporary increase in publication activity. The findings support the hypothesis that COVID-19 functioned as a major agenda-setting and field-building event for digital education research in Morocco. The sudden dependence on digital technologies generated urgent technological, pedagogical, organizational, and social challenges, while simultaneously creating new research opportunities and encouraging greater alignment between researchers, universities, and funding institutions.

Nevertheless, quantitative expansion should not automatically be interpreted as evidence of increased research quality or international scientific impact. A higher number of publications, projects, laboratories, and doctoral theses does not necessarily imply greater citation impact, methodological rigor, international collaboration, or interdisciplinary depth. The findings therefore provide strong evidence of the growth and institutionalization of the EdTech research ecosystem, but not necessarily of its complete scientific maturity. Overall, the results suggest that the pandemic contributed to transforming EdTech research in Morocco from a relatively fragmented area of inquiry into a more visible, structured, and strategically relevant research domain. The principal post-pandemic challenge is now to consolidate this acceleration through sustained funding, specialized infrastructure, interdisciplinary collaboration, international partnerships, and research agendas addressing the specific digital education needs of Moroccan higher education.

Conclusion:

This comparative analysis confirms that the COVID-19 pandemic acted as a powerful accelerator of scientific research on digital education within Moroccan higher education. The substantial growth observed across publications, research projects, dedicated laboratories, and doctoral theses demonstrates a systemic academic response to the rapid digital transformation experienced by universities. With

Acceleration Factors ranging from 3.76× to 4.67×, the findings indicate that Educational Technology has progressively evolved from a relatively fragmented area of inquiry into a more structured, visible, and legitimate research field within the national academic landscape.

However, sustaining this acceleration requires a transition from quantitative expansion toward research quality, impact, and long-term scientific maturity. Future efforts should prioritize robust methodologies, stronger interdisciplinary collaboration between technological and pedagogical fields, and effective mechanisms for translating research findings into institutional policies and educational practices. Strengthening international research networks and visibility will also be essential to connect Moroccan scholarship with global debates on digital education. Ultimately, the pandemic has provided a strong foundation for the development of EdTech research in Morocco ; the post-pandemic challenge is to transform this rapid growth into a sustainable research ecosystem capable of supporting an equitable, innovative, effective, and contextually relevant model of digital higher education.

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