An-Najah University Journal for Research – B
Humanities

مجلة جامعة النجاح للأبحاث – ب
العلوم الإنسانية

The digitalization of higher education and its effects on human capital: an analysis of student skills and satisfaction

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Type: Full Article. Received: 15 December 2025, Accepted: 16 April 2026

Abstract: Objective: The rapid expansion of digital technologies in higher education has reshaped teaching and learning environments, raising important questions about their role in human capital development. While digital transformation is widely promoted as a lever for improving skills and learning outcomes, empirical evidence remains limited in emerging economies, where digital infrastructures and institutional readiness vary significantly. In Morocco, recent national reforms have positioned digitalization as a strategic priority for higher education. This study aims to examine whether digitalized higher education institutions contribute more effectively to the development of technical, digital, and behavioral skills, as well as student satisfaction, compared to non-digitalized learning environments. **Methodology:** A quantitative cross-sectional research design was adopted. Data were collected from a sample of 176 students enrolled in Moroccan public higher education institutions with differing levels of digitalization. Students' skills and satisfaction were measured using a structured questionnaire. The data were analyzed using descriptive statistics, independent sample t-tests, ANOVA, and ordinal logistic regression to identify differences between digitalized and non-digitalized institutional contexts. **Key Findings:** The findings reveal significant differences between the two learning environments. Students studying in digitalized institutions reported higher levels of technical and digital skills, along with greater satisfaction with their learning experience. In contrast, behavioral and soft skills showed only marginal variation between the groups. These results suggest that digitalization plays a meaningful role in strengthening certain dimensions of human capital, while its contribution to social and behavioral competencies remains limited. **Conclusions:** Digitalization enhances certain dimensions of human capital, particularly technical and digital competencies, while its contribution to behavioral and soft skills remains limited. These findings underscore the need for blended learning approaches that combine digital tools with face-to-face interaction to ensure holistic human capital development. **Recommendations:** Policymakers and institutions should invest in inclusive digital infrastructure, continuous faculty development, and pedagogical innovation to reduce inequalities and promote balanced human capital development in emerging higher education systems.

Keywords: Human Capital, Digitalization, Higher Education, Technical Skills, Digital Skills, Soft Skills.

رقمنة التعليم العالي وآثارها على رأس المال البشري :تحليل مهارات الطلبة ورضاهم

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تاريخ التسليم: (2025/12/15)، تاريخ القبول: (2026/4/16)

الملخص: الهدف: تهدف هذه الدراسة إلى تحليل مدى مساهمة مؤسسات التعليم العالي المُرقمنة في تنمية المهارات التقنية والرقمية والسلوكية، إضافةً إلى رضا الطلبة، مقارنةً بالمؤسسات ذات الأنماط التعليمية التقليدية غير المُرقمنة**المنهجية:** اعتمدت الدراسة على منهج كمي ذي تصميم مقطعي .جُمعت البيانات من عينة مكوّنة من 176 طالبًا ينتمون إلى مؤسسات التعليم العالي العمومية بالمغرب، تختلف في مستوى رقمنتها .جرى قياس مهارات الطلبة ودرجة رضاهم من خلال استبيان مُنظَّم، وتم تحليل البيانات باستخدام الإحصاءات الوصفية، واختبارات t) لعينتين مستقلتين، وتحليل التباين(ANOVA)، والانحدار اللوجستي الرتبي، بهدف الكشف عن الفروق بين المؤسسات المُرقمنة وغير المُرقمنة **النتائج:** أظهرت النتائج وجود فروق ذات دلالة إحصائية بين البيئتين التعليميتين .فقد أفاد الطلبة المنتمون إلى المؤسسات المُرقمنة بمستويات أعلى من المهارات التقنية والرقمية، إلى جانب درجة أعلى من الرضا عن تجربتهم التعليمية .في المقابل، لم تُسجَّل المهارات السلوكية والناعمة سوى فروق طفيفة بين المجموعتين .وتشير هذه النتائج إلى أن الرقمنة تسهم بشكل ملحوظ في تعزيز بعض أبعاد رأس المال البشري، في حين .يظل تأثيرها على الكفاءات الاجتماعية والسلوكية محدودًا**الاستنتاجات:** تُعزّز الرقمنة بعض أبعاد رأس المال البشري، ولا سيما الكفاءات التقنية والرقمية، في حين يبقى تأثيرها على المهارات السلوكية والناعمة محدودًا .وتؤكد هذه النتائج ضرورة اعتماد نماذج تعليمية هجينة تجمع بين البيئتين الرقمية والوجاهية لضمان تنمية شاملة ومتوازنة لرأس المال البشري**التوصيات:** يُوصى صانعو القرار والمؤسسات التعليمية بالاستثمار في بنية رقمية شاملة، وتطوير أعضاء هيئة التدريس باستمرار، وتعزيز الابتكار البيداغوجي، للحدّ من الفوارق وتعزيز تنمية متوازنة لرأس المال البشري في أنظمة التعليم العالي بالاقتصادات الناشئة

الكلمات المفتاحية: .رأس المال البشري، الرقمنة، التعليم العالي، المهارات التقنية، المهارات الرقمية، المهارات الناعمة

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Introduction

Digital technology has profoundly transformed higher education systems worldwide (Nazyrova et al., 2025), driving the adoption of online platforms, data-informed pedagogy, and comprehensive digital ecosystems (OECD, 2023; Bond et al., 2021; Lakhal et al., 2021). The COVID-19 pandemic accelerated this shift globally (CarrascoHernández et al., 2023), making digitalization's impact on student skills a central concern for researchers and policymakers.

Beyond its pedagogical impact, digitalization is increasingly recognized as a key driver of human capital development. Classical economic theories hold that the knowledge, skills, and competencies embodied in individuals generate productivity and long-term economic growth (Becker, 1964; Schultz, 1961; Mincer, 1974).

Recent research confirms that digital competencies have become essential employability skills alongside technical and behavioral ones in knowledge economies (Rosak-Szyrocka et al., 2022; Jared & Grace, 2020). This growing body of evidence underscores the central role of digital competence in educational outcomes and employability (Ma & Ismail, 2025). However, comparative empirical studies remain scarce, particularly in emerging economies where digitization advances unevenly.

In Morocco, digital technologies have become a clear national priority. Policy documents such as the New Development Model (2021) and the Pacte ESRI 2030 identify the modernization of higher education and human capital development as central pillars of national competitiveness. Moroccan universities have progressively adopted digital platforms, virtual classrooms, and blended learning approaches. Significant disparities persist, however, between institutions with developed digital infrastructures and those relying on traditional instruction (Soomro et al., 2020; Kerrouch & Bouazizi, 2023), raising important questions about equity and the effectiveness of digital transformation in supporting student competency development.

Several gaps persist in this literature. Few studies directly compare digitalized and non-digitalized institutions within the same country. Soft skills (communication, teamwork, and time management) receive less attention than technical competencies, despite their importance to human capital (Bedenlier et al., 2020). Moreover, many studies in developing countries rely on descriptive methods, with fewer using robust inferential approaches.

Given these gaps, this study addresses the following research question: To what extent does the digitalization of higher education impact students' development of technical, digital, and behavioral skills, and their overall academic satisfaction? To answer this question, a quantitative comparative design was applied to a sample of 176 students enrolled in Moroccan higher education institutions. The study examines student experiences in both digitalized and traditional learning contexts, offering an empirically grounded perspective on how digitalization shapes human capital formation.

Theoretically, this study advances human capital theory by examining how digital infrastructure and teaching practices shape student competencies in an emerging economy. Empirically, it applies t-tests, ANOVA, and ordinal logistic regression to compare skill development across two distinct institutional contexts contributing one of the few quantitative comparative studies of its kind in Morocco.

Literature review

The relationship between digitalization and human capital development has become a central focus in higher education research. As technological change accelerates and labor market expectations evolve, understanding how digital tools shape student skill acquisition has grown increasingly important (Paul & Jefferson, 2019; Lytras et al., 2024). This section reviews key theoretical frameworks and empirical studies on the development of

technical, interpersonal, and digital competencies, as well as student satisfaction across varying institutional contexts.

Human Capital: Conceptual Foundations and Theoretical Perspectives

Human capital has become a central concept in economic development, particularly in knowledge-based economies where skills, innovation, and individual competencies drive growth and competitiveness (Oltulular, 2025; Zhang et al., 2023; Mohsin et al., 2024). While early thinkers such as Adam Smith recognized the productive value of education in *The Wealth of Nations* (1776), the formalization of human capital theory emerged in the mid-twentieth century through the work of Schultz (1961) and Becker (1964, 1975), who demonstrated that investments in education, training, and health enhance individual productivity and long-term economic growth.

Schultz (1961) emphasized the role of human capital in explaining post-war economic recovery, arguing that education should be viewed as a productive investment rather than consumption. Similarly, Becker (1964) conceptualized education as an investment based on expected returns, highlighting the relationship between schooling and lifetime earnings. Mincer (1974) further contributed through his earnings function, showing that both education and work experience significantly influence income and employment outcomes.

The concept has expanded beyond cognitive skills: the OECD (1998) defines human capital as encompassing knowledge, competencies, and attributes contributing to individual and collective well-being. Hanushek and Woessmann (2021) confirm that skill quality not years of schooling alone drives productivity, while recent scholarship extends this to social, emotional, and adaptive competencies (Mohsin et al., 2024; Oltulular, 2025).

These perspectives highlight the multidimensional nature of human capital, integrating education quality, skill development, and learning environments. In this study, human capital is operationalized through technical, digital, and soft skills as key indicators for assessing the impact of digitalization on student competencies and satisfaction (Chamak & Fromage, 2006).

Digitalization and Higher Education: A Catalyst for Human Capital Development

Rapid technological advances have driven profound transformations in higher education, positioning digitalization as a structural force that reshapes institutional practices, pedagogical approaches, and student skill development (Bond et al., 2021; Fainshmidt et al., 2016). Beyond the mere adoption of digital tools, digitalization represents a systemic transformation affecting knowledge production, governance, and learning processes (Lytras et al., 2024; Nazyrova et al., 2025).

This transformation aligns with the principles of Industry 4.0 and Education 4.0, which emphasize integrated technologies, responsiveness, and learner-centered approaches (Reis et al., 2018). Contemporary models increasingly incorporate artificial intelligence and adaptive learning systems to support competency-based education (Huang et al., 2024). In this context, digitalization involves the widespread use of technologies such as artificial intelligence, big data, and the Internet of Things to reshape educational and economic systems (Brynjolfsson & McAfee, 2014). Effective implementation, however, requires alignment between technological, organizational, and social dimensions (Reis et al., 2018).

In higher education, this transformation is reflected in the expansion of online and blended learning, virtual collaboration tools, and digital assessment methods (Bond et al., 2021). The concept of "Higher Education 4.0" captures this shift toward flexible, personalized, and skills-oriented learning environments (Altbach et al., 2019; Matt et al., 2015), where the focus extends beyond access to enhancing student engagement and learning quality (Bond et al., 2020).

Although often used interchangeably, digitalization and digital transformation represent distinct processes: the former refers to integrating digital tools into existing practices, while the latter involves broader institutional changes affecting governance and pedagogical models (OECD, 2023).

The COVID-19 pandemic accelerated this transition, exposing both opportunities and structural weaknesses across institutions (Bond et al., 2021). While some universities adapted effectively, others faced challenges related to infrastructure, faculty readiness, and unequal student access. As a result, digitalization cannot be considered a universal solution; its effectiveness depends on the alignment between technology, pedagogy, and institutional capacity (Singun, 2025). Empirical evidence suggests that digital environments can enhance access, support skill development, and promote active learning approaches (Lakhal et al., 2021; Jared & Grace, 2020), particularly in areas such as data analysis, programming, and online collaboration (Rosak-Szyrocka et al., 2022).

However, the benefits of digitalization are not automatic. Learning outcomes depend on effective instructional design and meaningful integration of technology (Bond et al., 2020). Fully virtual environments may limit the development of interpersonal and behavioral skills due to reduced social interaction (Giménez-Mercado et al., 2024), while hybrid approaches combining digital and face-to-face learning are more conducive to balanced skill development (García et al., 2019). Recent studies confirm that while digital tools support technical competencies, soft skills require intentional pedagogical strategies (Pan et al., 2025).

In Morocco, digital transformation is a strategic priority, as reflected in the New Development Model (CSMD, 2021) and the Pacte ESRI 2030. These initiatives emphasize the role of higher education in human capital development and national competitiveness. Efforts have been made to integrate digital technologies into curricula, enhance access, and promote lifelong learning (Ministère de l'Enseignement Supérieur, 2022; Ministère de l'Économie et des Finances, 2022). However, significant disparities persist between institutions due to differences in infrastructure, faculty training, and digital culture (Soomro et al., 2020; Kerrouch & Bouazizi, 2023), raising concerns about equity and inclusion.

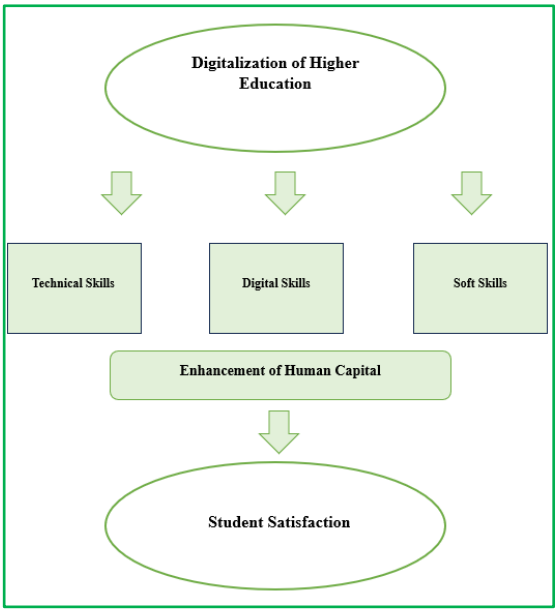
Student satisfaction is a key indicator of educational quality and is closely linked to the usability, accessibility, and interactivity of digital tools (Paechter & Maier, 2010; Martin et al., 2019). Higher satisfaction levels are associated with effective communication, instructor presence, and user-friendly platforms (Bond et al., 2021), contributing to both academic success and broader human capital development (Schunk & DiBenedetto, 2020).

Overall, digitalization represents a critical lever for human capital development but requires coherent policies, inclusive strategies, and pedagogical innovation to ensure equitable and effective outcomes (Bonfield et al., 2020; UNESCO, 2023; Lytras et al., 2024).

Conceptual framework

This study proposes a conceptual framework linking the level of institutional digitalization to student competency outcomes and satisfaction. Digitalization is treated as the independent variable, while technical, digital, and soft skills—along with overall satisfaction—constitute the dependent variables. The framework draws on human capital theory and digital learning literature, positing that technology-enhanced learning environments improve skill acquisition and educational effectiveness.

Figure (1): Conceptual Framework



Research Hypotheses

Using the above theoretical and empirical bases, this study will suggest hypotheses as a basis for exploring how digital technologies influence student competencies in higher education:

H1: There are statistically significant differences in technical skills between students enrolled in digitalized and non-digitalized higher education institutions.

H2: There are statistically significant differences in digital skills between students enrolled in digitalized and non-digitalized higher education institutions.

H3: There are statistically significant differences in soft skills between students enrolled in digitalized and non-digitalized higher education institutions.

H4: Students' competencies significantly predict academic satisfaction.

H4a: Technical competencies significantly predict students' academic satisfaction.

H4b: Digital competencies significantly predict students' academic satisfaction.

H4c: Soft skills significantly predict students' academic satisfaction.

Methods

Research Design

This study employed a quantitative, comparative cross-sectional design in examining the impact of digitalization in higher education on student competencies and satisfaction. Data were collected using a structured questionnaire, which was e-mailed to students who were attending institutions with digitalized and non-digitalized mode of instruction in Morocco. This method provides for the systematic collection of students' perceptions and experiences of learning environments at institutions whilst considering the differences in educational contexts and learning environments. The approach provides a systematic mechanism for recording the similarities and differences and making possible explanations for the observed differences as a result of the presence or absence of technology in the teaching and learning contexts. The design also allows for appropriate observation of these contrasting educational contexts at one point in time to allow for additional evidence to be considered which could assist in making a comparative basis for the data.

Sample and Data Collection

The study drew on students from Moroccan public universities and vocational higher education institutions. A convenience sampling technique was employed, targeting students

with direct experience of either digitally embedded or traditional learning programs. Data were collected between August and September 2024 via an online questionnaire (n = 176) administered through Google Forms.

To ensure methodological transparency, the classification of institutions as digitalized or non-digitalized was based on a set of operational indicators reflecting the level of technological integration in teaching and learning processes. Institutions were considered digitalized when they demonstrated regular use of learning management systems, online course delivery, digital assessment tools, and virtual collaboration platforms. Conversely, institutions categorized as non-digitalized relied primarily on traditional face-to-face instruction with limited integration of digital learning tools. These criteria were established based on institutional practices reported by students and reflect a practical digitalization index adapted to the comparative nature of the study.

By the time of data collection, 120 students were enrolled at an institution with a high degree of digital embedding and 56 students were enrolled at an institution with little or no digital embedding. This sample is indicative of an appropriate context to juxtapose the two modalities of education and draw conclusion using evidential basis with regard to the level of influence (if any) provided by digital transformation on students' learning experience, development of skills and satisfaction level.

Limitations related to sampling strategy

Convenience sampling limits external validity, as students from more accessible or survey-ready institutions may be overrepresented. Results should therefore be considered indicative rather than representative of the Moroccan higher education system as a whole. Future research should employ stratified or probability-based sampling to improve generalizability.

Variables and Measures

The questionnaire comprised four constructs: (1) technical skills (use of software, data analysis, programming); (2) digital skills (platform navigation, online collaboration, digital research); (3) soft skills (communication, teamwork, time management); and (4) overall satisfaction (perceived quality and usefulness of the learning experience).

The items were rated on a five point Likert scale (1 = "strongly disagree" to 5 "strongly agree"). Prior to running statistical analyses, construct validity and internal consistency were tested to measure the reliability of the measures, confirming the instrument's significance for providing comparisons of competencies and satisfaction in educational settings.

To ensure measurement reliability and internal consistency, Cronbach's alpha coefficients were calculated for each construct. The results confirm satisfactory reliability levels exceeding the recommended threshold of 0.70. Construct validity was assessed through content validation based on prior validated scales and expert review.

Table (1): Reliability Analysis of Measurement Constructs

Construct	Number of Items	Cronbach's Alpha
Technical Skills	3	0.80
Digital Skills	3	0.85
Soft Skills	3	0.70

Source: Authors' elaboration based on SPSS results

Analytical Techniques

Data were analyzed using IBM SPSS Statistics (v.26) through four steps: (1) descriptive statistics to characterize the sample; (2) independent-samples

t-tests to compare competency scores between groups; (3) one-way ANOVA to examine whether field of study or institution type moderated outcomes; and (4) ordinal logistic regression to assess whether competencies predicted satisfaction, controlling for institutional type.

Preliminary diagnostic testing using the Shapiro–Wilk test revealed deviations from normality for some variables. However, parametric tests were retained because the sample size exceeded commonly accepted thresholds supporting robustness under the Central Limit Theorem. In addition, skewness and kurtosis indices were examined and remained within acceptable ranges, further supporting the suitability of parametric statistical procedures. Nonparametric tests were also conducted as robustness checks where appropriate, yielding consistent results.

Furthermore, effect sizes were calculated to assess the practical magnitude of observed differences and to enhance the interpretative value of the statistical findings. Overall, the analytical strategy aimed to ensure methodological rigor while capturing students' experiences within their educational contexts.

Results and discussions

This section presents the empirical results of the comparative analysis. Findings are interpreted through human capital theory (Becker, 1964; Schultz, 1961) and contemporary literature on digital transformation in education (Lakhal et al., 2021; Rosak-Szyrocka et al., 2022; Bond et al., 2021).

Descriptive Results

Below is a descriptive table of the sample, based on data collected from 176 students

Table (2): Descriptive Characteristics of the Sample

Characteristic	Group 1 – Digitized Institutions	Group 2 – Non-Digitized Institutions	Total
Number of Students	120	56	176
Percentage	68.2%	31.8%	100%
Average Age (years)	21.4		21.4
Average Years of Study	2.6		2.6

Source: Authors' elaboration

This table offers a general overview of the sample, highlighting the proportion of participants and basic demographic characteristics (age, average years of study) in each group.

From the questionnaires, 47% of respondents are in an Economics and Management program, 21% are in Humanities and Social Sciences such as English Studies, French Studies, Sociology, Geography etc., while 23% are in science programs (Computer Science, Mathematics and Statistics, Physics…...) Legal Studies comprise only 9% of the total sample.

Therefore, 37% of our sample are enrolled in selective-access institutions (ENCG, ENSA, ENSAM, ENSIAS, EST, FST etc.), 47% are enrolled at open-access institutions (faculties) and 16% are enrolled in vocational training centers.

Table (3): Averages for Technical, Digital, and Soft Skills

Skills Type	Digitalized Group (Average)	Non-Digitalized Group (Average)
Technical Skills	4.2	3.0
Digital Skills	4.0	2.8
Soft Skills	4.5	3.1

Source: Authors' elaboration

Descriptive findings reveal meaningful differences in skill development between the two groups. Technical and digital skills show the largest discrepancies, consistent with literature documenting digital platforms' positive role in knowledge acquisition (Lakhal et al., 2021). Soft skill differences are smaller, suggesting non-technological factors play a greater role in this area (Bond et al., 2020).

In addition, students' levels of confidence and perceptions about employability in digitalized environments align with the arguments made by Jared and Grace (2020), and emphasize that digital skills are an essential part or component of human capital in knowledge economies.

Becker's (1964) Human Capital Theory states that investments in education, which is design, with a particular focus on technology and innovation, can result in more productivity or potential future earnings. Students in technology enabled institutions have access to virtual libraries, e-learning platforms, and collaborative digital tools which provide a real advantage in the labor market.

On the other hand, students in non-digitalized institutions face challenges that are consistent with the concerns raised by Rosak-Szyrocka et al., (2022), who suggest that digital exclusion may be occurring in developing countries. Students at these institutions often experience limitations to infrastructure and pedagogy that impede the development of critical 21st Century skills or competencies such as digital collaboration, autonomous learning, and managing information in digital contexts. This issue also supports UNESCO's (2022) call to action for equity in access of digital technologies in higher education to ensure equity and employability.

The divergences between selective-access and open-access institutions echo the observations of Altbach et al. (2019), who note that unequal resource allocation compounds inequities in digital access. Selective institutions tend to benefit from more favorable staffing ratios, greater financial autonomy, and stronger faculty development frameworks (Fitzgerald et al., 2013), while open-access institutions face persistent infrastructure and budget constraints that limit effective digital integration (Matt et al., 2015; Reis et al., 2018).

These findings heavily correspond to the priorities articulated in Morocco's New Development Model (2021) and the ESRI 2030 Pact, which emphasized values of an education system that is innovation driven and characterized by digital inclusivity. Both documents call for focused investments in digital infrastructure, ongoing professional learning for faculty, and responsive pedagogies to decrease the divide in technology and educational differences among institutions.

In short, variation in students' skills and perceptions of preparedness informs us that digitalization is not a neutral process. Efficient digital transformation plans require governance attention dedicated to ensuring equity and quality in capacity building. Without sufficient governance attention, digitalization may simply reproduce existing gaps and disparities in educational outcomes and job readiness.

Interpretation of ANOVA Tests in the Evaluation of Student Human Capital

Students completed a questionnaire assessing how digitalization contributed to their skill development. The following dependent variables were evaluated:

- Technical skills (which were assessed on a scale of 1 to 5.)
- Digital skills (which were assessed on a scale of 1 to 5.)
- Soft skills (which were assessed on a scale of 1 to 5.)

Then, we used ANOVA to test the extent of significance of digitalization on each of these competencies. ANOVA test was used to determine whether the mean differences between groups were statistically significant at the 5% level.

Collected Data

Table (4): Skill Averages by Group

Group	Technical Skills	Digital Skills	Soft Skills
Group A (Digital)	4.2	4.0	4.5
Group B (Non-Digital)	3.0	2.8	3.1

Source: Authors' elaboration

Analysis of Variance (ANOVA) was employed to assess whether the observed differences in mean skill levels between groups were statistically significant. The hypotheses tested were as follows:

- Null hypothesis (H_0): There is no statistically significant difference in student skill levels between Group A (students from digitalized institutions) and Group B (students from non-digitalized institutions).
- Alternative hypothesis (H_1): There is a statistically significant difference in student skill levels between the two groups.

Table (5): ANOVA Results – Technical Skills

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F	p-value
Between Groups	72.3	1	72.3	40.0	0.000
Within Groups	314.4	174	1.8		
Total	386.7	175			

Source: Results provided by SPSS

The ANOVA results summarized in Table 5 show a statistically significant difference in technical skills between students enrolled in digitalized and non-digitalized institutions ($F = 40.0$, $p < 0.001$). This indicates a statistically significant difference between the two groups.

Table (6): ANOVA Results – Digital Skills

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F	p-value
Between Groups	14.4	1	14.4	3.56	0.052
Within Groups	703.2	174	4.0		
Total	717.6	175			

Source: Results provided by SPSS

In Table 6, the findings show a highly significant difference ($F = 57.2$, $p < 0.001$) between the two groups. The students in digitalized institutions show much higher levels of digital competence, which may reflect a stronger institutional emphasis on digital literacy and technology integration.

Table (7): ANOVA Results – Soft Skills

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F	p-value
Between Groups	14.4	1	14.4	3.56	0.052
Within Groups	703.2	174	4.0		
Total	717.6	175			

Source: Results provided by SPSS

The results in Table 7 show that the difference in soft skills between the two institutional categories is not statistically significant in conventional terms ($F = 3.56$, $p = 0.052$).

While a very slight trend can be seen, the results indicate that soft skills are dependent on more than just the presence of digital technologies and are conditioned by more social interaction and pedagogical design.

The absence of significant differences in soft skills likely reflects the inherent limitations of fully digital environments in fostering behavioral and interpersonal competencies. This finding supports the growing body of evidence on the effectiveness of hybrid learning models, which combine technological flexibility with face-to-face communication and collaborative activities. Such approaches facilitate peer interaction, social skill development, and experiential learning that fully digital settings may not adequately support. The results thus reinforce the theoretical case for integrating hybrid pedagogical approaches alongside digitalization to ensure balanced human capital development.

To complement statistical significance testing, effect size indicators were calculated using eta squared (η^2) and Cohen's d to evaluate the practical magnitude of observed differences between students enrolled in digitalized and non-digitalized institutions.

Table (8): Effect Size Measures for Competency Differences Between Institutional Types

Variable	η^2	Interpretation	Cohen's d	Interpretation
Technical Skills	0.19	Large effect	0.96	Large effect
Digital Skills	0.25	Very large effect	1.15	Very large effect
Soft Skills	0.02	Small effect	0.28	Small effect

Source: Results provided by SPSS

The results indicate substantial practical differences in competency development across institutional types. Digitalization demonstrates a strong effect on technical skills ($\eta^2 = 0.19$; $d = 0.96$) and an even stronger effect on digital skills ($\eta^2 = 0.25$; $d = 1.15$), suggesting that digital learning environments significantly enhance students' technological proficiency. In contrast, the effect size for soft skills remains small ($\eta^2 = 0.02$; $d = 0.28$), indicating that digitalization alone has limited influence on socio-emotional competency development. These findings reinforce the need for complementary pedagogical approaches, such as blended learning models, to support holistic human capital formation.

Discussion of ANOVA Results

According to the ANOVA results, the level of digitalization is significantly associated with differences in students' technical and digital skills, with p-values below 0.001. Students in digitalized institutions report higher levels of competence compared to those in non-digitalized settings. These findings are consistent with Lakhal et al. (2021) and Bond et al. (2021), who show that the use of digital tools such as learning management systems and collaborative platforms enhances student performance and engagement, particularly in technical domains.

These results also align with Becker's Human Capital Theory (1964), which emphasizes that targeted investments in education and technology contribute to productivity gains. Exposure to digital tools facilitates the development of transferable skills relevant to the labor market (Jared & Grace, 2020).

Similarly, the significant improvement in digital competencies supports the findings of Reis et al. (2018), highlighting that ICT integration promotes interactive, personalized, and self-directed learning environments. In this context, digitalization extends beyond a technical shift and becomes a strategic driver of human capital development.

In contrast, the results for soft skills do not reach the conventional significance threshold ($p = 0.052$). This finding is consistent with Bond et al. (2020), who argue that soft skills primarily develop through social interaction and collaborative learning. Fully digital environments may limit opportunities to develop competencies such as teamwork, leadership, and adaptability.

This limitation underscores the importance of hybrid learning models that combine digital tools with face-to-face interaction. From a socio-constructivist perspective (Vygotsky, 1978), learning is inherently social, making peer interaction essential for non-cognitive skill development. Complementary approaches such as project-based learning, mentorship, and experiential activities further support the development of soft skills in response to labor market demands (Villegas, 2024).

In conclusion, the findings confirm that digitalization enhances technical and digital skills while highlighting the need for pedagogical strategies to support soft skill development. This dual perspective aligns with Morocco's New Development Model (2021) and the ESRI 2030 Pact, which emphasize both digital integration and inclusive human capital development.

Comparative analysis between digitalized and non-digitalized institutions: impacts on satisfaction and skills

To provide a more comprehensive understanding of the impact of digitalization on

human capital development in higher education, a comparative study was conducted with two student cohorts (i.e. non-digitalized and digitalized institutions). The study explored multiple indicators related to the development of technical skills, digital skills, soft skills, and also students' global satisfaction regarding the use of educational technology. The comparative approach allows us to evaluate participants' developed skills and perceptions of educational quality in relation to the digital infrastructure of their institution.

Before reporting on the results of the statistical tests (e.g. t-test, ordinal logistic regression, etc.), we have provided a table below summarizing the skill categories that we focus on, and the abbreviations we use throughout this paper:

Table (9): Abbreviations of assessed technical, digital, and soft skill

Category	Code	Skill
Technical Skills	TS 1	Use of domain-specific software (e.g., statistical, design, etc.)
	TS 2	Data management and analysis
	TS 3	Knowledge of programming or software development
Digital Skills	DS 1	Use of online learning platforms (e.g., Moodle, Classroom)
	DS 2	Use of online collaboration tools (e.g., Google Drive, Teams)
	DS 3	Information search and digital resource management
Soft Skills	SS 1	Online communication
	SS 2	Time and task management in a digital environment
	SS 3	Remote collaborative work

Source: Authors' elaboration

This section presents the findings of this comparative study, with a particular focus on the differences more generally identified between the two institutional settings and the impact of these on the students' perceptions.

Digitalized Institutions

Table (10): Descriptive statistics of self-reported competencies – Digitalized institutions

		Statistic	Df	P
TS1	Student's t	102.0	119	< .001
TS2	Student's t	97.7	119	< .001
TS3	Student's t	90.8	118	< .001
DS1	Student's t	116.8	119	< .001
DS2	Student's t	110.8	119	< .001
DS3	Student's t	109.1	119	< .001
SS1	Student's t	76.9	119	< .001
SS2	Student's t	75.8	119	< .001
SS3	Student's t	56.9	119	< .001

***Source*:** Authors, based on survey data.

Overall, students reported highly positive self-assessments, as reflected by the high mean scores for DS1 (4.73), DS2 (4.69), and TS1 (4.64), all with a median of 5.00. Each of the other components showed positive scores, if slightly lower than the previous three examples: TS2 (4.47), SS1 (4.38), and SS2 (4.14). Conversely, TS3 (3.97) and SS3 (3.50) had the lowest means and highest variabilities, indicating a higher level of variability in the evaluation of each by respondents.

Table (11): One-sample t-test results (Test value =3 – Digitalized institutions

	N	Mean	Median	SD	SE
TS1	120	4.64	5.00	0.499	0.0455
TS2	120	4.47	4.00	0.501	0.0457
TS3	120	3.97	4.00	0.478	0.0438
DS1	120	4.73	5.00	0.444	0.0405
DS2	120	4.69	5.00	0.464	0.0423
DS3	120	4.14	4.00	0.416	0.0380
SS1	120	4.38	4.00	0.624	0.0570
SS2	120	4.14	4.00	0.598	0.0546
SS3	120	3.50	4.00	0.674	0.0615

***Source*:** Authors, based on statistical test results.

According to the findings, students had a very favorable opinion of the efficacy of digital learning environments, as seen by the mean scores being much higher than the neutral test value. Rather than reflecting response

consistency, this departure from the middle indicates a typically positive assessment.

Table (12): Shapiro-Wilk normality test – Digitalized institutions

Note. A low p-value suggests a violation of the assumption of normality

	W	P
TS 1	0.628	< .001
TS 2	0.635	< .001
TS 3	0.650	< .001
DS 1	0.552	< .001
DS 2	0.581	< .001
DS 3	0.555	< .001
SS 1	0.750	< .001
SS 2	0.725	< .001
SS 3	0.788	< .001

Source: Authors, based on data analyzed using SPSS

Revealed by the Shapiro-Wilk normality test all the variables less than. 001 a legitimate breach of the normality assumption. This means that the least values of W are for (0.552) DS 1, (0.555) DS 3, (0.628) TS 1 respectively, indicating the most pronounced deviations from normality. The W values for SS 3 (0.788) and SS 1 (0.750) are comparatively higher, though the normality assumption remains rejected for all variables. These results justify the use of non-parametric tests as robustness checks.

Ordinal logistic regression

Model fit measures shown are deviance, AIC, and R^2Mcf. The deviance of this model is 294, and the AIC 318, providing a metric for how well the model describes the observed data. Model R^2Mcf = 0.0344: proportion of variance explained.

Table (13): Model fit measures of the ordinal logistic regression – Digitalized institutions

Note. The dependent variable 'What is your level of overall satisfaction with the integration of digital technologies in your university?' follows the following order: 0 | 1 | 2 | 3

Model	Deviance	AIC (Akaike Information Criterion)	R^2McF
1	294	318	0.0344

***Source*:** Authors, based on statistical modeling.

Table (14): Ordinal logistic regression coefficients – Overall satisfaction based on perceived competencies – Digitalized institutions

Coefficients of the model - What is your level of general satisfaction with the integration of digital technologies in your university?

Predictor	Estimation	Standard Error	Z	p
TS 1	-0.2349	0.382	-0.614	0.539
TS 2	0.6179	0.405	1.525	0.127
TS 3	0.3220	0.387	0.832	0.405
DS 1	-0.2080	0.628	-0.331	0.740
DS 2	-0.1464	0.624	-0.235	0.815
DS 3	0.1253	0.456	0.275	0.783
SS 1	-0.6733	0.334	-2.015	0.044
SS 2	0.3691	0.330	1.119	0.263
SS 3	0.0461	0.262	0.176	0.860

Source: Authors, based on regression model results.

The SS 1 predictor is the only one statistically significant with respect to the aggregate level of respondent's satisfaction with the integration. In fact, SS 1 has an estimate of -0.6733 (p-value 0.044), which is statistically significant at the 0.05 level. All the other predictors like TS 1 ,TS 2, TS 3, DS 1, DS 2, DS 3, SS 2 and SS 3 do not have a significant effect, their p-values being higher than 0.05 respectively. Thus, this evidence indicates that they are less likely to affect user satisfaction as a whole in the context of digital technology integration in universities.

Table (15): Omnibus likelihood ratio test – Digitalized institutions

Predictor	χ^2	df	P
TS 1	0.3794	1	0.538
TS 2	2.3414	1	0.126
TS 3	0.6960	1	0.404
DS 1	0.1102	1	0.740
DS 2	0.0550	1	0.815
DS 3	0.0758	1	0.783
SS 1	4.1780	1	0.041
SS 2	1.2607	1	0.262
SS 3	0.0309	1	0.860

***Source*:** Authors, based on ordinal model analysis.

The results of the omnibus likelihood ratio test show the impact of each predictor on the model. The test examines whether a predictor significantly improves the fit of the model compared to the null hypothesis (which states that the predictor has no effect).

Of the predictors analyzed, SS 1 is the only one to have a significant effect, with a χ^2 statistic of 4.1780 and a p-value of 0.041, which is below the threshold of 0.05, indicating that this predictor contributes significantly to the fit of the model. The other predictors, such as TS 1,TS 2, TS 3, DS 1, DS 2, DS 3, SS 2, and SS 3, do not have a statistically significant effect, as their p-values are all greater than 0.05. This means that these predictors do not significantly improve the overall fit of the model.

Table (16): Odds ratio estimates with 95% confidence intervals – Digitalized institutions

		Confidence interval at 95%					
Predictor	**Estimate**	**Inf terminal**	**Superior**	**Standard error**	**Z**	**P**	**odds ratio**
TS 1	-0.2349	-0.995	0.5106	0.382	-0.614	0.539	0.791
TS 2	0.6179	-0.173	1.4206	0.405	1.525	0.127	1.855
TS 3	0.3220	-0.434	1.0909	0.387	0.832	0.405	1.380
DS 1	-0.2080	-1.461	1.0249	0.628	-0.331	0.740	0.812
DS 2	-0.1464	-1.384	1.0894	0.624	-0.235	0.815	0.864
DS 3	0.1253	-0.765	1.0316	0.456	0.275	0.783	1.134
SS 1	-0.6733	-1.342	-0.0274	0.334	-2.015	0.044	0.510
SS 2	0.3691	-0.275	1.0261	0.330	1.119	0.263	1.446
SS 3	0.0461	-0.472	0.5619	0.262	0.176	0.860	1.047

***Source*:** Authors, based on output from the ordinal logistic model.

The 95% confidence intervals confirm that SS 1 (OR = 0.510) is the sole significant predictor: a one-unit increase in SS 1 is associated with a 49% decrease in the odds of reporting higher satisfaction. No other predictor reaches significance (all $p > 0.05$).

Non-digitized Institutions

Based on this approach, our model is mathematically presented by the following equation:

Satisfaction=0.1301×TS1+0.1212×TS2+0.0878×TS3+0.1061×DS1+0.1011×DS2+0.0986×DS3+0.1319×SS1+0.1090×SS2+0.0968×SS3

Table (17): Descriptive statistics of self-reported competencies – non-digitalized institutions

	N	Mean	Median	SD	SE
TS 1	56	3.63	4.00	0.558	0.0746
TS 2	56	3.38	3.50	0.702	0.0938
TS 3	56	2.45	2.50	0.601	0.0803
DS 1	56	2.96	3.00	0.466	0.0622
DS 2	56	2.82	3.00	0.543	0.0726
DS 3	56	2.75	3.00	0.580	0.0775
SS 1	56	3.68	4.00	0.811	0.1084
SS 2	56	3.04	3.00	0.660	0.0881
SS 3	56	2.70	3.00	0.630	0.0842

***Source*:** Authors, based on survey data.

The descriptive analysis of the variables indicates relatively high means, where the variable TS 1 (3.63) and SS 1 (3.68) obtained the highest values, indicating a more favourable perception of these dimensions. By contrast, TS 3 (2.45) is the lowest a much more restrained score. Zero represents the balance between agree and disagree, and the medians are generally not far from the averages, reflecting a reasonably symmetrical spread of responses. Nonetheless, the larger standard deviations for SS 1 (0.811) and TS 2 (0.702) indicate greater variability in responses for those dimensions.

Table (18): One-sample t-test results – non-digitalized institutions

		Statistic	Df	P	Mean difference
TS 1	Student's t	48.6	55.0	< .001	3.63
TS 2	Student's t	36.0	55.0	< .001	3.38
TS 3	Student's t	30.5	55.0	< .001	2.45
DS 1	Student's t	47.6	55.0	< .001	2.96
DS 2	Student's t	38.9	55.0	< .001	2.82
DS 3	Student's t	35.5	55.0	< .001	2.75
SS 1	Student's t	33.9	55.0	< .001	3.68
SS 2	Student's t	34.4	55.0	< .001	3.04
SS 3	Student's t	32.0	55.0	< .001	2.70
Note. H_a $\mu \neq 0$					

Source: Authors, based on statistical test results**.**

All variables yielded high t-statistics with p-values below 0.001, confirming significant departures from the neutral reference value. TS 1 (t = 48.6), DS 1 (t = 47.6), and TS 2 (t = 36.0) produced the strongest results, reflecting high consistency in responses. TS 3 (t = 30.5) and SS 3 (t = 32.0) were comparatively lower, indicating more moderate perceptions for those dimensions. Overall, these results confirm a highly significant assessment across all measured variables.

Table (19): Shapiro-Wilk normality test – non-digitalized institutions

	W	P
TS 1	0.649	< .001
TS 2	0.756	< .001
TS 3	0.730	< .001
DS 1	0.635	< .001
DS 2	0.714	< .001
DS 3	0.742	< .001
SS 1	0.842	< .001
SS 2	0.796	< .001
SS 3	0.731	< .001
Note. A low p-value suggests a violation of the assumption of normality		

Source: Authors, based on data analyzed using SPSS.

The results of the Shapiro-Wilk normality test show that all the variables analyzed (TS 1, TS 2, TS 3, DS 1, DS 2, DS 3, SS 1, SS 2 and SS 3) have p values less than 0.001. This low p-value suggests that there is a violation of the normality assumption for each of these variables. In other words, the data distributions for these variables do not follow a normal distribution, which may require the use of non-parametric statistical techniques or other adjustments in the analysis, because many statistical methods assume that the data is normally distributed.

Ordinal logistic regression

Measures of model fit indicate a deviance of 144 and an AIC (Akaike Information Criterion) of 168 for Model 1. These values make it possible to assess the quality of the model's fit to the observed data. The R^2Mcf, which is 0.0243, suggests that the model explains a very small proportion of the variance in the dependent variable.

Table (20): Model fit measures of the ordinal logistic regression – non-digitalized institutions

Model	Deviance	AIC (Akaike Information Criterion)	R^2_{McF}
1	144	168	0.0243
Note. The dependent variable 'What is your level of overall satisfaction with the integration of digital technologies in your university?' follows the following order: 0 | 1 | 2 | 3			

Source: Authors, based on statistical modeling.

Table (21): Ordinal logistic regression coefficients – Overall satisfaction based on perceived competencies – non-digitalized institutions

Predictor	Estimation	Error standard	Z
TS 1	-0.2674	0.506	-0.528
TS 2	0.3393	0.375	0.906
TS 3	0.4367	0.461	0.948
DS 1	0.5037	0.539	0.934
DS 2	0.0909	0.676	0.134
DS 3	-0.1676	0.620	-0.270
SS 1	-0.2447	0.370	-0.662
SS 2	-0.0624	0.477	-0.131
SS 3	0.2805	0.471	0.596

Source: Authors, based on regression model results.

In non-digitalized institutions, none of the predictors reaches significance (all $p > 0.05$), suggesting that competency perceptions do not substantially drive overall satisfaction in traditional learning settings.

Table (22): Omnibus likelihood ratio test – non-digitalized institutions

Predictor	χ^2	df	P
TS 1	0.2789	1	0.597
TS 2	0.8228	1	0.364
TS 3	0.9064	1	0.341
DS 1	0.8748	1	0.350
DS 2	0.0181	1	0.893
DS 3	0.0734	1	0.786
SS 1	0.4378	1	0.508
SS 2	0.0171	1	0.896
SS 3	0.3566	1	0.550

Source: Authors, based on ordinal model analysis.

The omnibus likelihood ratio test confirms a non-significant overall model ($p = 0.938$), and the low pseudo-R^2 (McFadden's $R^2 = 0.024$) reinforces that competency perceptions are weak predictors of satisfaction in non-digitalized environments.

Table (23): Odds ratio estimates with 95% confidence intervals – non-digitalized institutions

		Confidence interval at 95%					
Predictor	Estimate	Inf terminal	Superior	Standard error	Z	p	odds ratio
TS 1	-0.2674	-1.269	0.732	0.506	-0.528	0.597	0.765
TS 2	0.3393	-0.396	1.085	0.375	0.906	0.365	1.404
TS 3	0.4367	-0.461	1.356	0.461	0.948	0.343	1.548
DS 1	0.5037	-0.557	1.586	0.539	0.934	0.350	1.655
DS 2	0.0909	-1.227	1.447	0.676	0.134	0.893	1.095
DS 3	-0.1676	-1.417	1.038	0.620	-0.270	0.787	0.846
SS 1	-0.2447	-0.980	0.486	0.370	-0.662	0.508	0.783
SS 2	-0.0624	-1.000	0.885	0.477	-0.131	0.896	0.939
SS 3	0.2805	-0.641	1.217	0.471	0.596	0.551	1.324

Source: Authors, based on output from the ordinal logistic model.

The model coefficients confirm the omnibus result: no predictor significantly predicts satisfaction in non-digitalized institutions (all $p > 0.05$). Coefficient signs and magnitudes are reported in Table 22 for reference.

The regression results indicate that lower levels of communication effectiveness significantly reduce the probability of students reporting higher satisfaction levels. This suggests that interpersonal and collaborative competencies play a crucial role in shaping students' academic experiences in digital learning environments.

Discussion of Statistical Results

The findings provide clear evidence of the differentiated impact of digitalization on student competencies and satisfaction in Moroccan higher education. Students in digitalized institutions report significantly higher levels of technical and digital skills, confirming prior research highlighting the role of technology-enhanced learning environments in developing employability-related competencies (Bond et al., 2021; Nazyrova et al., 2025). These results also align with the broader Education 4.0 perspective, where digital competencies are essential in increasingly automated and data-driven labor markets (Fainshmidt et al., 2016).

The strong performance in technical skills suggests that digitally mature environments facilitate access to tools, personalized learning, and authentic tasks (Lytras et al., 2024; Reis et al., 2018). Higher satisfaction levels further support the idea that digital environments can enhance engagement and perceived usefulness (García et al., 2019; Bond et al., 2021).

However, no significant differences were found in soft skills, indicating that these competencies depend more on social interaction and collaborative learning processes. This finding supports previous studies emphasizing the importance of blended approaches that combine digital tools with face-to-face interaction (Lakhal et al., 2021; Vygotsky, 1978). It also highlights the role of institutional support and human mediation in developing socio-emotional skills (Bedenlier et al., 2020).

The results also show that digitalization positively influences student satisfaction, although this relationship remains context-dependent. Factors such as pedagogical design, instructor readiness, and institutional coherence play a crucial role (Matt et al., 2015; Lytras et al., 2024). These findings are consistent with studies conducted during the COVID-19 pandemic, which revealed

inequalities in access and digital readiness (Martin et al., 2019; Jebbour, 2022).

While regression results indicate statistically significant relationships, the relatively low pseudo-R^2 values suggest that satisfaction is influenced by multiple factors beyond competencies. Therefore, the findings should be interpreted as indicative rather than fully explanatory.

Overall, digitalization contributes unevenly to human capital development, with stronger effects on technology-related competencies than on behavioral skills. This highlights the need for integrated approaches combining technological investment with pedagogical innovation and human-centered learning design.

Recommendations

Drawing on the conclusions of this study as Based on the study findings and existing literature, several recommendations emerge:

- Increase Digital Access: Governments and universities should invest in digital infrastructure, particularly in open-access institutions, to ensure equitable access to learning tools and foster inclusive human capital development.
- Faculty Digital Pedagogy Training: Effective digitalization requires not just technology but high-quality pedagogy. Institutions should provide continuous professional development to enhance faculty skills in integrating digital tools (Reis et al., 2018).
- Promote Hybrid Learning: To support both technical and soft skills, higher education should implement hybrid courses combining online and in-person instruction (Nayar & Koul, 2020).
- Align Curriculum with Labor Market Needs: Programs should prepare students with relevant competencies, including programming, data analytics, digital communication, and teamwork (World Bank, 2019).
- Support Digital Equity Policies: Inclusive digitalization policies, such as device subsidies, lending libraries, and improved internet access, can reduce digital divides and enhance engagement.
- Enhance Experiential Learning: Institutions should strengthen project-based learning, peer mentoring, and extracurricular activities to develop interpersonal, leadership, and collaborative skills.

These recommendations align with Morocco's New Development Model (2021) and the ESRI 2030 Pact, promoting a digitally enabled, inclusive, and competency-based higher education system.

Theoretical Significance

This study advances the understanding of human capital development in Moroccan higher education by linking digitalization with differentiated competency outcomes. It extends human capital theory by showing that digital infrastructure enhances technical and digital skills but requires complementary pedagogical strategies to support interpersonal skill development.

Practical Significance

For practitioners, the findings underscore the importance of investing in educational models that balance digital infrastructure with interactive and collaborative learning, thereby preparing students more effectively for evolving labor market demands.

Conclusion

This study demonstrates that digitalization in Moroccan higher education significantly enhances students' technical and digital competencies. Using a comparative quantitative approach, the findings reveal that students in digitalized institutions report higher proficiency in digital tools, online collaboration, and professional software, reflecting the demands of an evolving labor market.

However, the development of soft skills remains limited, suggesting that digital environments alone are insufficient to foster interpersonal competencies. This supports the relevance of blended learning models that integrate digital and face-to-face interactions to promote holistic human capital development.

Despite its contributions, the study has limitations. The sample size and use of

convenience sampling restrict generalizability, while self-reported data may introduce bias. Additionally, the binary classification of institutions simplifies varying levels of digital maturity. Future research should adopt larger samples, mixed methods, and multi-level analyses to better capture institutional dynamics.

Overall, the findings confirm that digitalization is a necessary but insufficient condition for effective human capital development. Its success depends on the alignment between technological infrastructure, pedagogical practices, and institutional strategies.

Theoretical and Empirical Contributions

This study contributes to the literature by demonstrating that digitalization affects competency development unevenly, with stronger effects on technical and digital skills than on behavioral competencies. It also provides empirical evidence from Morocco, an underexplored context, thereby extending the geographical scope of existing research.

From a managerial perspective, the findings highlight the need for integrated digital strategies combining infrastructure, faculty development, pedagogical innovation, and equity-oriented policies. Digital transformation should therefore be viewed as a strategic lever for building inclusive and sustainable educational systems.of educational and socio-economic progress.

Disclosure Statement

The authors declare that they have no relevant or material financial interests related to this study.

- **Ethical approval and consent to participate:** This study involved a questionnaire-based survey conducted among university students. Participation was voluntary, and informed consent was obtained from all participants prior to data collection. Respondents were informed about the purpose of the study and assured of confidentiality and anonymity. No personal identifying information was collected.
- **Availability of data and materials:** The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.
- **Author contribution:** All authors listed have contributed to the work and approved it for publication.
- **Conflict of interest:** The authors declare that they have no competing interests.
- **Funding:** This research received no external funding.
- **Acknowledgments:** The authors would like to thank all the students who participated in this study for their valuable time and cooperation.

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