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Technological training and management in the development of competitive human capital: A systematic review

Formación tecnológica y gestión en el desarrollo del capital humano competitivo: una revisión sistemática

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Abstract

This systematic review analyzes the relationship between technological training, management tools, and the development of competitive human capital in technical and higher education institutions. Scopus and Web of Science (2020-2025) were consulted, applying rigorous inclusion criteria: peer review, thematic relevance, and educational focus. Twenty five selected articles were analyzed using thematic coding, organized into five main areas: (1) human capital development and employability, with improvements in labor market integration and adaptability; (2) technological training and digital skills, linked to critical thinking, problem-solving, and digital literacy for teachers; (3) management tools for academic and organizational management, which optimize planning, evaluation, and productivity; (4) educational innovation and curriculum adaptation, through flexible and sustainable curricula aligned with the labor market; and (5) institutional transformation in volatile work environments, driven by leadership, governance, and digital excellence to foster resilience. Gaps are identified in regional integration, heterogeneity of digital skills, and university-industry-government collaboration in Latin America. Policies are proposed that integrate technological investment, curriculum updates, and talent development. Limitations include the time frame, the use of only two databases, and language biases. These findings outline a roadmap for enhancing the relevance and competitiveness of the education sector.

Keywords: human capital, labor competitiveness, technical higher education, technological training, management tools.

Resumen

La presente revisión sistemática analiza la relación entre la formación tecnológica, las herramientas gerenciales y el desarrollo de capital humano competitivo en instituciones de educación técnica y superior. Se consultaron

Scopus y Web of Science (2020-2025), aplicando criterios rigurosos de inclusión: revisión por pares, pertinencia temática y enfoque educativo. De 25 artículos seleccionados, se realizó un análisis mediante codificación temática, organizado en cinco ejes principales: (1) desarrollo del capital humano y empleabilidad, con mejoras en inserción laboral y adaptabilidad; (2) formación tecnológica y competencias digitales, ligadas a pensamiento crítico, resolución de problemas y alfabetización digital docente; (3) herramientas gerenciales para la gestión académica y organizacional, que optimizan planificación, evaluación y productividad; (4) innovación educativa y adecuación curricular, mediante currículos flexibles y sostenibles alineados al mercado laboral; y (5) transformación institucional en entornos laborales volátiles, impulsada por liderazgo, gobernanza y excelencia digital para fomentar resiliencia. Se identifican brechas en integración regional, heterogeneidad de competencias digitales y articulación universidad-empresa-Estado en América Latina. Se proponen políticas que integren inversión tecnológica, actualización curricular y desarrollo de talento. Limitaciones incluyen el recorte temporal, el uso de solo dos bases de datos y sesgos idiomáticos. Estos hallazgos delinean una hoja de ruta para elevar la pertinencia y competitividad del sector educativo.

Palabras clave: capital humano, competitividad laboral, educación superior técnica, formación tecnológica, herramientas gerenciales.

Introduction

In the knowledge era and amid ongoing digital transformation, technical and higher education institutions face considerable challenges in cultivating competitive human capital capable of meeting global labor market demands. The convergence of technological training and the strategic deployment of management tools has emerged as a critical driver for enhancing employability, productivity, and organizational sustainability (Đorđević et al., 2025). In this context, higher education must not merely transmit knowledge but also develop complex, flexible, and adaptive competencies through innovative pedagogical models centered on technology and knowledge management.

A growing body of research indicates that approaches such as competency-based education, active learning, and virtual training environments strengthen graduates' employability and organizational resilience (Rodríguez, 2024). Likewise, management tools, understood as techniques and methodologies for optimizing educational and organizational processes, serve as key instruments for aligning technological training with institutional development goals (Romero-Ochoa et al., 2025). Human capital thus functions not only as an operational resource but as a strategic asset tied to sustainable development and national and international competitiveness (Kisahwan et al., 2025).

Labor competitiveness in higher education has become a central axis for institutional sustainable development in a global context marked by rapid technological shifts (Silva et al., 2017). Technological training and management tools emerge as critical factors for strengthening competitive human capital (Caroline et al., 2025; Hayat et al., 2022). Indeed, recent studies demonstrate that institutions integrating technology-oriented human capital management practices enhance faculty well-being, improve institutional efficiency, and actively engage with the Sustainable Development Goals (Romero-Ochoa et al., 2025).

Consequently, higher education, as an engine of human development, faces the challenge of articulating technical capacities with management tools that facilitate labor insertion and the generation of sustainable competitive advantages (Đorđević et al., 2025). Strengthening human capital in this environment extends beyond academic training to encompass competency assessment models, strategic leadership, and adaptation to emerging digital environments. These transformations also drive a reconfiguration of institutional policies, with a focus on innovation, academic staff well-being, and sustainable organizational management.

This phenomenon holds particular relevance in Latin America, where structural gaps in educational quality, technological access, and management capacities constrain the full development of university human capital. Addressing this topic from an integrative perspective grounded in current scientific evidence therefore becomes imperative.

Hence, this systematic review addresses a fundamental question: What scientific evidence exists on the relationship between technological training, the use of management tools, and the development of competitive human capital in technical and higher education contexts?

Through an examination of recent scientific literature, this study analyzes how these elements interact to strengthen employability, academic leadership, and organizational competitiveness, particularly within Latin American educational institutions.

Methodology

This research was conducted as a systematic literature review, rigorously following the PRISMA 2020 guidelines (Page et al., 2021). The review protocol was developed a priori and comprised four sequential phases: source identification, study selection, data extraction, and evidence synthesis. Two primary electronic databases were consulted: Scopus and Web of Science to identify relevant grey literature. Bilingual search strategies (English and Spanish) were implemented using structured Boolean combinations, as detailed in Table 1.

Table 1

Search strategies implemented by database

Database	Boolean Combination
Scopus	((“Technological Training" AND "Management Tools”) OR (“Technological Training" AND "Human Capital") OR ("Technological Training" AND "Job Competitiveness") OR ("Management Tools" AND "Human Capital") OR ("Management Tools" AND "Job Competitiveness")) AND ("Education" OR "Educational Context" OR "Educational Institutions" OR "Technical Education" OR "Higher Education")
Web of Science	TS= (("Technological Training" AND "Management Tools") OR ("Technological Training" AND "Human Capital") OR ("Technological Training" AND "Job Competitiveness") OR ("Management Tools" AND "Human Capital") OR ("Management Tools" AND "Job Competitiveness") OR ("Human Capital" AND "Job Competitiveness")) AND TS= ("Education" OR "Educational Context" OR "Educational Institutions" OR "Technical Education" OR "Higher Education")

The search strategies were designed by combining the concepts of *technological training*, *management tools*, and *competitive human capital* as applied in educational contexts. These strings were adapted to the specific syntax of each database (Scopus and Web of Science) to ensure precise retrieval of relevant studies published between 2020 and 2025.

In addition, inclusion and exclusion criteria were precisely defined prior to the search (Table 2). These criteria were applied systematically during the screening phases to ensure the selection of truly relevant and methodologically sound studies.

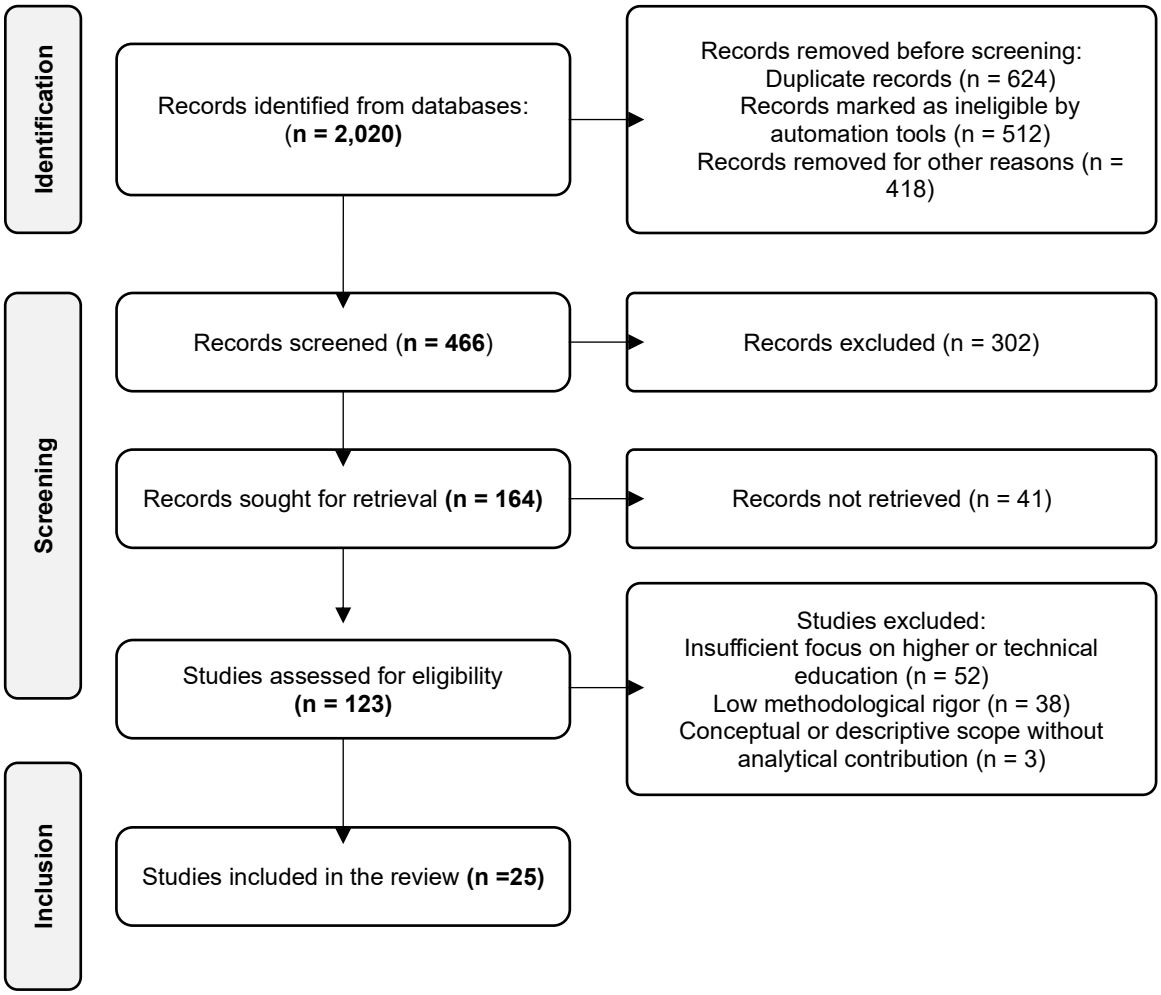
Table 2

Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Peer-reviewed articles published between 2020–2025	Non-peer-reviewed or unrefereed literature
Empirical studies or systematic reviews on technological training, management tools, human capital, or labor competitiveness in higher education	Opinions, editorials, columns, book reviews, interviews, or articles without explicit scientific methodology
Open-access publications indexed in Scopus and Web of Science	Duplicate documents or those published outside the selected databases
Research focused on technical or higher education institutions (universities, institutes, technology centers)	Studies in corporate, K–12, or non-higher technical contexts
Studies published in English or Spanish	Publications in other languages without translation
Articles centered on Latin America or with findings transferable to similar sociocultural realities	Studies whose empirical evidence is not transferable to comparable sociocultural settings

These inclusion and exclusion criteria were established to ensure the scientific validity, thematic relevance, and contextual appropriateness of the selected studies, prioritizing recent, peer-reviewed research indexed in Scopus and Web of Science and focused on Latin American higher education.

Figure 1
PRISMA 2020 flow diagram of inclusion and exclusion criteria



Note. The PRISMA diagram shows the selection process for studies included in the systematic review

As a result of this process, a total of 2,020 records were initially identified across the two consulted databases. Subsequently, an initial deduplication was performed, removing 624 duplicate records found between Scopus and Web of Science. Automated filters related to publication year, document type, language, and subject area were then applied, leading to the exclusion of 512 additional records. A further 418 records were discarded for other reasons, such as non-scientific nature, absence of peer review, or general thematic irrelevance.

After this stage, 466 records remained and underwent title and abstract screening. During this phase, 302 studies were excluded for not directly addressing technical or higher education, human capital development, employability, or the use of management tools in educational settings. As a result, 164 articles were considered potentially eligible, and full-text retrieval was attempted.

Of the articles selected for retrieval, 41 could not be obtained due to access restrictions or unavailability of full text. Consequently, 123 studies were ultimately evaluated in depth for eligibility.

Eligibility assessment was conducted against the predefined criteria. Studies were excluded if they exhibited insufficient focus on technical or higher education, significant methodological weaknesses, or were exclusively conceptual or descriptive without offering relevant analytical evidence. In this phase, 93 studies were

excluded, leaving 25 investigations that fully met the inclusion criteria and were incorporated into the final qualitative synthesis.

Inclusion criteria considered studies published in peer-reviewed journals indexed in Scopus or Web of Science, written in English or Spanish, developed within the established timeframe, and explicitly addressing at least one of the study's core dimensions: technological training, digital competencies, management tools, curricular innovation, employability, or human capital development in technical or higher education. Conversely, non-peer-reviewed documents, conference proceedings, editorials, book chapters, studies outside the temporal range, and those without sufficient methodological or analytical contribution were excluded.

Finally, information synthesis was conducted through a thematic analysis process, which organized the findings from the included studies into common conceptual categories. This procedure facilitated the identification of convergences, divergences, and emerging trends in the literature, providing a comprehensive understanding of the studied phenomenon and strengthening the interpretive validity of the results obtained.

Results and discussion

Below is a table synthesizing the most relevant studies, distributed across categories such as technological training, digital competencies, knowledge management, academic leadership, educational innovation, and employability. These categories reflect the main current and emerging research lines on strengthening human capital in a highly competitive labor environment.

Table 3

Representative studies on technological training, management, and competitive human capital development in higher education

Study title	Author(s)	Journal	Topic addressed	Research objective
Education and the labor market in Latin America: Confronting globalization	Carlson	CEPAL Review	Employability and human capital	Analyze the relationship between higher education and the labor market in Latin America amid globalization processes
The impact of educational technologies in higher education	Cabaleiro-Cerviño & Vera	GIST Education and Learning Research Journal	Technological training	Examine the impact of educational technologies on university teaching-learning processes
Competency-based training: A challenge for higher education	Martínez	Revista Iberoamericana de Educación	Competencies and employability	Analyze the competency-based approach as a response to labor market demands
Competency-based training in higher education: Current approaches and challenges	Velarde Rodríguez	Yachay Revista Científica	Digital competencies	Evaluate technology-based pedagogical strategies for developing transversal competencies
Key factors in digital literacy in learning and education: A systematic literature review using text mining	Audrin & Audrin	Education and Information Technologies	Digital competencies	Analyze the relationship between learning and digital competence
Sustainable management of digital transformation in higher education: Global research trends	Abad-Segura et al.	Sustainability	Digital transformation	Examine scientific productivity as a trend in social sciences

Cybersecurity and innovative digital educational environment	Burov et al.	Information Technologies and Learning Tools	Digital inclusion	Evaluate the role of inclusive virtual environments in educational quality
Knowledge management strategies supported by ICT for the improvement of teaching practice: A systematic review	Romero-Ochoa et al.	Information	Knowledge management	Analyze the impact of ICT-supported knowledge management on academic productivity
Planning and strategic management of higher education considering the vision of Latin America	Inga et al.	Education Sciences	Management tools	Analyze management strategies to ensure student-centered education
Open innovation: A technology transfer alternative from universities. A systematic literature review	Padilla et al.	Journal of Open Innovation: Technology, Market, and Complexity	Technological innovation	Analyze innovation and its contribution to technological processes in universities
Employability and its relationship with the competency-based approach, teaching methodologies, and assessment in higher education: A systematic review	Pérez et al.	Frontiers in Education	Curricular innovation	Analyze curricular adaptation in response to labor environment demands
Systematic literature review: Inter-relatedness of innovation, resilience and sustainability—Major, emerging themes and future research directions	Zupancic	Circular Economy and Sustainability	Innovation and institutional resilience	Analyze the relationship between innovation, sustainability, and organizational resilience
Graduate employability and competence development in higher education: A systematic literature review using PRISMA	Abelha et al.	Sustainability	Human capital and employability	Analyze the relationship between competence development and employability in higher education through a systematic review
Employability: A core role of higher education?	Tight	Research in Post-Compulsory Education	Employability and educational policies	Examine the strategic role of employability in contemporary higher education
The impact of human capital on employment quality: A scoping review	Congna & Saad	Cogent Social Sciences	Human capital and productivity	Analyze how human capital influences employment quality and labor sustainability
Graduate employability and higher education's contributions to human resource development in sport business before and after COVID-19	Sato et al.	Journal of Hospitality, Leisure, Sport & Tourism Education	Human capital and innovation	Evaluate higher education's contribution to human capital development and employability

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Teachers' digital competencies in higher education: A systematic literature review	Basilotta-Gómez-Pablos et al.	International Journal of Educational Technology in Higher Education	Teacher digital competencies	Analyze the relationship between teacher technological training and institutional digital competence
A systematic review of digital competence evaluation in higher education	López-Núñez et al.	Education Sciences	Digital transformation	Examine digital competence assessment in university contexts
Analysis and comparison of international digital competence frameworks for education	Mattar et al.	Education Sciences	Digital competencies	Analyze and compare international digital competence frameworks for education
Digital competence of higher education professor according to DigCompEdu	Cabero-Almenara et al.	Sustainability	Digital competencies	Evaluate teacher digital competence in higher education under the DigCompEdu framework
Reimagining our futures together: A new social contract for education	UNESCO	UNESCO	Educational digitalization	Analyze the role of education and digitalization in sustainable human capital development
Implementing the global model of the research university in a national context: Perspectives of deans and department heads	Hladchenko & Benninghoff	International Journal of Educational Management	Management tools	Analyze strategic management models applied to higher education institutions
The determinants of university strategic positioning: A reappraisal of the organisation	Fumasoli et al.	Higher Education	Managerial innovation	Examine how managerial innovation impacts productivity and university governance
Knowledge or competencies? A controversial question in contemporary curriculum debates	Rasmussen et al.	European Educational Research Journal	Curricular innovation	Analyze the integration of active methodologies to enhance curricular relevance
Five visions of competence-based education and curricula as travelling policies: A systematic research review 1997–2022	Tahirsylaj & Sundberg	Journal of Curriculum Studies	Curricular adaptation	Examine curricular adaptation in response to emerging technological and labor demands

Note. The table presents the studies included in the systematic review

The review also reveals geographic diversity across the analyzed studies, encompassing experiences from Europe, Latin America, Asia, and Africa, with particular emphasis on Latin American contexts. This allows for a global yet contextualized perspective on capacity development in the education sector. The review established solid criteria for evaluation, analysis, and synthesis through an iterative process of open coding, thematic grouping, and conceptual refinement (Braun & Clarke, 2006). This approach facilitated the identification of recurrent patterns, convergences, and divergences in the literature, generating a narrative synthesis structured around five predominant thematic axes.

Relationship between technological training, use of management tools, and development of competitive human capital in technical and higher education

The systematic analysis reveals that technological training and the implementation of management tools are essential components for strengthening human capital in technical and higher education institutions. Digital transformation has redefined teaching-learning dynamics, positioning educational technologies as strategic elements for enhancing the competencies of both students and faculty (Cabaleiro-Cerviño & Vera, 2020).

Human capital development and employability

The literature demonstrates that training oriented toward human capital development and employability constitutes a fundamental pillar for labor competitiveness in technical and higher education. Abelha et al. (2020), Tight (2023), and Congna and Saad (2025) emphasize that educational policies should focus on creating training environments that enhance human capacities with a sustainability and productivity orientation. Similarly, Sato et al. (2021) and Pérez et al. (2025) propose talent development strategies that strengthen the relationship between education, innovation, and the labor market. From a practical standpoint, professional internships and labor competency assessment are key mechanisms for ensuring training relevance. Furthermore, educational management should be oriented toward creating human capital strategies aligned with productive sector challenges, thereby consolidating a sustainable employability model.

Technological training and digital competencies

Technological training has become a determining dimension in the generation of digital competencies and professional updating within the university setting. Basilotta-Gómez-Pablos et al. (2022) confirm that faculty technological training predicts high levels of institutional digital competence, while López-Núñez et al. (2024) link digital transformation to improved educational competitiveness. According to Mattar et al. (2022), technology-based pedagogical strategies promote critical thinking and problem-solving, essential skills in dynamic labor contexts. Burov et al. (2020) and Cabero-Almenara et al. (2021) complement this view by noting that digital literacy and inclusive virtual environments are indispensable for ensuring equity and training quality. Along these lines, UNESCO (2021) emphasizes that educational digitalization contributes to developing transferable competencies applicable across multiple economic sectors, thereby enhancing human capital in the post-industrial era.

Management tools for academic and organizational administration

Management tools emerge as strategic instruments for improving efficiency, planning, and institutional governance in educational settings. Hladchenko and Benninghoff (2020) argue that applying strategic management models optimizes academic processes and strengthens organizational decision-making. Fumasoli et al. (2020), through a systematic review, demonstrate that managerial innovation in university systems promotes scientific productivity and administrative efficiency. Likewise, tools such as the balanced scorecard and competency-based management improve academic productivity, while Couper and Stoakes (2010) underscore the need to train administrative personnel in leadership and modern management using SandRA, a visual management tool for analyzing and communicating the research-teaching nexus, thereby facilitating academic strategy management and organizational decision-making. Collectively, these studies indicate that data-driven management and robust organizational strategies increase institutional competitiveness and the quality of educational services.

Educational innovation and curricular adaptation

Studies on educational innovation concur that academic programs must adapt to the new demands of the technological and labor environment (Tahirsylaj & Sundberg, 2025). Rasmussen et al. (2022) argue that competitive curricula require integrating interdisciplinary approaches and active methodologies oriented toward real-world problem-solving. Andino-González et al. (2024) extend this view by pointing out that managerial skills and employability should be considered cross-cutting axes in curricular design. Sava et al. (2022) maintain that training innovation must link education, research, and professional practice to strengthen learning relevance. Okanovic et al. (2021) offer a sustainable perspective, highlighting the need for green and inclusive curricula that respond to Fourth Industrial Revolution transformations. Curricular adaptation thus emerges as a tool for continuous updating that enables the educational system to anticipate labor market changes.

Institutional transformation amid changing work environments

Recent literature reveals that educational institutions must transform themselves to adapt to new labor contexts marked by digitalization and automation. Huber and Pruitt (2024) highlight the role of transformational

leadership in modernizing technical education, while Carlson (2002) emphasizes the need for greater alignment between university training and labor market demands. Custodio-Ferrando and Cabero-Fayos (2025) contend that competency-based education fosters flexible human capital prepared for uncertainty. Likewise, Wiggberg et al. (2022) affirm that digital excellence and institutional transformation policies must be articulated with global competitiveness objectives. Finally, Zupancic (2022) concurs that synergy among technology, management, and innovation policies is essential for ensuring institutional sustainability and resilience amid changing labor environments.

Conclusions

The studies underscore that technological training and the strategic use of management tools are key factors for strengthening competitive human capital in technical and higher education contexts. Integrating emerging technologies into training processes has significantly contributed to developing digital competencies, analytical thinking, complex problem-solving, and autonomous learning, all essential for meeting the challenges of the Fourth Industrial Revolution.

Concurrently, adopting managerial practices in educational settings has optimized strategic planning, competency-based management, institutional evaluation, and informed decision-making. These mechanisms not only improve organizational efficiency but also align educational objectives with the dynamic demands of the socio-productive environment.

The synergistic interaction between technology and management drives institutional transformation, enhances graduate employability, and promotes adaptive, sustainable, student-centered training models. This integrative approach helps close the gaps between educational supply and labor market requirements, thereby strengthening relevance, quality, and innovation in higher education.

The findings also underscore the need for public policies that promote curricular updating, academic leadership, investment in digital infrastructure, and continuous faculty development. These actions are fundamental for consolidating resilient and competitive educational ecosystems capable of training human talent prepared for a globalized, automated, and constantly evolving environment.

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