Digital Transformation in Higher Education: A Bibliometric Analysis.

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Abstract: Digital transformation is one of the innovative development strategies of society, which involves the evolution of teaching and adaptation to new learning needs, promoting practical and creative education. Higher education institutions face every day a complex and challenging scenario with globalization, technological advances and labor market demands, which drives the need for digital transformation to improve the experience of courses, teaching materials, project management and student training through digital technologies in the teaching process. This article aims to analyze global research trends and new technologies in digital transformation in higher education, based on bibliometric indicators and focus on their influence on managing educational projects. A search was conducted in the Scopus and Web of Science databases from 2013 to 2023, and the Bibliometrix tool was used to study scientific maps. The results allow identifying that China is one of the countries with the most significant contribution to scientific knowledge in the subject, and Wang Y is the most relevant author and the one with the most important collaborations between authors. In global research trends, massive data, artificial intelligence, digital transformation, technologies and innovation were identified. In project management, digital technologies influence strategic planning, software and data analysis tools. This article highlights the importance of digital transformation in higher education institutions as a tool to improve educational quality and accessibility.

Keywords: project management; digital transformation; higher education; pedagogical innovation; technology tools.

Transformación Digital en la Educación Superior: Un Análisis Bibliométrico

Resumen: La transformación digital es una de las estrategias de desarrollo innovador de la sociedad, que involucra la evolución en la forma de enseñar y adaptación a las nuevas necesidades de aprendizaje, impulsando la educación practica y creativa. Las instituciones de educación superior se enfrentan cada día a un panorama complejo y desafiante con la globalización, avances tecnológicos y demandas del mercado laboral lo que impulsa a la necesidad de la transformación digital para mejorar la experiencia de los cursos, materiales didácticos, gestión de proyectos y formación de los estudiantes por medio de tecnologías digitales en los procesos de enseñanza. Este articulo tiene como objetivo analizar las tendencias globales de investigación y las nuevas tecnologías en la transformación digital en la educación superior, basados en indicadores bibliométricos y enfocándose en su influencia en la gestión de proyectos educativos. Se realizó una búsqueda en las bases de datos Scopus y web of Science durante el periodo 2013 – 2023 y se utilizó la herramienta Bibliometrix para el estudio de mapas científicos. Los resultados permiten identificar que China es uno de los países con mayor aporte al conocimiento científico en la temática y Wang Y es el autor más relevante y el de mayores colaboraciones entre autores. En las tendencias globales de investigación se identificó los datos masivos, inteligencia artificial, transformación digital, tecnologías e innovación. En la gestión de proyectos las tecnologías digitales influyen en la planificación estratégica, software y herramientas de análisis de datos. Este articulo resalta la importancia de

la transformación digital en las instituciones de educación superior como herramienta para mejorar la calidad y accesibilidad educativa.
Palabras clave: gestión de proyectos; transformación digital; educación superior; innovación pedagógica; herramientas tecnologías.

Introduction

Education, technology and human talent are the fundamental pillars of modern society, which drive the growth and competitiveness of professionals through digital technologies in education [1]. One of the innovative development strategies of society is Digital Transformation (DT), which encompasses the adoption of online platforms, electronic libraries and communication tools [2]. DT is a strategic approach, which involves the evolution in the way of teaching and adaptation to the new learning needs of the student [3], promoting practical and creative education with the incorporation of new didactic models [4]. For this reason, higher education institutions (HEIs) must incorporate digital technologies in the teaching-learning processes [5], ensuring that the educational experience is similar to the work experience, with more realistic and practical methods, which form qualified professionals prepared for a digital work environment [6].

TD studies in education have gained considerable attention in recent years due to the technological advancement of the fourth industrial revolution, which forces HEIs to evolve comprehensively and address their dimensions or processes [7], to support various 21st-century skills and enable students to implement technology in a flexible, innovative and adaptive way [8]. TD has had greater impetus in education during the COVID-19 Pandemic [9], where digitization became necessary for HEIs to improve the experience of courses, teaching materials and student training [3]. For this reason, TD is recognized as a priority for HEIs, which seeks to ensure the continuous quality of teaching and learning environments [10]. Technology in universities is seen as an interconnected environment that enables digital learning, where the main task of the HEI is the modeling of digital skills networks such as critical thinking, media literacy, and intercultural competence, among others [11].

Studies such as Alam and Parvin (2021) investigate the impact of online teaching on students' academic success and work readiness [12]; Rodriguez (2017) identifies key and complex elements of TD in HEIs such as people, structures, strategies, processes and competitive dynamics [13]; Elena (2017) analyzes TD from the perspective of education and studies how to integrate digital technologies with teaching, learning and organizational practices [14], among others. Video technologies, social networks, computer systems, simulations and artificial intelligence are examples of the diversity of digital technologies in HEIs [15], [16], [17]. Numerous studies have investigated best practices for applying different DT approaches in HEIs, seeking to identify difficulties in the implementation process [18]. However, there are few studies that include a bibliometric analysis to identify the scientific production related to TD in HEIs.

This article aims to conduct a bibliometric analysis of TD in higher education, seeking to study global trends in research and new technologies by HEIs and to identify the influence of digital technologies in the management of research projects. Additionally, it aims to answer the following research questions: What is the current level of research on digital transformation in education in Covid-19? Which are the leading authors in this field in terms of scientific production? Which are the leading countries, journals and institutions in this research? and What could be the future directions of TD in education?

Methodology

Data search and selection

A review of research related to digital transformation in higher education in the period from 2013 to 2023 was conducted using the search equation ("digital transformation") AND ("education higher" OR "education" OR "Higher education institutions" OR "Education 4.0") in Scopus and web of science (WOS) databases. The review identified 2,786 documents in Scopus and 1,656 in WOS, which presented different types of documents including

research articles, session papers, review articles, book chapters, conference reviews, early access articles, books, etc. The preliminary selection process was based on limiting the documents to research articles only, obtaining a total of 2620 scientific articles, 1128 from WoS and 1492 from Scopus, which were unified in a database, where duplicates were removed using Rstudio with the merge function, resulting in 2084 scientific articles. Additionally, documents in languages other than Spanish and English were removed.

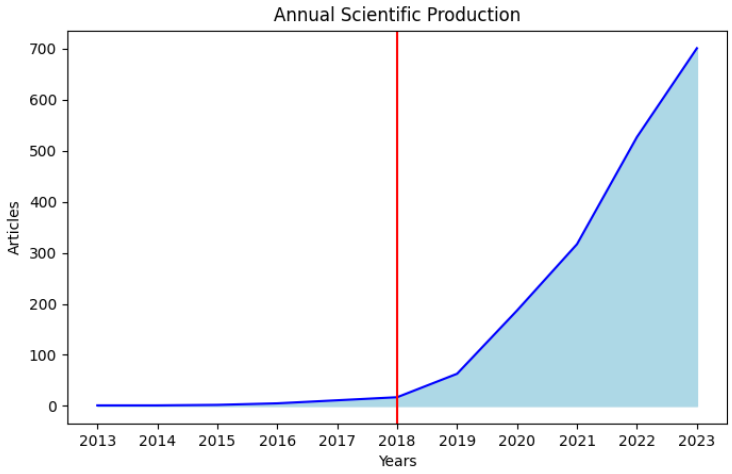
Bibliometric analysis

The bibliometric analysis was performed using the Rstudio-based web environment interface called Bibliometrix as a tool for quantitative research in scientific mapping studies [19]. Using this tool, the 1832 research articles were analyzed to analyze co-citations by identifying connections between documents and word coupling to predict past, present and future perspectives of digital transformation in higher education [20].

Results

Figure 1 shows a red vertical line that divides into two subperiods from 2013 - 2018 and 2019 - 2023 by the evolution of the literature related to TD in higher education, where only 2% of the scientific production is identified in the first period and exponential growth in the second period with 1795 documents, where in the last two years 2022 and 2023 was the most significant production of articles, contributing 67% of the total. This exponential growth evidences the importance of TD in HEIs in the academic and scientific community and governments as a way to improve teaching-learning processes and adopt digital solutions in education due to the impact of COVID-19, global competition, demand for digital skills, convergence of technologies and participation in the industry [21], [22].

Figure 1. Annual scientific production related to TD in higher education.

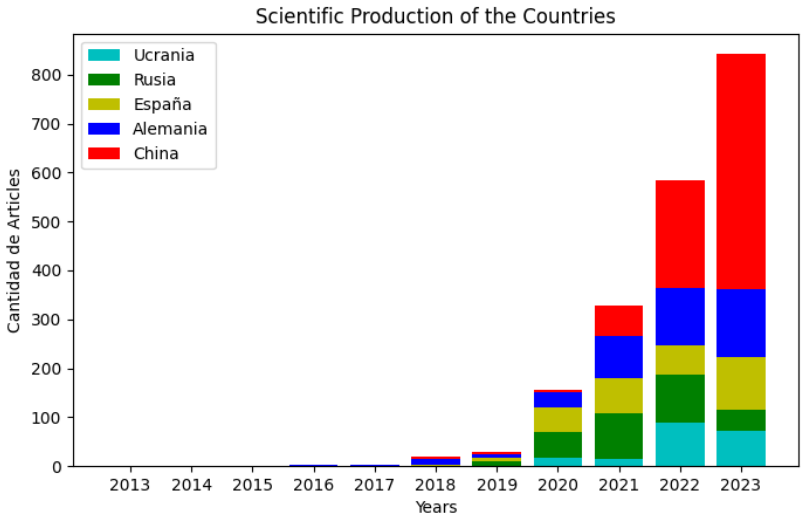


Source: authors' own.

On the other hand, Figure 2 shows that the top 5 countries with the highest contribution to knowledge are China, Germany, Spain, Russia and Ukraine, with 775, 396, 301, 296 and 195 respectively. Additionally, it is identified that in the period 2013 -2016 there was no contribution from the countries in the thematic and the period 2017 - 2019 there was little contribution to new knowledge and in the period 2020 to 2023 the 5 countries had an exponential

growth, being more significant in China mainly in the years 2022 and 2023. Scientific production on digital transformation in higher education in China, Germany and Spain is driven by a combination of factors such as government prioritization, investment in research and development, innovation culture in HEIs, social demand for quality education and experience in the implementation of digital technologies.

Figure 2. Annual scientific production of the 5 most productive countries related to TD in higher education.



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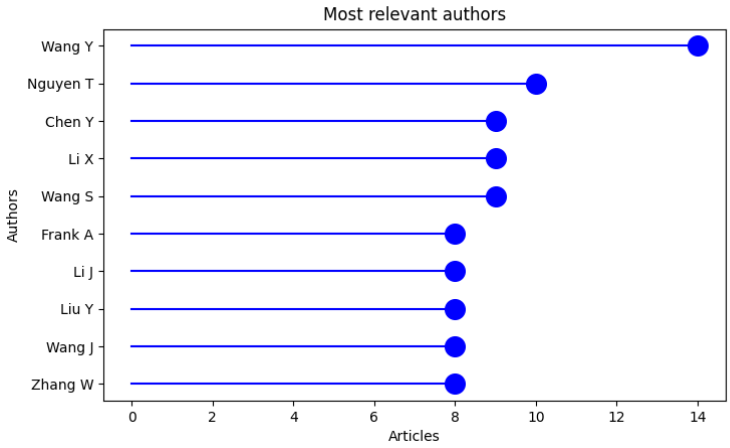
The analysis identified more than 100 journals with publications related to TD in higher education, where it is determined that the one with the highest contribution is Sustainability, with 123 scientific articles, equivalent to 43% of the 10 most relevant journals, followed by Education sciences, Education and information technologies, Frontiers in Psychology, IEEE access with 30, 28, 22 and 16 respectively. On the other hand, in the analysis of the authors of the articles related to the topic, it was identified that approximately 45 authors have published more than five scientific articles related to digital transformation in higher education, with Wang Y, Nguyen T., and Chen Y being the most relevant authors according to the number of documents (Figure 3). It is necessary to note that Wang Y's contributions have been related to artificial intelligence technologies in education [23], training of future talents in science and technology [24], and TD as a boost in manufacturing enterprises [25], among others.

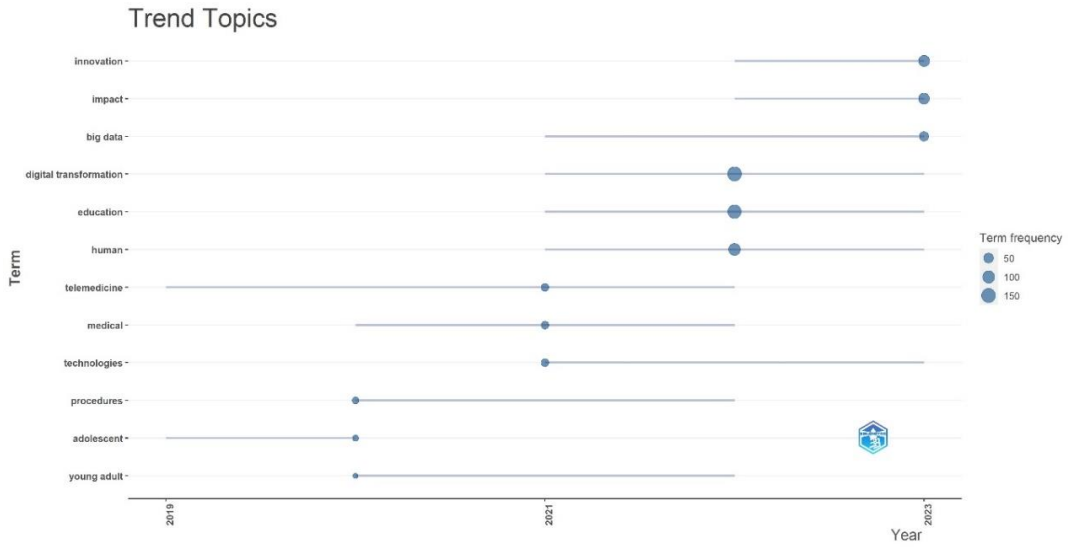
Figure 3. The trend of research topics over time.



Source: authors' own.

TD, education, e-learning, innovation, technology, education engineering and students have been identified as prominent keywords in the bibliometric analysis. However, other popular keywords in general terms would be artificial intelligence, information technology, higher education, teaching, and performance, among others. Additionally, trending topics such as TD, education, and humans have been identified in Figure 4, where it is observed that since 2021, the timeline started, having a frequency of 50 in terms of terms in the year 2022; in addition, a projection is seen with the words innovation, impact, and technologies. This indicates that research on this topic is expected to increase about TD in higher education.

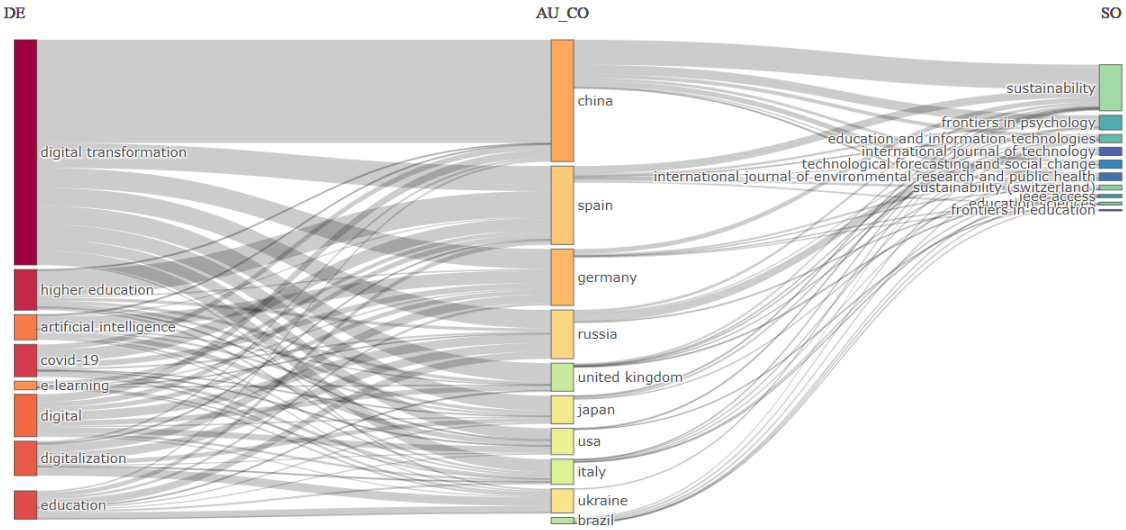
Figure 4. The trend of research topics over time.



Source: authors' own.

The information analyzed for countries, keywords and journals can be visualized in a Sankey diagram using connections in the subject matter. Figure 5 shows a thick line between TD and China, which indicates a large number of research studies between the rectangular nodes, as well as the connection between TD and Spain, Germany, Russia, the United Kingdom, Japan, the United States and Italy. On the other hand, the number of lines between China and the different journals can be seen.

Figure 5. Three-field diagram. They show the network between keywords (left), countries (center) and journals (right).



Source: authors' own.

Table 1 shows the top 5 scientific articles related to TD in higher education by number of citations, where we find the paper entitled "Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life" by Dwivedi YK, which has been cited 559 times globally since its publication in 2020 [26]. Followed by the article "Digital transformation of everyday life - How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care?" by Iivari N with 477 citations [27] and Frank AG's "Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective" with 428 citations [28].

Table 1. Top scientific articles by number of citations

First Author	Title	Journal	Year	Citations	Citations by year
Dwivedi YK [26]	Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life	International Journal of Information Management	2020	559	111.80

Iivari N [27]	Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care?	International Journal of Information Management	2020	477	95.40
Frank AG [28]	Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective	Technological Forecasting and Social Change	2019	428	71.33
García-Peñalvo FJ [29]	Online assessment in higher education in times of COVID-19	Education in the Knowledge Society	2020	331	66.20
Bond M [30]	Digital transformation in German higher education: student and teacher perceptions and usage of digital media	International Journal of Educational Technology in Higher Education	2018	255	36.43

Source: authors' own.

In these articles, the TD initiated by the COVID-19 pandemic in education is evidenced as an extensive, sudden and unexpected transformation worldwide, where the need for digital technologies for the improvement of teaching in higher education by confinement was identified [27]. Additionally, perspectives related to online learning, digital strategy, artificial intelligence, information management, social interaction, cyber security, big data among others are observed [26], as part of the transformations in industry 4.0, which seek to create value for industrial activities through cyber physical and intelligent systems [28].

HEIs are increasingly adopting digital technologies such as the virtual learning environment to support students in their efforts to achieve specific higher education goals [31]. Applications such as zoom, Microsoft teams and google meet play an important role in real-time videoconferencing for remote lectures, virtual classrooms, group discussions and live interactions [32]. Similarly, learning management systems such as Moodle, Canvas, Blackboard and google classroom are used for sharing course materials, discussions, assignments and collaborative work [33].

Digital technologies have significantly transformed how teaching and learning are delivered in higher education [34], as well as in the development of research projects from planning to evaluation. Digital tools offer benefits in planning, communication, data collection and analysis, access to information, dissemination of results [33]. Project management has a wide range of applications in different fields, including engineering projects, technology and innovation projects, new product development projects, among others [35]. Particularly, educational innovation projects are initiatives designed to make significant changes and improvements in education. TD in project management encompasses the expert use of software, digital communication tools, data analysis, virtual collaboration, understanding of digital security risks, and the ability to manage projects in a digital environment [36]. The most famous models are Project Management Institute (PMI) PMCDF 3.0 and International Project Management Association (IPMA) ICB 4.0.

Conclusions

he study reveals a significant growth of research in the field of digital transformation in higher education worldwide during the period from 2013 to 2023 due to the recognition of TD as a priority for HEIs, where the years 2022 and 2023 have been the years of most significant publication of scientific articles, approximately 67%

of the total number of publications, which may be related to the need to adopt digital solutions in education due to the impact of COVID-19. The countries with the most significant contribution to knowledge are China, Germany, and Spain due to factors such as government prioritization, investment in research and development, innovation culture in HEIs, social demand for quality education, and experience in implementing digital technologies.

The most prominent authors are Wang Y., Nguyen T., and Chen, according to the number of papers, where Wang Y's research has been related to artificial intelligence technologies in education, training of future talents in science and technology, TD as a boost in manufacturing companies, among others. The most prominent thematic areas in the research are: digital technologies in the classroom, digital tools for project management, the impact of TD on the academic performance of students, and challenges and opportunities of TD in HEIs, so in the global research trends identify massive data, artificial intelligence, digital transformation, technologies and innovation, among others.

In project management, digital technologies influence strategic planning, software, and data analysis tools. Hence, TD positively impacts the management of educational projects with new approaches, methodologies, and programs, which have greater use with the tools of planning, implementation, and monitoring of projects. However, more in-depth studies are required to understand the impact of TD in different areas of educational projects developed in a HEI, which is essential to keep in mind the constant evolution of digital technologies and new opportunities to improve the quality of education and learning. On the other hand, it is crucial to indicate that TD enhances collaboration and communication in the work team, which allows efficiency and sustainability in the teaching and learning processes.

Future research will be based on the analysis and improvement of digital software platforms and technological tools to seek advances and innovation of technologies seeking a high impact on education and industry, along with research on project management technologies in higher education and industry, involving evaluation, impact measurement and definition of the most appropriate technologies that offer reliable results in research. Similarly, publications are expected to address the challenges of privacy and digital security related to ethics and developing countries' challenges. Finally, it can be concluded that TD is fundamental for teaching and learning processes in higher education and for the training of talents in digital skills required by industry.

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