Bibliometric Analysis of Existing Knowledge on Digital Transformation in Higher Education

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Abstract. Higher Education Institutions (HEIs) have been feeling great pressure to advance in digital transformation. This pressure has been intensified with the outbreak of the COVID-19 pandemic at the end of 2019. Because the digital transformation of HEIs has been attracting a growing number of publications, the present study sought to carry out a bibliometric analysis of such titles. For this purpose, 643 relevant documents were identified from the Scopus database in January 2022. The descriptive results show an accelerated growth of the relevant literature, with conference papers being the main form of publication, followed by articles, conference reviews, and book chapters. The areas with which the majority of documents were associated were computer science, followed by social science, engineering, and business and management. An analysis of the co-occurrence of terms based on the titles and abstracts enabled the identification of three thematic areas of interest: 1) digital transformation in teaching, particularly under the pressure exerted by COVID-19; 2) environmental influences on the digital transformation of HEIs; and 3) enabling technologies for digital transformation. A longitudinal analysis also based on titles and abstracts allows us to see how the primary focus shifted from the economic issue (in 2019) to the COVID issue (in 2021). This study concludes by discussing the theoretical and practical implications of the findings, demonstrating as a particularly interesting area for future research the study of the digital transformation of HEIs in a future post-COVID scenario.

Keywords: Digital transformation · Higher education · HEIs · Universities · COVID-19

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G. Meiselwitz et al. (Eds.): HCII 2022, LNCS 13517, pp. 231–240, 2022.
https://doi.org/10.1007/978-3-031-22131-6_17

1 Introduction

Higher education institutions (HEIs) play a strategic role in all societies because they are central to research and innovation and the development of human capital [1]. Various factors, including the confluence of disruptive technologies and intensity of competition, have been putting pressure on HEIs to make strides towards digital transformation. This process implies the incorporation of digital technologies and, ultimately, a complete organizational change. Digital transformation efforts are particularly complex among HEIs, which have established organizational cultures that evolve slowly [1].

The pressure that HEIs had been experiencing amid their respective digital transformations has been raised by the effects of the COVID-19 pandemic. In a matter of weeks, these institutions were forced to adapt to new forms of work that used digital technologies intensively to provide online education and administrative services [2].

The great importance of the digital transformation of HEIs has meant that many academics have become attracted to investigating the topic, which in turn has become an area of exponential growth in research in recent years [3, 4]. However, among the problems associated with any rapidly growing research area is the potential division and lack of consolidation of the accumulating knowledge [5]. Although previous studies have focused their efforts on ordering and systematizing knowledge about the digital transformation of HEIs, their analysis efforts have covered only a few dozen studies. For this reason, this study seeks to contribute to the consolidation of existing knowledge concerning the digital transformation of HEIs using a broader focus than that of previous studies, and it aims to achieve the following objective:

- Establish through the use of bibliometric techniques the characteristics and structure of the existing body of knowledge on digital transformation in higher education institutions.

2 Digital Transformation in Heis

Digital transformation is a process of integrating technologies, and digital technology in particular, into an organization. This implies a deep organizational transformation across all areas [6]. HEIs began efforts towards digital transformation some years ago to improve their educational and administrative services and as a strategy to better compete in and serve new markets and society in general [1].

Before the COVID-19 pandemic, HEIs were rather conservative in their approach to digital transformation. They established an agenda that listed an order of priorities whereby teaching came first, followed by infrastructure, administration, research, business processes, and human resource management [4]. In addition, the use of digital technology in teaching processes—the first priority of HEIs—has focused on a limited number of technologies [7]. Additionally, the digital transformation efforts of HEIs have revolved around two actors: teachers and students [4].

This rather conservative process was changed by the emergence of the COVID-19 pandemic at the end of 2019. In response to government quarantine and social distancing measures, HEIs carried out rapid adoption of digital technologies to enable their activities

to remain open. However, rapid and forced digital transformation also brings associated problems. Students and teachers reported experiencing anxiety, stress, and depression at levels that exceeded those observed before the pandemic [8, 9]. Specifically, the factors associated with these levels of stress and anxiety revolved around the players' lack of experience in using digital technologies, the enormous work required to adapt materials [10], delays in graduations, and the loss of job opportunities and internships [11].

Regarding past authors' attempts to order the existing literature, several previous publications were identified. However, these publications had different objectives than those of the present study: Aditya, Ferdina, and Kusumawardani [12] focused only on systematizing the barriers to digital transformation in HEIs. Alenezi [13] focused on reviewing the digital maturity models applicable to HEIs. Castro Benavides et al. [4] focused on a systematic review of the literature based on a few dozen articles.

3 Method

This research has followed the recommended stages for studies oriented to systematic literature reviews and bibliometric analyses [14, 15]. In this way, the present study is organized in three stages: 1) formulation of the objectives, 2) definition of the inclusion criteria and content search strategies, and 3) presentation of the results. Considering that the objectives of this study were already stated in the introductory section, this section focuses on detailing the inclusion criteria and the search strategies used. The following section will serve to detail the analysis carried out on the body of documents and the results obtained.

The objective of this study was the main guide for establishing content inclusion criteria. Thus, the documents included had to be relevant to the proposed objective (digital transformation in higher education institutions) and present an acceptable level of quality. In turn, these criteria guided the search strategies. Of the various academic–scientific information bases, Scopus was selected for its wide coverage, high level of quality, and built-in search and analysis tools [3]. As for the search terms, these were also guided by the objective of the research, and it was decided that two types of content would be present simultaneously: digital transformation and higher education. In this way, the following structure of search terms was used: ({digital transformation} AND ({higher education} OR universities OR university)).

An additional delimitation was to restrict the documents to the English language. No restrictions were adopted concerning the date or type of document. The search was carried out on January 24, 2022, and 643 documents were obtained.

4 Analysis and Results

A first approach to the body of documents analyzed was based on the evolution of the number of documents published over the years. As can be seen in Fig. 1, scientific and academic production on digital transformation and higher education was almost non-existent until 2015. A subsequent period, 2016–2018, showed moderate growth, and the 2019–2021 period showed explosive growth, which some authors have described as

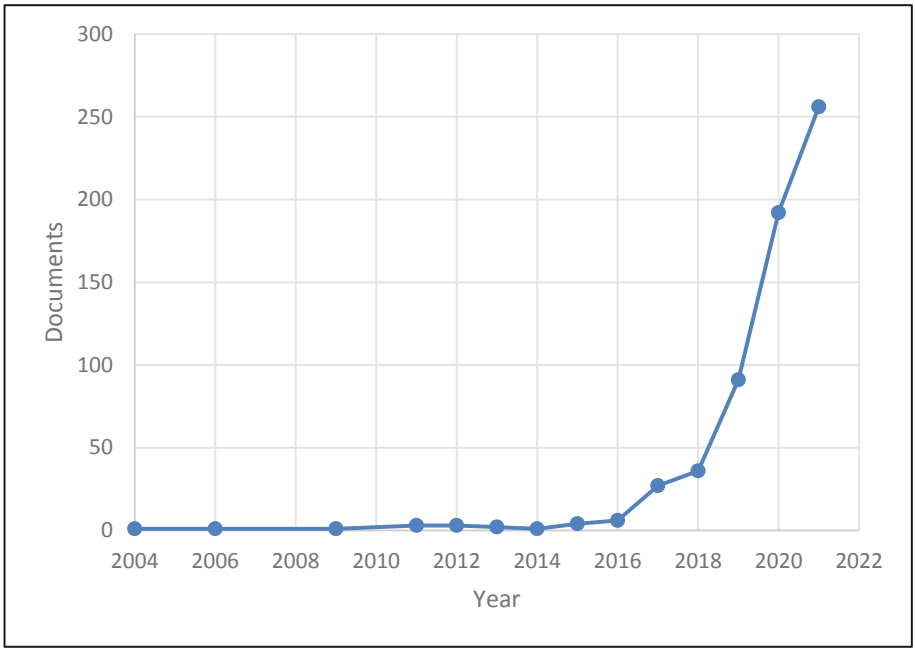

Fig. 1. Evolution of the number of documents published (Source: Scopus).

"exponential" [3, 4]. In 2021, the last full year analyzed, 256 documents were published on the topic under analysis.

Another descriptive analysis was carried out regarding the area of knowledge with which the publications were related (Table 1 presents the results). It is necessary to clarify in this regard that the same document could have been assigned to several areas.

Thus, most of the documents (n = 352; 54.7%) had Computer Science, followed by Social Science (232; 36.1%), Engineering (171; 26.6%), and Business and Management (112; 17.4%), among the related areas. These data reflect the multidisciplinary nature of digital transformation studies, in which both technologies and social and organizational issues are involved [16]. Another interesting aspect was the type of publication. Conference papers were the main form of publication, with 320 documents (49.8%), followed by articles (215; 33.4%). Other types of publication carried little weight.

Another important piece of information comes from the countries to which the authors are related, based on their institutional affiliation. In this regard, it should be considered that since the existence of several authors in the same document is very frequent, a document may be related to several institutions and countries at the same time. Thus, Russia stood out with 140 (21.8%) associated documents, followed by Germany (70; 10.9%), Spain (49; 7.6%), and the United States (34; 5.3%).

Regarding the authors' affiliated institutions, Table 2 presents the universities and institutions with more than five associated documents. As can be seen in the aforementioned table, 11 universities and institutions meet this requirement. Tecnológico de Monterrey of Mexico and Kazan Federal University of the Russian Federation lead

Table 1. Main areas of knowledge

Subject area	Documents	%
Computer Science	352	54.7%
Social Sciences	232	36.1%
Engineering	171	26.6%
Business, Management and Accounting	112	17.4%
Decision Sciences	94	14.6%
Environmental Science	61	9.5%
Mathematics	56	8.7%
Energy	44	6.8%
Earth and Planetary Sciences	30	4.7%
Economics, Econometrics and Finance	29	4.5%
Physics and Astronomy	21	3.3%
Psychology	20	3.1%

this group. It is also worth noting that the same document can be associated with several institutions; the same is possible for an author, who can be associated with several institutions.

Table 2. Main universities and institutions

University/Institution	Associated documents
Tecnologico de Monterrey	12
Kazan Federal University	11
Financial University under the Government of the Russian Federation	10
Peter the Great St. Petersburg Polytechnic University	9
Ural Federal University	9
International University of La Rioja	8
The State University of Management	7
Don State Technical University	7
Universidade de Aveiro	6
Telkom University	6
Centro de Estudos Organizacionais e Sociais do Politécnico do Porto	6

To analyze of the co-occurrence of terms, VOSviewer 1.6.15 software [17] was used, and an estimation was performed based on the titles and abstracts. The minimum number of occurrences of a term to be considered was set at 15, and 118 terms qualified. After

cleaning the list of terms, which consisted of the elimination of very general terms and a grouping of terms of similar meaning, 107 terms qualified. The co-occurrence analysis generated three thematic clusters, which are presented in Fig. 2.

Cluster 1 (red; 41 items): This gathered the most elements. Terms such as "teaching," "COVID-19," "course," "teacher," "ability," "crisis," and "group" suggest that this thematic area focused on one of the applications of digital transformation—the one related to teaching—particularly under the pressure exerted by COVID-19.

Cluster 2 (green; 33 items): Among the terms that were part of this thematic area were "economy," "training," "labor market," "activity," "region," and "readiness." This composition of terms suggests an area focused on environmental influences in the digital transformation of HEIs.

Cluster 3 (blue; 33 items): Among the terms that were part of this cluster were "industry," "innovation," "artificial intelligence," "big data," "capability," "internet of

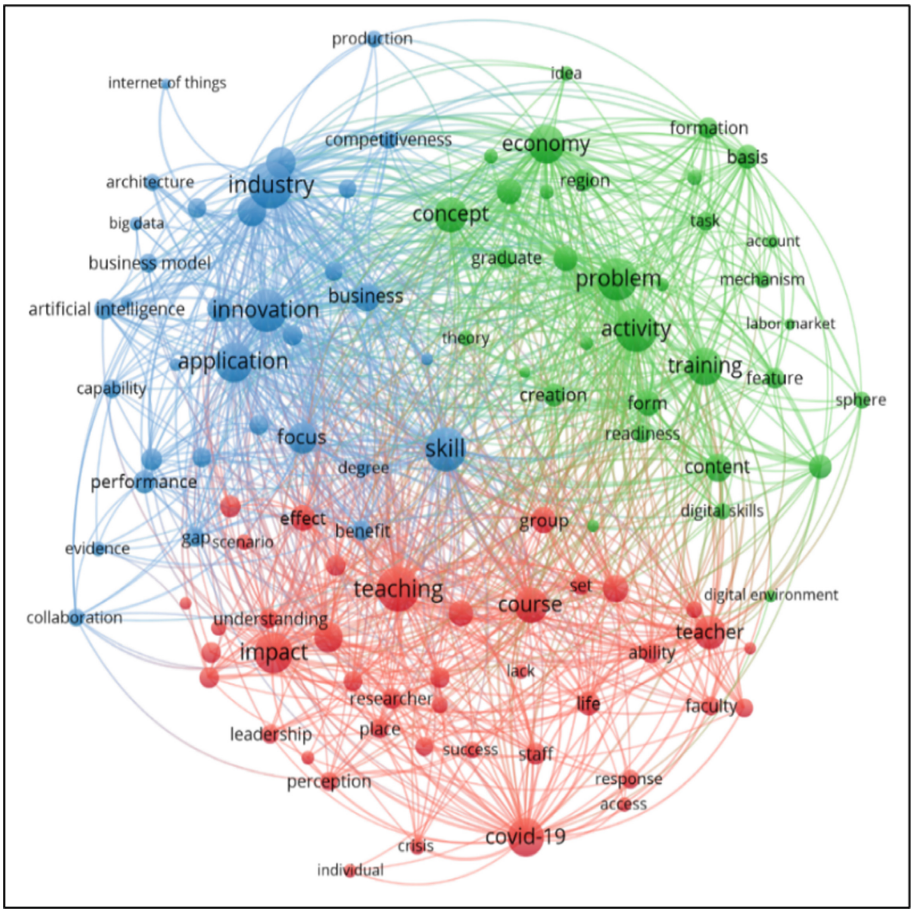

Fig. 2. Co-occurrence network of terms. (Color figure online)

things," "performance," and "application." This composition of terms suggests a thematic area focused on the enabling technologies of digital transformation and their applications.

An additional analysis carried out with the same VOSviewer 1.6.15 software was to overlay visualization of the existing terms in titles and abstracts. This tool makes it possible to visualize the currency of a term based on the average year of publication of the documents that mention it [17]. Figure 3 presents the results. The oldest terms appear in violet, the most current ones in yellow, and the intermediate ones in green.

As can be seen in Fig. 3, "COVID-19" was the most outstanding (largest node size) among the most topical terms in the digital transformation of universities. At the other extreme was "economy," which is a macro-environmental force and a term frequently mentioned by documents published in 2019.

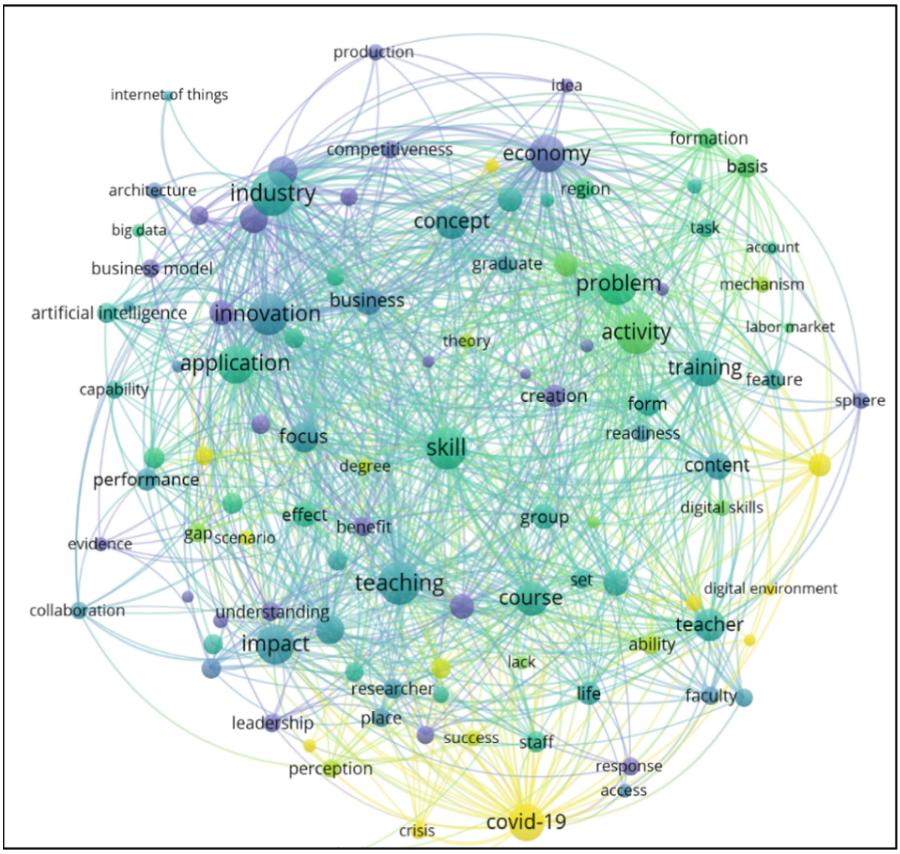

Fig. 3. Overlay visualization of terms. (Color figure online)

5 Discussion and Implications

The descriptive analysis of the body of documents on the digital transformation of HEIs reveals several characteristics. This area of research has in recent years shown growth characterized by a very steep curve. This trend coincides with the appreciation of various authors about the enormous interest that this research topic is arousing [3, 4]. As for the countries with which the authors and their affiliated institutions are related, Russia, Germany, Spain, and the United States—both developed and emerging countries (in the case of Russia)—stand out. In this regard, a recommendation for future research is to include other less studied scenarios such as developing countries.

One of the most important results of this study concerns the thematic areas of research on digital transformation and HEIs. Thus, three areas of interest could be established. The first is related to digital transformation in teaching, particularly with it under pressure from COVID-19. Although teaching has been an aspect of digital transformation to which HEIs have been giving more importance [4], this emphasis has become even greater due to the pandemic [2]. A second area of research interest is environmental or background influences on HEIs such as the economy, labor market, and regional characteristics. In this regard, it should be noted that HEIs were initially attracted by digital transformation to improve their products and services, improve competitiveness, and find more and better markets [1]. The final thematic area is related to enabling technologies of digital transformation. In this sense, it should be remembered that digital transformation is energized by the confluence of a series of technologies such as artificial intelligence, the internet of things, and big data [6].

Another very interesting aspect is given by the evolution over time of research priorities. Currently, COVID-19 is the factor with the greatest influence on the digital transformation of HEIs; however, the pandemic is following a very dynamic course [5]. For this reason, a recommendation for future studies is the investigation of digital transformation in HEIs in light of the evolution of the pandemic. For example, mass vaccination campaigns will mark new stages of behavior of governments and populations.

Going deeper into the subject of COVID-19, a topic of great interest for future research and for professional practice is the normalization process that would follow the massive vaccination campaigns and the decrease in cases. In this sense, it is very important for HEIs to maintain the digital capabilities developed during the pandemic. In short, do not think about a return to the same starting point as before the pandemic. Thus, the delivery of education through mixed or hybrid media (in person and online) in different proportions can contribute to the maintenance of these developed digital capacities.

A final issue is the relationship of the present study to previous attempts to organize the existing literature [4, 12, 13]. These studies focused on understanding and systematizing the literature based on a few dozen articles. Hence, a distinguishing characteristic of the present study is the quantity and variety of the studies considered. In total, this study included 643 documents of different formats, such as conference proceedings, articles, and book chapters. Therefore, a consequence for the theory is that the present study shows a more complete and broader (although not deeper) picture of the existing literature.

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