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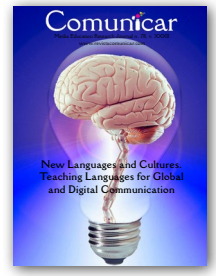

Bibliometric Study and Network Mapping of Teacher Technostress Between 1992-2022

Estudio Bibliométrico y Mapa de Redes del Tecnoestrés Docente Entre 1992-2022

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ABSTRACT
The purpose of this research was to realize a metric study of scientific production between1992 and 2022 on one of the topics that has acquired great importance in the educational field, due to the pandemic caused by COVID-19: teacher technostress. For such purpose, 139 scientific documents indexed in the Web of Science database were examined. The content was analyzed using an Excel spreadsheet and the VOSviewer software. To guarantee the quality of the methodological procedure, the PRISMA protocol was followed. First, a bibliometric analysis of the extracted publications was conducted, taking several indicators of production and dispersion as references. Second, a network analysis was performed to understand the collaboration structure between countries and the conceptual structure of the topic under study. The results highlight that existing scientific information on teacher technostress is scarce, that it is widely dispersed in terms of research areas, and that there are no major producers on the subject. Nonetheless, COVID-19 has been a decisive turning point that has generated the highest percentage of scientific production recorded to date and has contributed to bringing greater visibility to technostress, not only as a psychosocial occupational risk but also as a phenomenon affecting the teaching profession as one of the most vulnerable work collectives in an online context.

RESUMEN
El propósito de esta investigación es realizar un estudio métrico de la producción científica generada en el periodo 1992-2022 sobre uno de los tópicos que ha adquirido mayor importancia en el ámbito educativo debido a la pandemia provocada por el virus COVID-19: el tecnoestrés docente. Para ello, se examinaron 139 documentos científicos indexados en la base de datos de Web of Science durante ese periodo, cuyo contenido se analizó a través de la hoja de cálculo Excel y el programa VOSviewer. Para garantizar la calidad del procedimiento metodológico, se utilizó el protocolo PRISMA. En primer lugar, se realizó un análisis bibliométrico de las publicaciones extraídas, tomando como referencia varios indicadores de producción y de dispersión. En segundo lugar, se realizó un análisis de redes, con objeto de intentar comprender la estructura de colaboraciones entre países y la estructura conceptual del tema objeto de estudio. Los resultados ponen de relieve que la información científica existente sobre el tecnoestrés en docentes es escasa, que se encuentra muy dispersa por áreas de investigación y que no existen grandes productores sobre la temática. Asimismo, el COVID-19 ha sido un punto de inflexión determinante que ha generado el mayor porcentaje de producción científica registrado hasta la fecha, lo cual está contribuyendo a dar mayor visibilidad al tecnoestrés como riesgo psicosocial laboral y a la profesión docente como uno de los colectivos más vulnerables.

KEYWORDS | PALABRAS CLAVE
Bibliometric Analysis, Technostress, ICT, Social Network Mapping, Teaching, COVID-19.
Análisis Bibliométrico, Tecnoestrés, TIC, Mapa de Redes, Docencia, COVID-19.

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1. Introduction

The introduction of Information and Communications Technology (ICT) has brought about a profound change in society over recent decades, particularly due to the emergence of new information channels developed through digital technologies (Yu et al., 2018). However, ICT has been a real revolution in the educational field.

In this context, ICT has contributed to innovation in teaching, has redefined the role of the teacher, and has become a major teaching resource (Boyer-Davis, 2020). Indeed, the massive use of ICT has been a precursor to the transformation of classic teaching processes and has gradually incorporated new learning scenarios characterized by the use of digital technologies, such as e-learning and blended learning (Tayebinik & Puteh, 2012).

Such new educational models have continued to evolve, and, with the appearance of smartphones in 2007 (Alegría Martín, 2015), have given rise to a new learning trend under the name of mobile learning. This is characterized by the ubiquity and use of mobile devices (e.g., smartphones, personal digital assistants, tablets) in the teaching-learning process (West & Vosloo, 2013).

Regardless of the specific educational model, the advancement of ICT has also contributed to the rise in innovative active teaching strategies, such as the flipped classroom. This technique began to emerge in 2014 and up to 78% of teachers have acknowledged having used this technique in one of their classes (Peinado-Rocamora et al., 2019). Game-based learning, gamification in the classroom and virtual reality form part of these recent pedagogical trends (Buzón-García et al., 2021).

ICT has revolutionized educational programs and become an essential requirement of them, so much so that in one of the last ministerial conferences of the European Higher Education Area (EHEA), held in Yerevan, Armenia (Bologna Process, 2015), expressly stressed, and for the very first time, clear support for the promotion of pedagogical innovations that use ICT in the educational process.

Undoubtedly, ICT brings positive benefits in the school community (Belotti, 2018). However, technological changes may also have negative consequences for workers, including reduced concentration and psychological well-being, stress, burnout, anxiety, fatigue and insomnia, among other effects (Llorens et al., 2007; Syvänen et al., 2016). This is what some researchers have called the dark side of ICT (Pressley, 2021; Salanova et al., 2013; Tarafdar et al., 2015a, 2015b).

In this regard, adapting the educational context to technological requirements can be a stressful experience. For example, teachers are put under pressure to constantly update their knowledge, in order to adapt to innovative technological resources. In addition, they have to modify their teaching methodologies and develop an adequate competence in digital teaching skills, often with limited resources and support (Gisbert et al., 2019). Furthermore, it has been observed that teachers with lower competences in digital skills tend to develop technophobia, that is, fear and anxiety in relation to it, and even outright rejection of its use (González Elices, 2021).

Another related stressor is digital hyperconnectivity, which erodes the dividing line between the times and spaces of professional and personal life (Mansour et al., 2022; Tarafdar et al., 2015a, 2015b). It is thus clear that ICT implies additional efforts that generate greater work pressure, in both physical and mental terms. Likewise, prolonged exposure to ICT in combination with a lack of skills and abilities to deal with it, is a major source of technological stress or technostress, as it has been conceptualized in scientific literature (Salanova, 2007; Salanova et al., 2013).

Although the origin of the term technostress dates back to 1982 (Brod, 1982), it was two years later, in 1984, that the researcher Craig Brod defined it as "a modern disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner (Brod, 1984). As discussed by Llorens et al. (2007), with the passing of years, technology has advanced and so has the concept of technostress, being no longer merely about a lack of skills or abilities in relation to technology, but about the negative consequences that its use entails.

In this context, according to Salanova (2007), technostress is a general concept that encompasses different types of technostress. First of all, techno-anxiety relates to high levels of discomforting physiological activation in the use of ICT. Second, techno-fatigue implies cognitive fatigue and feelings of inefficacy in the use of ICT. Finally, techno-addiction is a specific technostress in those who are dependent on technology and make it the main axis of their lives.

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Teacher stress was already a scientifically recognized psychosocial risk (MacIntyre et al., 2020) before the emergence of the unexpected global pandemic caused by COVID-19 in 2019, which contributed to drastically worsening the exposure of teachers to technostress, including the effects of anxiety, fatigue, depression, burnout, etc. (Boyer-Davis, 2020; Collie, 2021; Li et al., 2020). Among other causes, one of the triggers of technostress was the mandatory closure of educational institutions, which made it necessary to replace face-to-face teaching with improvised teleworking as the main pedagogical means of reaching pupils and students (García Peñalvo et al., 2020). Furthermore, and associated with this incipient form of labor organization (teleworking), there has been evidence of increased exposure of teachers to a large number of psychosocial risk factors, including feelings of isolation, difficulties in reconciling academic and family life, the lack of a regular work schedule, and increased working hours and mental overload, which have been associated with an increase in the incidence of the phenomenon of teacher technostress, and more so in women in particular (Eurofound and the International Labour Office, 2017; García-González et al., 2020).

In Spain, the COVID-19 public health emergency was declared on March 14, 2020, and was extended until June 21 of the same year (Royal Decree Law 21/2020). In the following months, an attempt was made to limit the effects of the pandemic with a relaxation of emergency measures, which came to be known under the banner of the new normalcy. However, a severe rebound in COVID-19 cases and successive waves of infections lead to the declaration of a new public health emergency, this time extending from November 9, 2020 to May 9, 2021 (Royal Decree 926/2020). This lead to several long months affected by a complex scenario of stress, isolation, insecurity, long work hours, uncertainty, fear, depression, fatigue and technological anxiety, among other disorders (Ramírez et al., 2021). With regard to this context, of particular note is Law 10/2021 on Remote Work, which expressly regulates the right to digital disconnection from the workplace and makes an explicit mention of digital hyperconnectivity in association with the COVID-19 public health emergency.

The literature review carried out by the authors indicates that technostress is a recent construct, concerning which very few scientific studies have analyzed the evaluation or development of the phenomenon in teachers. Indeed, while there are various qualitative analyses (in the form of systematic reviews) on this topic, no metric analysis was found to investigate teacher technostress from a quantitative point of view. To bridge this gap, an attempt has been made to shed light on the topic through research from the perspective of scientometrics.

Scientometrics is a multidisciplinary field focused on quantitative studies of scientific production, using a range of specific measurement techniques, such as bibliometrics, webometrics, statistics, mathematics and social network analysis. The results give indications on the progress, impact and evolution of contemporary science (Faba-Pérez et al., 2004).

In this regard, the general aim of the present study was to evaluate and analyze scientific production on teacher technostress during the period 1992-2022, through the application of the methodologies of bibliographic analysis and scientometrics. The specific aim was to explore the historical evolution of scientific production on the topic, the productivity index of authors, and specifically that of the most prolific authors, dispersion indicators, the collaborative and conceptual structure, and emerging and future lines for the advancement of research in this field.

2. Materials and Methods

Descriptive and retrospective bibliometric and network analyses were conducted. These analyses focused on scientific literature on the topic retrieved through a systematic search process.

Extracted data was used to elaborate common bibliometric indicators, including production and scientific dispersion. Furthermore, the most relevant two-dimensional mappings were elaborated, allowing for the identification of the conceptual and collaboration structure in the field of study.

It is opportune to point out that the data collection and analysis methodologies used, as they should be for all research, were designed to be rigorous, reliable, transparent and replicable. Consequently, although this is not a typical systematic review, it was decided to used an adaptation of the PRISMA 2020 protocol (Yepes Nuñez et al., 2021) for this research, which, as is known, consists of a set of specific recommendations to guarantee quality and avoid bias in systematic reviews. In this way, it was possible to verify and compare the quality of the overall methodological process followed.

The PRISMA 2020 checklist items verified in this research included:

a) Information sources.
b) Eligibility criteria.
c) Search strategy.
d) Selection process.
e) Data collection process.
f) Study risk of bias assessment.

To mitigate bias and improve the quality of the article, a second reviewer was involved in the study selection phase (Higgins et al., 2019).

2.1. Information Sources

The Web of Science (WOS) database was selected, since it is considered a leading reference database for bibliographic analyses (Archambault et al., 2009). Indeed, this database has recognized prestige in the scientific community, due to the fact that the journals and publishers indexed in it are continuously evaluated by groups of experts to guarantee their relevance and impact (Mangan, 2019; Okumus et al., 2019). The search was conducted during the third week of November, with the last consultation made on November 16, 2022.

In order to achieve the stated aims and adequately cover the field under study, the Web of Science Core Collection database was used as the specific source of data, including the following editions: Science Citation Index Expanded (SCI-Expanded); Social Science Citation Index (SSCI); Arts & Humanities Citation Index (AHCI); and Emerging Sources Citation Index (ESCI). It is important to note that only peer-reviewed articles were taken into consideration, therefore expressly excluding databases related to book chapters and conference proceedings.

2.2. Eligibility Criteria

In a preliminary search of the WOS database, it was found that the first indexed study on technostress in teachers appeared in 1992. It was therefore decided to include this as the start date in the search parameters. Further eligibility criteria were defined, divided up between the following inclusion criteria (IC) and exclusion criteria (EC).

Inclusion criteria:

IC1: Topic: Technostress in teaching professionals, including teachers and professors.
IC2: Period: 1992 to Nov 2022.
IC3: Databases: WOS Core Collection (SCI-Expanded; SSCI; AHCI; and ESC).
IC4: Languages: All languages.
IC5: Document type: Peer-reviewed articles.

Exclusion criteria:

EC1: Topic: Studies not related to technostress.
EC2: Topic: Technostress studies conducted outside the professional teaching field.
EC3: Document type: Conference proceedings and editorial materials.
EC4: Full text not retrieved.

2.3. Search Strategy

The search formula was elaborated in order to extract peer-reviewed articles related to technostress in teaching sector professionals. The formula was built from keywords combined with boolean operators.

The field abbreviation used was TS (for technostress), referring to the research topic and the search for terms in the title, abstract and keywords of articles.

The formula used was as follows: TS = ((technostress OR ("stress" AND (technology OR ICT))) AND (professor OR teacher)).

This search strategy led to the identification of a total of 311 documents. Using the document type exclusion criterion, conference proceedings (2) and editorial materials (1) were eliminated from these documents, leaving a matrix of 308 peer-reviewed articles, which were then subjected to the selection process.

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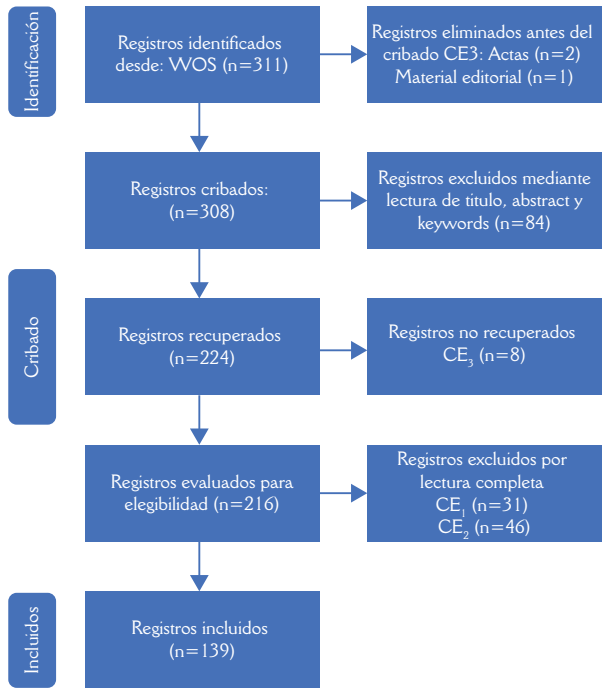
2.4. Selection Process

For the selection process, the records were analyzed by title, abstract and keywords, making a first screening of those that met the inclusion criteria. Consequently, a total of 84 studies were excluded from the matrix, and the full text of almost all the remaining articles was retrieved to properly assess them and make sure of their eligibility. In this way, a further 77 documents were excluded, obtaining a final total screened sample of 139 articles, of which 128 were original articles and 11 were review articles.

A second reviewer then verified the results of the selection process, which are shown in Figure 1.

Figure 1: The Selection Process of Articles for Inclusion in the Bibliographic Analysis.



2.5. Data Collection Process

The extracted data included the author, title, keywords, year of publication, country, journal, number of citations, and affiliations. Subsequently, the retrieved articles were categorized, the main indicators were calculated, and a scientific mapping was carried out. The data processing was performed using Microsoft Excel and the VOSviewer software, version 1.6.18.

2.6. Study Risk of Bias Assessment

The full texts of the articles selected for analysis were retrieved, in order to verify their relevance. In accordance with the PRISMA 2020 protocol, two reviewers independently performed the process of identifying and selecting the records included in the initial search matrix.

3. Analysis and Results

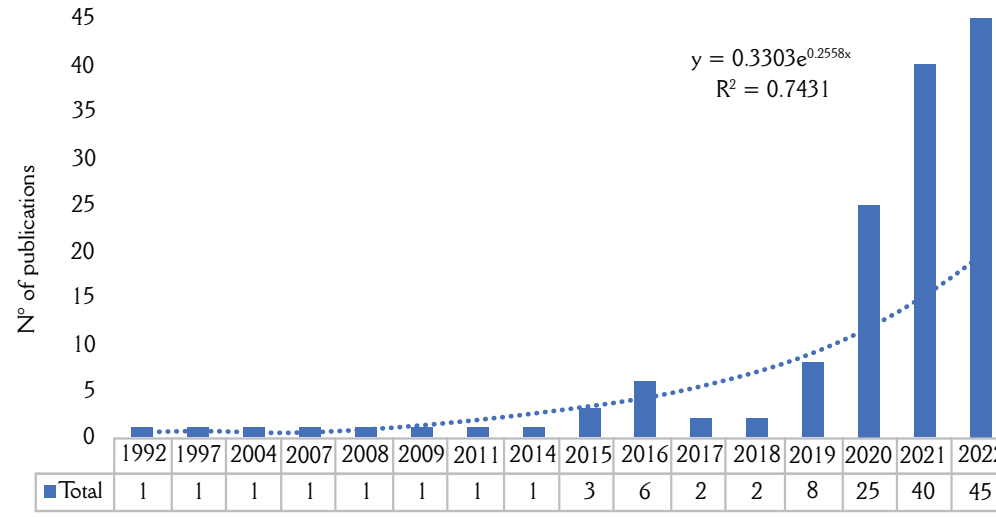
This section shows the results of the data analysis, grouped by the main bibliographic indicators.

3.1. Production Indicators

3.1.1. Diachronic Production

First of the indicators to be studied was diachronic production, which gives an indication of the evolution of the scientific literature over time (Figure 2).

Figure 2: Evolution of the Scientific Production and Citations until November 2022.



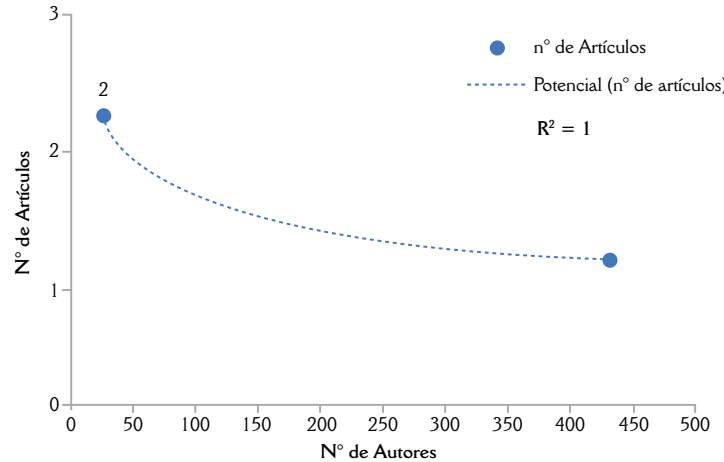
	1992	1997	2004	2007	2008	2009	2011	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total	1	1	1	1	1	1	1	1	3	6	2	2	8	25	40	45

According to these results, the first scientific publication to mention teacher technostress appeared in 1992, although it was not until 2015 that it became a specific topic of interest for the scientific community. On the other hand, from 2014 on, there was a progressive increase in contributions, especially during the most critical period of the health and social crisis caused by COVID-19: in the years 2020 (n = 25 articles), 2021 (n = 40 articles) and 2022 (n = 45 articles), during which 79% of the total number of articles were published.

3.1.2. Author Productivity

The productivity indicator is used to represent the number of articles associated with each author. Figure 3, entitled "Correlation between authors and articles" (https://doi.org/10.6084/m9.figshare.24047568), shows the results in comparison to the Inverse Square Law of Scientific Productivity, also called Lotka's law (Rousseau & Rousseau, 2000). In this analysis, both the first authorship and co-authorships were taken into account.

Figure 3: Correlation Between Authors and Articles.



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The multiple correlation index R2 = 1 shows the maximum fit.

This figure shows that the vast majority of authors (431) only published one article on the topic, while the rest (27) doubled the number of contributions. Therefore, the largest number of contributions per author was two.

The 27 authors with the highest number of articles per author on teacher technostress and their corresponding affiliations are listed below in alphabetical order:

Blandford, A. (University of London); Boada-grau, J. (Universitat Rovira i Virgili); Brasil, D.M. (Universidade Estadual de Campinas); Cascante-Sequeira, D. (Universidade Estadual de Campinas); Castillo, D. (Universidad de Santiago de Chile); Chen, M. (Cent China Normal Univ); Costa, E.D. (Universidad de Santiago de Chile); Edbrooke-childs. J. (UCL, Evidence Based Practice Unit, London); Estrada-Muñoz, C. (Univ Concepcion de Chile): Freitas, D.Q. (Universidade Estadual de Campinas); Garcia-González. G. (UNIR Univ Int Rioja); Huskic, A. (Univ Maribo, Slovenia); Khlaif, Z.N. (Univ Sains Malaysia); Kokol, Z. (Univ Maribo, Slovenia); Kosir, K. (Univ Maribo, Slovenia); Li, Y.T. (Cent China Normal Univ); Ludovichetti, F.S. (Univ Padua, Italy); Manning, J.B. (UCL London); Mehta, P. (Symbiosis Ctr Management Studies Nagpu, India); Owens, J.S. (University System of Ohio); Pace, F. (Univ Palermo); Sanmugam, M. (Univ Sains Malaysia); Santaella, G.M. (Univ Louisville), Torrano, F. (UNIR Univ Int Rioj); Vega-Muñoz, A. (Univ Autónoma Chile); Wang, X.H.(Cent China Normal Univ); Zhou (Cent China Normal Univ).

3.2. Dispersion Indicators

3.2.1. Bradford's Law Zones

Scientific production dispersion indicators represent how journals are dispersed according to the number of articles published on the research topic. To elaborate these indicators, the dispersion law of scientific bibliography, or Bradford's law, was applied. According to Bradford's postulates (Brookes, 1969), the production of scientific articles is unevenly dispersed.

Figure 4, entitled "Bradford distribution curve by journals" (https://doi.org/10.6084/m9.figshare.24047565), shows the calculation of the Bradford curve obtained by applying the mathematical model. It can be seen that the exponential growth follows a dispersion rate towards the periphery.

Figure 4: Bradford-Distribution Curve by Journals.

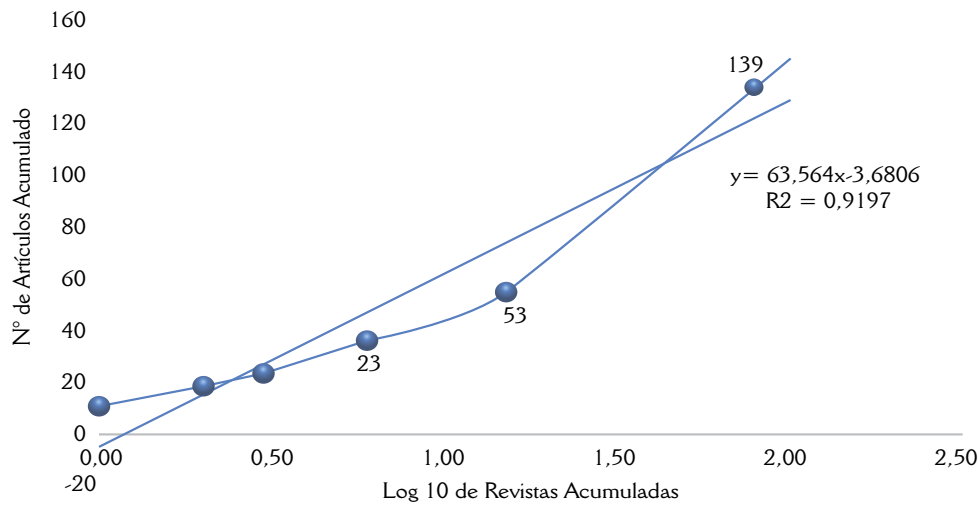
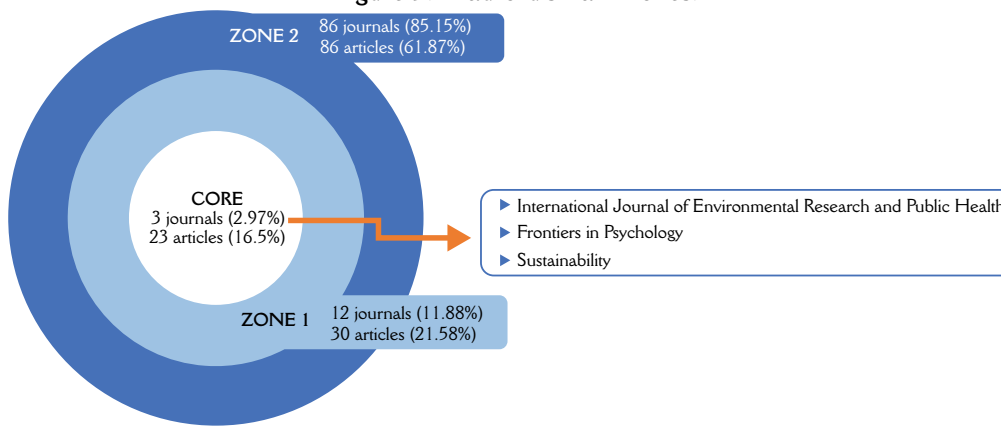


Figure 5 shows the analysis of the results of the distributions, clearly split into three Bradford zones, with the last zone, however, too dispersed and moving away from the one-third proportion of Bradford's model. The dispersion of the sample seems to conform to the Pareto principle (80-20), another model of dispersion (Ravichandra Rao, 1972).

Figure 5: Bradford's Law Zones.



The Bradford's law core and dispersion zones were identified as follows: the Core (1) consisting of 23 articles from only 3 journals; Zone 1 (2) consisting of 30 articles from 12 journals; and Zone 2 (3), the peripheral zone, consisting of 86 articles from 86 journals.

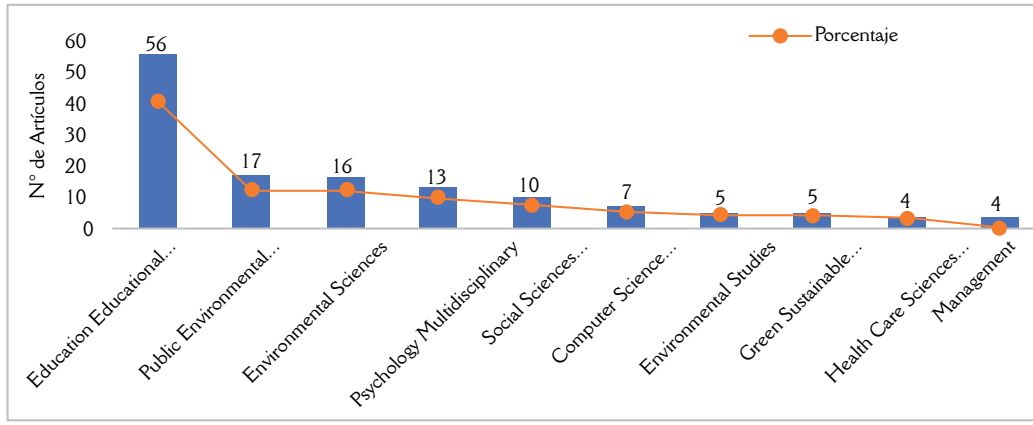
On the basis of these results, Figure 5 indicates the top 3 journals making up the Bradford core, and therefore leading scientific knowledge on teacher technostress. In first place is the international journal "Journal of Environmental Research and Public Health", with 11 articles, followed by "Frontiers in Psychology", with 7 contributions, and, finally, "Sustainability", accounting for 5 published articles.

Zone 1 accounts for the following 12 journals: "Computers and Education"; "Education and Information Technologies"; "Education Sciences"; "Arab World English Journal"; "The Asian-Pacific Education Researcher"; "Computers in Human Behavior"; "Frontiers in Education"; "International Journal of Information and Learning Technology"; "Odovtos - International Journal of Dental Sciences"; "Revista Conrado"; "School Mental Health"; and "Social Sciences - Basel".

3.2.2. Distribution by Scientific Area

Analyzing the sample distribution of articles by WOS research topic areas, as shown in Figure 6, entitled "Distribution of publications by WOS research areas" (https://doi.org/10.6084/m9.figshare.24049221), it can be seen that there are publications on teacher technostress in all areas. However, as to be expected, the Education topic area stands out as the one with the highest production.

Figure 6: Distribution of Publications by WOS Research Areas.



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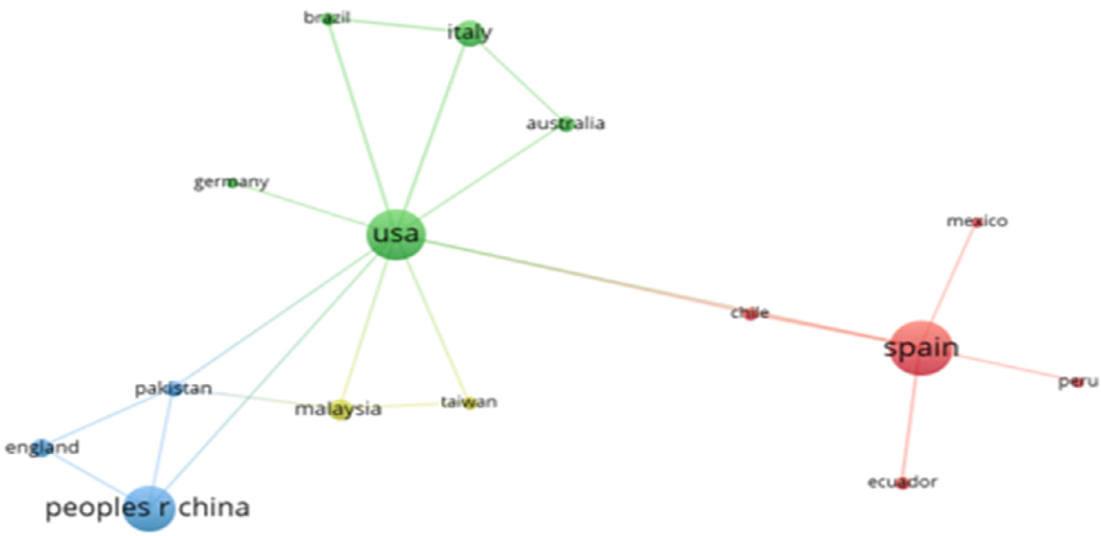
3.3. Network Mapping

To visualize the results of the network analysis, once the data had been normalized, two-dimensional bibliometric mappings were elaborated using the VOSviewer software. This tool leverages the visualization of similarities (VOS) technique, based on multidimensional scaling algorithms (van Eck & Waltman, 2007; Van Eck et al., 2010).

3.3.1. Country Collaboration Network

The network analysis by country gives a visualization of the relational structure between countries. Concerning scientific production on teacher technostress, Figure 7 shows the identified collaborative network.

Figure 7: Country Collaboration Network.



The social structure, as shown, is made up of 15 countries, grouped into the following 4 clusters:

Red cluster: Chile, Ecuador, Mexico, Peru and Spain.

Green cluster: Australia, Brazil, Germany, Italy and the USA.

Blue cluster: the United Kingdom, Pakistan and the People's Republic of China.

Yellow cluster: Malaysia and Taiwan.

It might be considered that the clustering is affected by language affinity, with the predominant language being English (123 publications), followed by Spanish (11 publications).

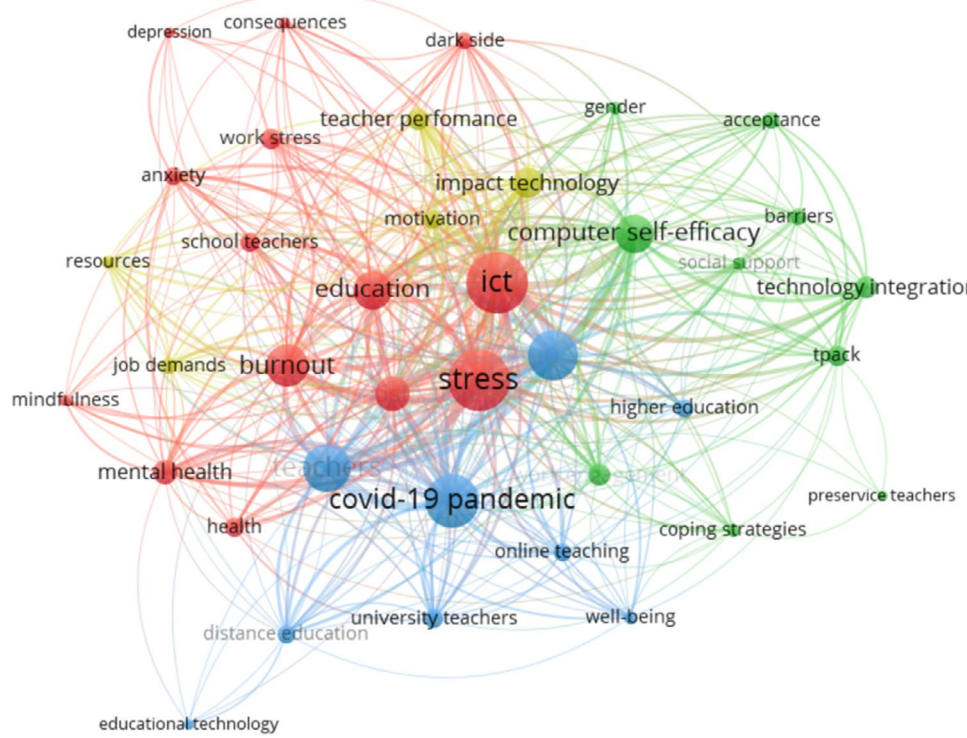
In the network map, the top 3 countries with the largest number of contributions are: Spain (21), USA (19), and the People's Republic of China (17), with the rest of the countries not exceeding 10 contributions.

3.3.2. Word Co-Occurrence Network

The conceptual structure of research was explored by elaborating a network mapping of word co-occurrence. This analysis makes it possible to identify patterns, trends, outliers and future lines of research, among other data of interest. In preparation, it was necessary to process the data by normalizing synonymous terms, which resulted in the identification of 38 keywords. Only keywords that exceeded a minimum frequency threshold of 4 occurrences were selected.

The result of the analysis is presented in the two-dimensional bibliometric mapping shown in Figure 8.

Figure 8: Keyword Co-occurrence Network.



Note: With VOSviewer's node distribution algorithm parameters: Attraction = 2, Repulsion = 1.

From the analyzed sample, a semantic structure formed by 4 clusters was obtained:

1. Red cluster: This cluster regroups topics relating to "the dark side of ICT". The cluster is made up of the following keywords: anxiety, burnout, consequences, dark side, depression, education, health, ICT, job satisfaction, mental health, mindfulness, schoolteachers, stress, and work stress.
2. Green Cluster: The line of research of this cluster is related to the theme that we have named the "ICT acceptance and integration model". It is made up of 10 keywords: acceptance, barriers, computer self-efficacy, coping strategies, gender, preservice teachers, social support, technology integration, TPACK (Technological Pedagogical Content Knowledge), and work engagement.
3. Blue Cluster: Contributions to the theme of "Technostress in different educational environments in times of COVID-19" were grouped in this cluster. The cluster is made up of 9 keywords: COVID-19 pandemic, distance education, educational technology, online teaching, higher education, teachers, technostress, university teachers, and well-being.
4. Yellow cluster: The line of research of this cluster is focused on studies of the "Impact of ICT on teaching performance". This cluster consists of 5 keywords: technology impact, job demands, motivation, resources, and teacher performance.

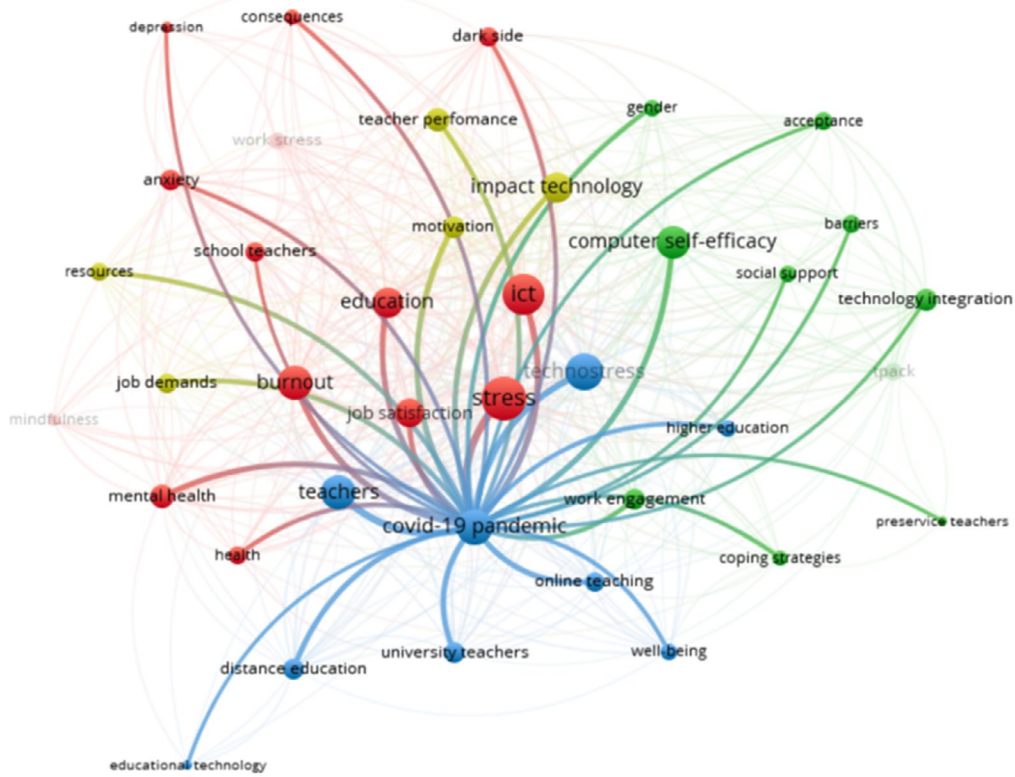
Without taking into account the keywords used in the search engine query, the most prominent co-occurrences were: COVID-19 pandemic (42), education (26), technology impact (19), burnout (30), computer self-efficacy (26), job satisfaction (22), and mental health (14). Furthermore, it can be seen that there are three clusters that stand out the most, blue, red, and green.

In the blue cluster is the keyword with the highest number of co-occurrences, which forms nucleus of that cluster. This keyword is linked to 34 other keywords. Due to its relevance for the topic at hand, and in order to graphically visualize the strength of links, Figure 9 provides a two-dimensional map of the

relational structure of this keyword "COVID-19".

As shown in the aforementioned Figure 9, the strongest and closest links with which the term COVID-19 is related concern the keywords: stress, ICT, education, burnout, technostress, and job satisfaction.

Figure 9: Relational Structure of the Term COVID-19.



4. Discussion and Conclusions

The metric study of the documentary information carried out made it possible to evaluate and analyze the thematic structure of scientific production on teacher technostress during the period 1992-2022.

First of all, it is noteworthy that the concept of technostress, despite its appearance in the literature in 1982, was not a main focus of research until 2015, a date that coincides with the rise of mobile learning (Mascarell Palau, 2020) and of the use of digital tools in the classroom (Peinado-Rocamora et al., 2019). This date furthermore coincides with the emergence of the express promotion of ICT by the main European political agendas in the field of education (Bologna Process, 2015).

The great impact that the global COVID-19 pandemic has had on the educational system does not go unnoticed, a fact reflected in the significant and unprecedented growth of scientific production on technostress since 2020. In particular, the sum of all contributions in the 2020-2022 period represent almost 80% of the total contributions since 1992, anticipating a possible similar growth perspective over the coming years. Undoubtedly, this increase in scientific production will serve to bring more visibility to one of the main psychosocial risks at work in relation to ICT, and will highlight the teaching profession as one of the groups most vulnerable to the risk of technostress.

Another second conclusion to consider has to do with the productivity index of the authors on the topic of interest. Although the total number of authors extracted from the database was 458, the maximum number of contributions per author was only two. Consequently, it cannot be considered that there are currently any large producers in this field. On the contrary, they appear to all be small producers. All in

all, it can be considered that the trend follows the aforementioned Lotka's law, since there is an inverse relationship between the number of authors and the number of publications.

Regarding the dispersion of the publications, there appears to be a core of a small number of specialist journals, and, at the same time, a wide universe of journals without a direct connection to the topic that nonetheless publish on the topic sporadically, revealing a wide overall dispersion. In relation to this data, it is interesting to note that the concept of teacher technostress has received more attention from multidisciplinary journals, above all in the field of health, to the detriment of specialist journals in the field of education, even though, as can be expected, the distribution by WOS scientific area is headed by that of Education. Indeed, the journal with the largest number of published articles was the international journal "Journal of Environmental Research and Public Health", which, in our opinion, shows that we are facing a new and emerging risk that has not yet been studied in depth from within the educational field. We therefore consider it necessary to launch a greater number of empirical investigations in the educational context, focused on the phenomenon of technostress and the causes leading to its appearance, which we hope will contribute to greater awareness and knowledge of this risk and the implementation of specific psychosocial intervention programs aimed at its prevention and management.

The network analysis brought to light some interesting implications, highlighting 4 collaboration networks between countries, three of which were more dominant (the red, green and blue clusters). A relevant fact is that Spain leads the collaboration network between countries, being the country with the largest number of published articles, followed by the United States.

Regarding the semantic structure of research, 4 clear research lines were revealed, which have been labeled as follows: 1) the dark side of ICT; 2) the ICT acceptance and integration model; 3) technostress in different educational environments in times of COVID-19; and 4) the impact of ICT on teaching performance. Within these fields of study, the strongest and closest relationships dealt with in the articles concerned different thematic aspects. The most notable was the COVID-19 pandemic, undoubtedly the variable most responsible for the recent increase in scientific production on technostress in the teaching field. In turn, this thematic aspect is strongly related to the psychosocial risks of stress and burnout, and to the field of study concerning the "dark side of ICT". In this context, the prominence of such terms as job satisfaction, mental health, anxiety, and depression is unsurprising. The latter are among the most prevalent aspects related to work stress negatively affecting health (European Parliament, 2022; Collie, 2021; Kim et al., 2016; Madsen et al., 2017).

Distance and online education seem to be the most relevant topic areas, with a greater number of occurrences compared to traditional education. In this regard, it can be seen that the intensification of ICT is greater in such contexts, in which teachers are thus more exposed to technostress. Regarding different educational stages, higher education stands out, and, within it, university education.

In the entire conglomerate of clusters, it can furthermore be observed that novel research lines are beginning to emerge in relation to teacher technostress. There is, for example, mindfulness, which is a physiological technique successfully used for stress management (Matiz et al., 2020). On another level, gender studies and coping strategies for teacher technostress stand out as pioneering and emerging lines of research, which are two of the main directions, in particular, in which future research may advance. women were reported to be at higher risk than men of developing symptoms of stress/anxiety/depression, and resilience was considered a key factor for positive mental health outcomes. In the present study, a sample of Italian female teachers (n = 66, age: 51.5 ± 7.9 years

Ultimately, the metric study carried out allows us to better understand research into the phenomenon of teacher technostress, and will be of considerable help in better adapting to new post-COVID educational scenarios, where the intensive use of ICT is increasingly widespread. It should not be forgotten that technostress is considered a new and emerging psychosocial risk that is directly related to burnout syndrome (Llorens et al., 2007; Syvänen et al., 2016), and that one of the most vulnerable groups to this risk is that of teaching professionals (Llorens et al., 2007). In this regard, educational institutions should bear in mind technostress as a psychosocial risk that must be included in occupational risk assessments, in order to identify the specific technostressors present in each institution. At the same time, they should intervene on certain risk factors directly related to technostress and teacher burnout, such as excessive workload, lack of specific training in digital skills, and lack of disconnection of teachers from work (Salanova, 2007; Salanova et al., 2013; Tarafdar et al., 2015a, 2015b; Touron et al., 2018). In turn, they must provide resources to teachers

so that they can develop coping strategies to mitigate the harmful effects of ICT use (Gisbert et al., 2019).

As for the limitations of this research, one is the hitherto scarce production on the subject. It should be taken into account that, in order to apply Bradford's law, it is necessary to have a period of scientific production of more than ten years, and yet, although the study sample meets this criterion, the scientific production before 2015 was minimal (11 articles). This fact constitutes a limitation that may distort the results in relation to the Bradford mathematical model. This paper therefore does not try to identify the most specialized journals, but rather sets out the journals that have thus far accumulated the greatest body of knowledge and production on the subject. A second limitation is the risk of bias, such as the language bias in favor of English. Editorial bias could also be present due to the inclusion in WOS of publication packages from large publishers, such as Elsevier, Springer, etc.

In the future, it would be interesting to replicate this study using the Scopus database (including PsycINFO), since the inclusion criteria are not as exigent as for the WOS database and might therefore cover a more varied scientific production. This, in turn, would highlight the growing phenomenon of adverse consequences for the mental health of teachers (European Agency for Safety and Health at Work, 2019). Furthermore, it would be relevant to include similar analyses that explore technostress according to different educational stages and levels in the education system.

Author Contribution

Idea, F.T.; Literature review (state of the art), R.L.; Methodology, R.L.; Data Analysis, R.L.; Results, R.L.; Discussion and conclusions, R.L., F.T.; Writing (original draft), R.L.; Final revisions, R.L., F.T.; Project design and sponsorship, R.L., F.T.

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