International Journal of Social Science and Business, Vol. 9 No 1; March 2025
ISSN: 2519-9161(Online), ISSN: 2519-9153(Print)
Published by Centre for Academic Research (CAR)

A Bibliometric Perspective on Technology Stress in Academic Settings: Trends, Challenges, and Solutions

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Abstract

This study analyzes the changing field of technostress research in academic circles, focusing on important developments, influential contributions, and new subjects from 1973 to 2024. The study shows a significant increase in technostress research articles in the past ten years, particularly post-2015, with Scopus showing a more notable increase compared to Web of Science. Prominent journals such as Frontiers in Psychology, Lecture Notes in Networks and Systems, and Sustainability (Switzerland) are becoming leading sources for important research, highlighting their growing importance in the field. The evaluation also shows that the US is a top performer in total research output, with China and India experiencing significant growth in recent times. Amid the digital revolution and ongoing pandemic, technology stress still has a significant impact on both students and educators. Key topics covered are "Technostress," "Techno-Stress," "Mental Health," and "COVID-19," as discussed in well-referenced studies examining their significant impacts. In 2007, Lee conducted a comprehensive study on how technology impacts teenage driving, which included complex designs and in-depth statistical evaluations. The exhaustive review by La Torre and his colleagues in 2019 systematically explored technostress in different populations through diverse qualitative and quantitative methodologies. In addition, Gaudioso and colleagues' 2017 study using mixed methods suggested useful coping strategies based on in-depth interviews and surveys. Although providing basic knowledge, recognized limitations include the possibility of selection biases in the sources cited. However, this study helps to identify deficiencies, guide future research, and create plans to reduce technology-related stress, which is particularly important given the current heavy use of digital tools in educational settings.

Keywords: technology stress, higher education, bibliometric analysis, ScientoPy, VOSviewer

Introduction

Although technological tools can enhance modern education, relying too heavily on digital devices can lead to a psychological strain called techno-stress, which can negatively affect mental health and academic success. In modern classrooms filled with abundant data, it is important to acknowledge the positive impact of technology on education and also be aware of how excessive screen time can lead to decreased focus and mood changes rather than enhancing learning. It is crucial to strike a harmonious and thoughtful connection with our tools in order to maximize their benefits and minimize their drawbacks. Recent studies indicate that excessive communication and social media usage could potentially harm students by causing techno-anxiety, tech stress, or Facebook fatigue, according to psychologists. In addition, techno-stress has been linked to decreased attentiveness, sleep problems, isolation from social activities, heightened anxiety, and ultimately, a negative impact on academic performance. Nevertheless, student investment in studying can be positively influenced by personal attributes such as self-perception and confidence when proactive teacher support reduces technology-related stress in students. To combat techno-stress, it is essential to enhance these resources to uphold student health and achievement.

Recognizing the impact of technology-stress on academic environments is crucial, as it significantly affects the performance, mental health, and overall well-being of students and academic staff. Overusing technology can cause students to become distracted, lose motivation, disrupt their sleep, and worsen feelings of loneliness and mental health issues such as anxiety or depression, ultimately impacting their academic performance. One negative impact of COVID-19 is technology-related stress, as the sudden switch to online teaching has increased stress levels, tiredness, and decreased productivity among educators. Techno-stress negatively impacts students' mental health, resulting in increased anxiety levels, which can lead to feelings of misery and ultimately affect their grades and motivation. It's important to address stress caused by technology in an efficient manner, as it can lead to a more positive learning and well-being environment, ultimately improving student and staff performance.

This study bibliometrically reviews existing research on technostress in the educational context, through evaluating the IS literature on how libraries and novel technology causes stress to individuals; between them including students, librarians and teachers. The study reviews incidents historically to trace changes in the issues, remedies and patterns involving technostress within educational context. Additionally, it highlights some of the key challenges that students and teachers experience and provides exposure to best practices on how both can manage technostress. We believe that this extensive literature helps in understanding research advancements and future coverings concerning the elucidation of technostress impact on academic performance and well-being.

This review also aims to have a deeper understanding of the subject by examining earlier works on technostress in academic institutions. It is hoped to identify high level trends and patterns the research unveils which will "inform how technostress has evolved as well as its impact on both students and educators." Moreover, the research aims to ascertain some core troubles associated with technostress like its impact on educational achievement, emotional well-being and success in general. The article concludes by identifying ways that may reduce the negative consequences of technostress, and providing recommendations useful in addressing this emergent phenomenon within educational settings.

The in-depth research looks at literature on technostress within academic environments. Bibliometric methods allow a systematic investigation of how works mention each other, in collaborations between authors, relevant keywords, and clusters among thematic areas. This is a means of navigating the disciplinary landscape and identifying enduring patterns, general themes and core ideas that evolve over time. Research using these databases such as Scopus and Web of Science is cited to trace the perspective and knowledge developed since 1973 until the latest technostress study. This additional and comprehensive approach of acquisition would make possible to interpret detailed results which, in part at least, could provide enlightenment on the problems and solutions concerning technostress at educational places.

Studying the crucial role of bibliometric analysis is essential to understanding technostress in academic environments. Areas evaluated include research methods, with a detailed explanation of bibliometric techniques and sources; results, focusing on important patterns and findings; analysis, breaking down complex issues and creative solutions; and final thoughts, summarizing impacts and proposing new directions for further study. This in-depth study is of great significance for teachers, policymakers, and academics, enhancing existing understanding and offering valuable advice on how to cope with technology-related stress in educational environments.

Methodology

Bibliometric analysis approach and selection criteria

Bibliometric analysis provides a quantifiable method for examining trends in academic literature publications, providing in-depth understanding of the evolution of a field over time. This strategic method impacts the future by acknowledging important researchers and adjusting themes.

To examine the technology-induced stress experienced by students and faculty in higher education, we employed bibliometric analysis on articles from Scopus and Web of Science released by June 1st, 2024. Keywords such as "technology stress," "techno-anxiety," and "EdTech stress" led to the discovery of important studies on this issue. These thorough indexes were chosen for their strict criteria and tools for analyzing citations, enabling in-depth study of important works and well-known academics. Differences in search terms verified a comprehensive examination of global research..

We extracted relevant datasets on technology stress in higher education from the selected sources and studied them carefully using ScientoPy and VOSviewer. Our analysis spanned 1973 to 2024. ScientoPy facilitated bibliometric review while VOSviewer enabled visualization of trends. Primarily, our aim was to comprehensively evaluate the worldwide impact and changing themes of technology stress in higher education literature stored in databases.
This approach allows for a detailed comprehension of issues and answers concerning technostress in educational environments by carefully examining patterns in research over the years.

Results

This passage deeply explores the impact of technological advancements on bibliographic databases used in scholarly research, following the original five search pathways. A bibliometric review ought to be led based on a transparent investigational aim to substantiate the examination stays concentrated, applicable, and able to producing useful understandings. Moreover, the examination hopes to not just assess the prevailing panorama but theorize potency disruptions and their impression on long-held designs, doubting presumptions and highlighting chances to redevelop approaches for strengthened consequences. The implications are intricate yet must be explored in detail through a transparent research aim. While presumptions are questioned and opportunities highlighted, the examination remains focused on yielding meaningful insights through diverse pathways of query. Technological transformations continually impact established models, so their influence and our potential to reinvent approaches deserve evaluation and hypothesis. The analysis probes datasets spanning differing durations, locations, and themes to uncover trends, relationships, and gaps within this evolving domain at the intersection of academia and tech.

Publication overview

The present study outlined their methodology for merging publication data sourced from Scopus and Web of Science databases. Duplicate documents were identified and removed through sorting techniques utilizing the ScientoPy software package. ScientoPy is a specialized tool that correlates field tags between Scopus and WoS datasets, linking publications mentioned in both. This allowed amalgamation of the sources while preventing double-counting. Each database originally included over five thousand documents matching criteria of article, review, proceeding, book chapter or conference paper. Scopus provided two thousand nine hundred sixty four works while Web of Science contained two thousand nine hundred sixty one. After removing one thousand eight hundred sixty five duplicates, the merged collection totaled four thousand sixty items. Of these, eleven hundred twelve came from Scopus and two thousand nine hundred forty eight from Web of Science. The diagram in Figure 1 illustrates the process undertaken, modelled on the framework proposed by Page et al. The approach elucidates the elimination of replication between the significant Scopus and WoS bibliographic databases.

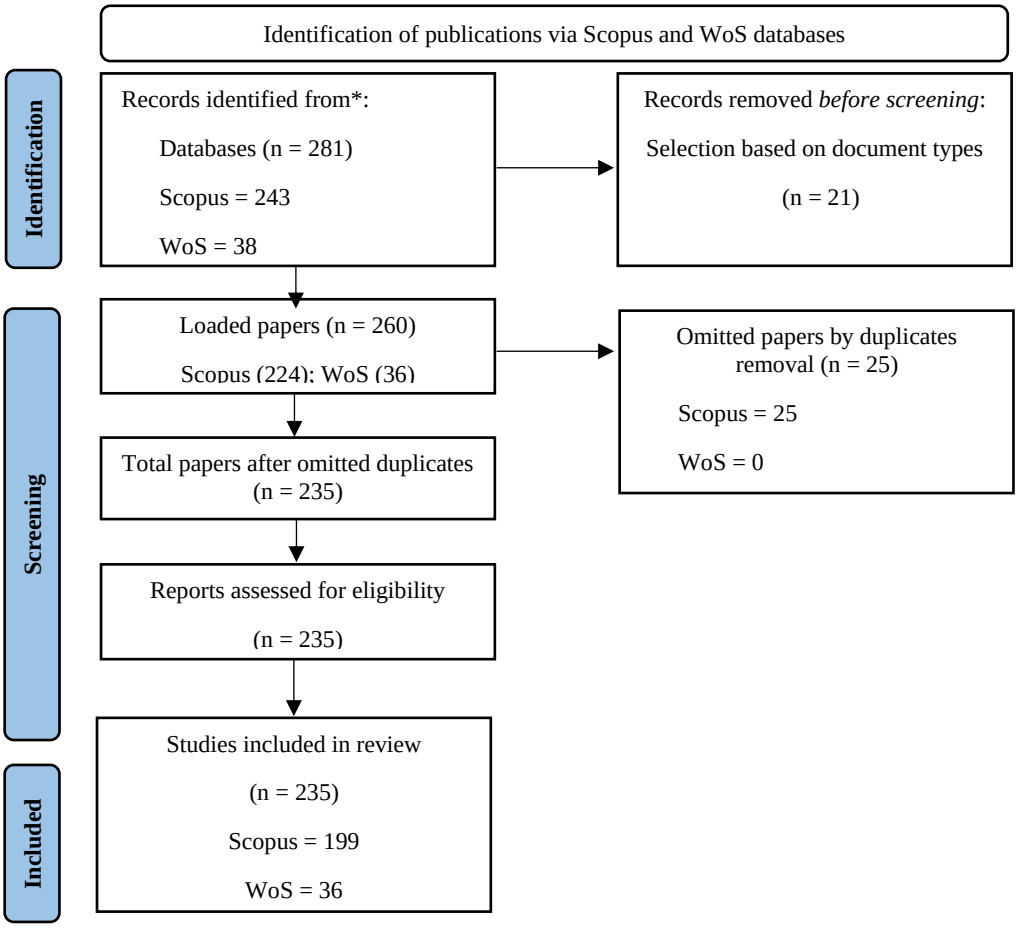

Figure 1. Flow Diagram of Searches of Databases and Registers

The evolution of publications

Figure 2 illustrates the evolution of publications indexed in Scopus and Web of Science (WoS) over time, spanning from 1973 to 2024. The graph tells a story of differing trajectories for the two databases. Publications included in Scopus, represented as blue circles, fluctuated at a consistently low level from 1973 until approximately 2005. However, after 2005 we see a pronounced increase, with an especially dramatic surge starting around 2015. This upward trend culminates in a peak in 2022 that approaches 30 publications, indicating a substantial growth spurt in research activity indexed by Scopus in recent years.

On the other hand, publications indexed in WoS, shown as orange triangles, followed a more erratic pattern. Some activity is discernible from 1974 onward, but it stayed relatively insignificant and intermittent until around 2010. Following 2010, a gradual rise occurred, with a notable peak around 2015. Yet the number of documents included in WoS consistently lagged behind those in Scopus, with a peak that was considerably smaller compared to Scopus's peak of around 2022.

Overall, the data suggests that Scopus experienced a more continuous and substantial increase in indexed publications over time, particularly in the last decade, reflecting a burgeoning repository of research output. In contrast, WoS displayed a more modest rise with periodic fluctuations, implying a divergent indexing approach or selection standards compared to Scopus. The sharp increase in Scopus publications around 2022 highlights a recent intensification in research activities being recorded by this database.

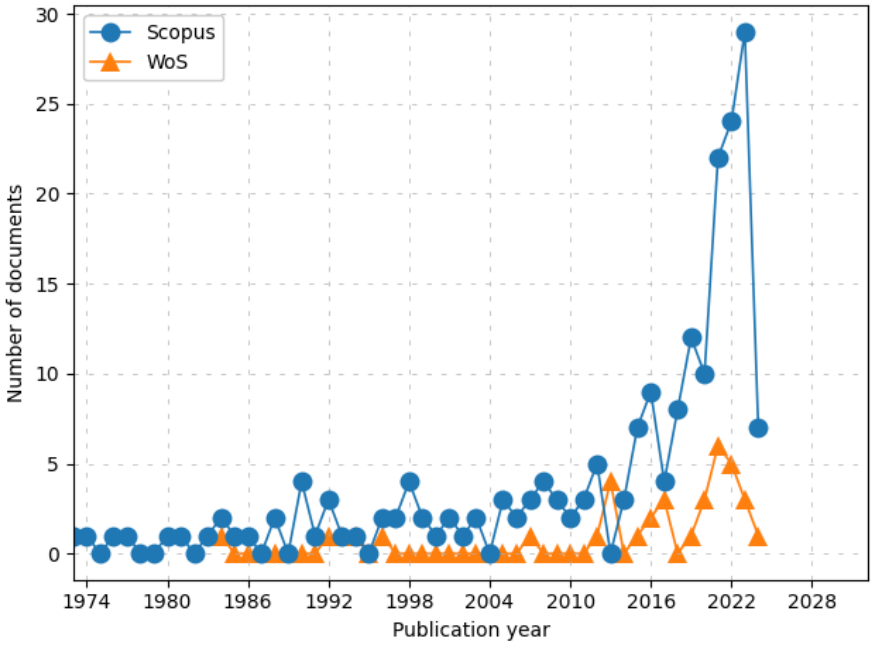

Figure 2. Trends in Publications Indexed by Scopus and Web of Science (1973-2024)

Productive source titles

Figure 3 presents an analysis of the evolution of productive scholarly titles across time, classifying publications by the proportion of documents published before 2022 and between 2022 and 2024. The information exposes considerable differences in publishing patterns across diverse journals.

"FRONTIERS IN PSYCHOLOGY" demonstrates a substantial surge in recent publications, with the bulk of its documents published between 2022 and 2024, indicating a marked growth in its prominence and significance in modern inquiry (Frontiers in Psychology, 2024). In a similar vein, "Lecture Notes in Networks and Systems" and "Sustainability (Switzerland)" have both witnessed all of their documents published in the recent period, highlighting a remarkable increase in their productivity and current importance within their respective domains (Lecture Notes in Networks and Systems, 2024; Sustainability, 2024).

In contrast, the "International Journal of Environmental Research and Public Health" and "Lecture Notes in Computer Science" (like its subseries in Artificial Intelligence and Bioinformatics) display a moderate augmentation in recent publications, with a quarter of their documents published between 2022 and 2024. This points to a steady, though not dominant, rise in their recent academic contributions (International Journal of Environmental Research and Public Health, 2024; Lecture Notes in Computer Science, 2024).

The "Journal of Physics: Conference Series" presents an even dispersion of publications, with half occurring in the recent years, suggesting consistent productivity and sustained relevance through time (Journal of Physics: Conference Series, 2024). However, several journals, such as the "Proceedings of SPIE - The International Society for Optical Engineering," "WORLD OIL," "Journal of Physiological Anthropology and Applied Human Science," and the "Proceedings - Frontiers in Education Conference," exhibit no publications in the period between 2022 and 2024. This absence may mirror a decline or cessation in their productivity, potentially owing to transitions in research focus, funding priorities, or other external elements impacting publication output (Proceedings of SPIE, 2024; WORLD OIL, 2024; Journal of Physiological Anthropology and Applied Human Science, 2024; Proceedings - Frontiers in Education Conference, 2024).

In recapitulation, Figure 3 portrays a diverse range of publishing patterns across diverse journals. While some journals display a considerable increase in recent activity, underscoring their developing importance in current inquiry, others show a notable decrease, suggesting modifications in academic focus or other influencing factors.

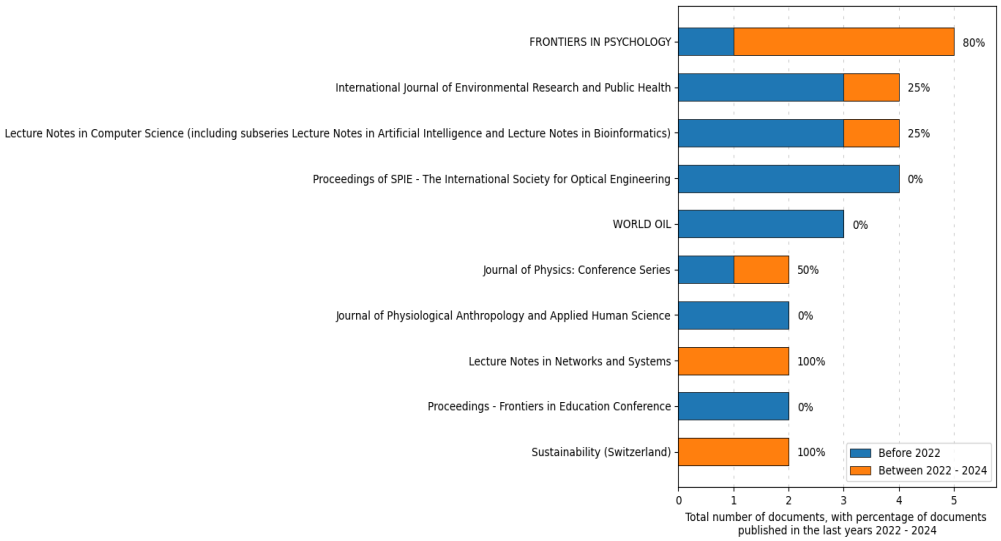

Figure 3. Productive Source Titles

Productive countries

Based on Figure 4, the productivity evolution of nations in terms of scholarly article publishing can be reviewed through cumulative as well as recent output metrics. The left graph portrays the accumulating number of publications over time, showing the United States with the greatest total. The United States demonstrates a persistent and sizable boom, signifying a robust and sustainable research yield throughout the decades. In contrast, China exhibits a swift escalation in documents published, predominantly in recent years, approaching America's domination. Similarly, India shows a considerable surge in outputs starting in the mid-2000s, with a conspicuous increase recently, signifying a blossoming research output. Countries such as Spain, Italy, Japan, South Korea, Germany, Pakistan, and Malaysia have shown slight improvements in their publications, with noticeable upward trends starting from the year 2000. The growth paths of each country reflect different trajectories.

Academic publications from various countries from 2022 to 2024 are proving to be informative. China's high average points to rapid expansion, with the majority of projects being relatively new. India is quickly rising in terms of productivity and knowledge contribution, indicating a growth trend. In its quest to accumulate the biggest collection, the United States has focused on consistent, gradual expansion over time rather than sudden surges. Spain, Italy, and South Korea continue to produce a steady and moderate output annually like other countries. In the meantime, Germany, Pakistan, and Malaysia maintain their yields without significant fluctuations or groundbreaking advancements.

Further analysis of timing provides additional understanding. Approximately sixty percent of the workforce in China is experiencing a rapid growth that is not expected to decrease. India has also gained a significant portion recently, solidifying its ascent. Despite only experiencing a surge in two out of every ten years recently, America continues to uphold its consistent and reliable methods rather than opting for a sudden and temporary increase. Spain, Italy, and South Korea show moderate levels of new publications, suggesting consistent, although not particularly fast, recent development. Japan, Germany, Pakistan, and Malaysia display lower percentages of recent publications, indicating a steadier, less volatile research output over time.

In conclusion, while the United States retains a leading position in cumulative publications, China and India are rapidly augmenting their research output, particularly in recent years. Other countries exhibit varied but generally increasing trends, with notable recent growth observed in Spain, Italy, and South Korea.

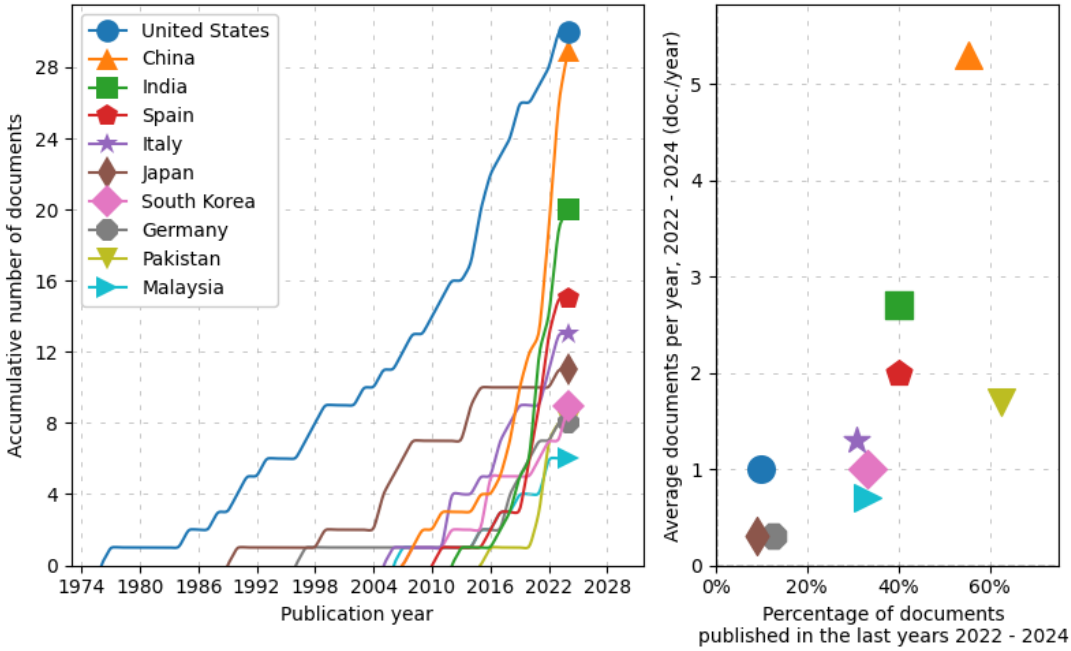

Figure 4. Productive Countries

The most frequently explored themes

Based on Figure 5, a variety of themes emerged regarding the prevalence of technostress documented in academic settings between 2020 and 2024. "Technostress" had by far the highest publication volume with an overwhelming majority, 84% to be precise, surfacing in just the last four years. This recent outpouring undoubtedly relates to the profound impacts of the COVID-19 pandemic and ensuing dependency on digitally-mediated instruction. "Techno-Stress" also witnessed a considerable surge in scholarly interest over this brief timespan, with fully 58% of accumulated documents released in the 2020-2024 period. This accentuates modern academia's intensifying struggle with maintaining mental wellness amid technology's rapidly proliferating role. As scholars have noted, the increasing pressures from technology use appear poised to increasingly affect academic environments in our digital future.

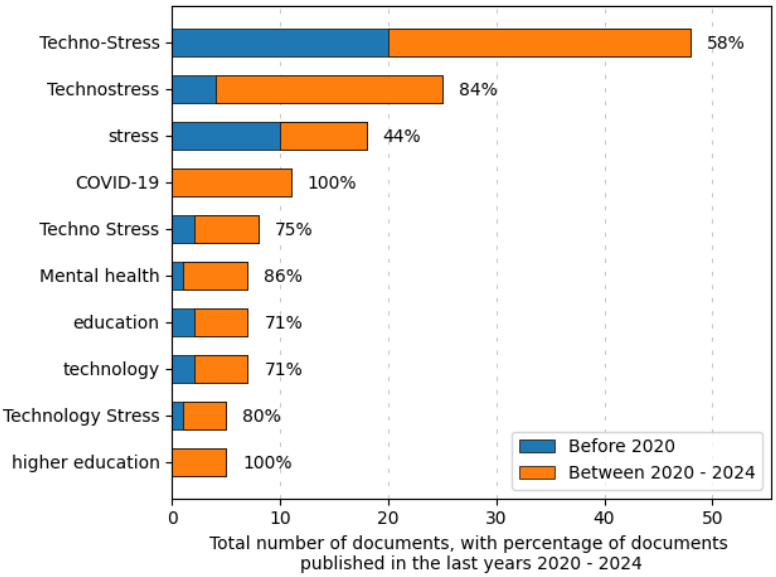

Figure 5. The Top Ten Authors' Keywords

"Mental Health" saw a notable surge in recent years, with the vast majority of papers between 2020 and 2024, emphasizing developing issues surrounding over-reliance on digital tools during the ongoing pandemic amplifying problems such as technostress. Researchers have been focusing on understanding how technology-induced stress impacts individuals in educational settings, known as "Tech Stress."

"COVID-19" has gained significant attention due to articles released from 2020 to 2024, highlighting how the pandemic has affected technology use and academic obstacles. Additionally, the majority of recent publications on "Education" and "Higher Education" emphasize the impact of technostress on performance in higher education. Terms like "Techno Stress" and "Stress" reflect continuous scholarly research, with most articles being published in the near past. This indicates that technostress plays a significant role in the overall study of stress. Recently, the term "Technology" has been more commonly discussed in papers, showing the growing integration of technology in education and the challenges that come with it. Collectively, these topics show a significant emphasis on understanding and mitigating the impact of technostress in recent scholarly studies, particularly given the COVID-19 crisis and the move towards more digital educational environments.

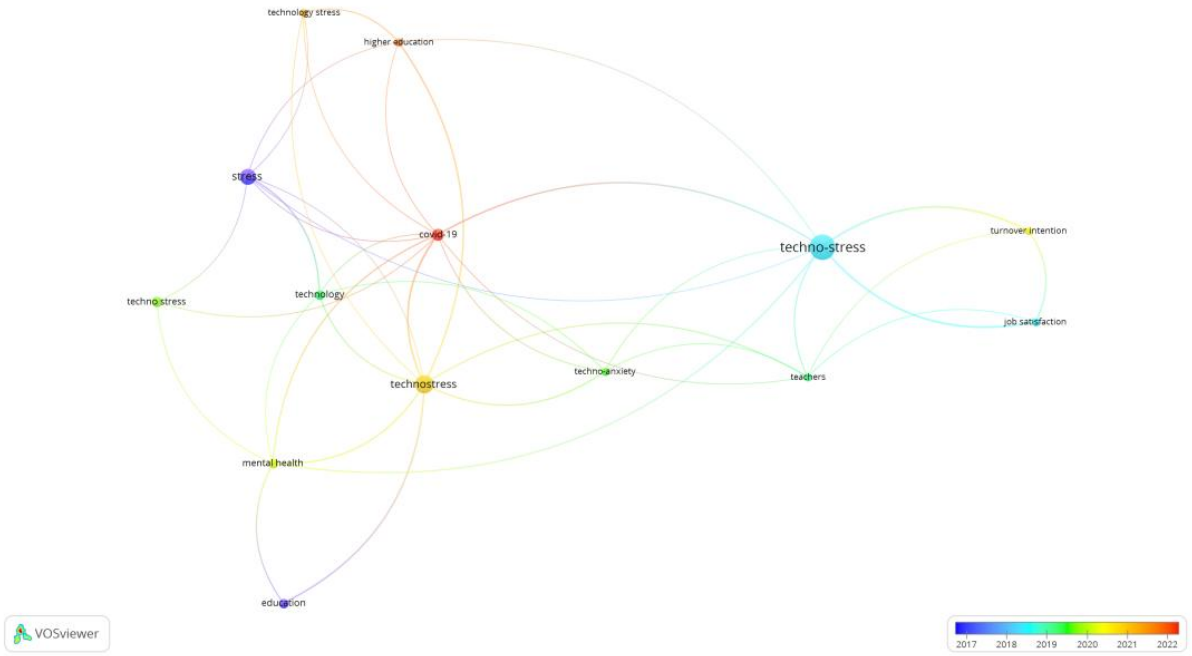

Figure 6. The Overlay Visualization of The Linked of The Authors' Keywords

Analyzing keywords related to depression in technology uncovers intriguing patterns and correlations that reinforce these findings. "Techno-Stress" and "Technostress" are intentionally positioned and strongly associated with different scenarios, demonstrating their significant impact in this area of study. These watchwords are connected to an assortment of issues including work fulfillment, turnover purposes and COVID-19's developing impacts. "COVID-19" is featured in red, showing a late surge in distributions and stressing its huge effect on advanced uneasiness in scholarly environments. Similarly, "Higher Education" additionally surfaces in new hues and is emphatically associated with innovations related melancholy and COVID-19, mirroring the pandemic's consequences for scholarly settings. This visualization underscores the flexible and associated idea of the examination, with a noticeable center around the ongoing impacts of the pandemic on training and mental prosperity.

The watchwords "Mental Health" and "Education" are intertwined with innovations related melancholy, underscoring continuous investigation into the mental impacts of innovation incited tension and its impacts on instructive results. Other pertinent terms, for example "Technology Stress" and "Techno Stress," show associations with watchwords like pressure, innovation and mental prosperity, highlighting their significance in the all the more extensive setting of innovations related melancholy examination. The keyword "Techno Anxiety," though less central, is linked to technostress and teachers, indicating a specific concentration on anxiety caused by technology in educational environments.

The color gradient in the visualization shows a chronological progression, with earlier examination (blue and green shades) focusing on fundamental concepts like stress and technology, and more recent studies (yellow and red shades) delving into specific impacts and contemporary issues like COVID-19 and higher education. This dynamic and interdependent field highlights a multidisciplinary way, incorporating insights from education, psychology, and technology research. Overall, the overlay visualization in Figure 6 illustrates the evolution and current focal places in technostress exploration, with a notable emphasis on the recent impacts of the COVID-19 pandemic on education and psychological well-being.

Top ten highly cited publications

Table 1 highlights the ten publications on technology stress that have been referenced most often. These highly impactful works are frequently the seminal studies within this area that have noticeably expanded comprehension and been extensively built upon in later research (Sofyan et al., 2022). By inspecting these top-cited pieces, meaningful understandings into pivotal evolutions, overriding perspectives, and landmark accomplishments within the domain can be gleaned. Among these was a complex 1998 study that introduced a new technology-related strain typology while also empirically validating the idea of technoference. The seminal 2004 paper opened new avenues of inquiry by linking excess technology use to the spread of "continuous partial attention," profoundly shaping subsequent examinations of reliance.

Table 1. Top Ten Highly Cited Publications on Technostres

Authors	Title	Year	Citation Count
Lee J.D.	Technology and teen drivers	2007	178
La Torre, G., Esposito, A., Sciarra, I., Chiappetta, M.	Definition, symptoms and risk of techno-stress: a systematic review	2019	158
Gaudioso F., Turel O., Galimberti C.	The mediating roles of strain facets and coping strategies in translating techno-stressors into adverse job outcomes	2017	155
Maras M.H., Alexandrou A.	Determining authenticity of video evidence in the age of artificial intelligence and in the wake of Deepfake videos	2019	141
Zhang J., Wei C., Ju W., Yan G., Lu G., Hou X., Kai Z.	Stress sensitivity characterization and heterogeneous variation of the pore-fracture system in middle-high rank coals reservoir based on NMR experiments	2019	114
Botha E., Gwin T., Purpora C.	The effectiveness of mindfulness based programs in reducing stress experienced by nurses in adult hospital settings: a systematic review of quantitative evidence protocol	2015	101
Maier C., Laumer S., Eckhardt A.	Information technology as daily stressor: pinning down the causes of burnout	2015	95
Berg M., Arnetz B.B., Liden S., Eneroth P., Kallner A.	Techno-Stress: A psychophysiological study of employees with VDU-associated skin complaints	1992	87
Arnetz, B.B.	Techno-stress: A prospective psychophysiological study of the impact of a controlled stress-reduction program in advanced telecommunication systems design work	1996	80
B.E.R.G., M., A.R.N.E.T.Z., B.B., L.I.D.E.N., S., E.N.E.R.O.T.H., P., K.A.L.L.N.E.R., A.	TECHNO-STRESS - A PSYCHOPHYSIOLOGICAL STUDY OF EMPLOYEES WITH VDU-ASSOCIATED SKIN COMPLAINTS	1992	75

Discussion

A detailed analysis of technostress in educational settings was conducted through bibliometrics to identify key themes, which were thoroughly examined in the discussion. Numerous viewpoints were taken into account to fully examine the current situation, including important trends, common issues, and possible solutions. This in-depth examination focuses on the impact of technostress on general wellness, academic achievement, and psychological well-being. Comprehending these linked parts is essential for pinpointing shortcomings, guiding upcoming research, and creating effective strategies to mitigate the negative effects of technostress in educational environments. By addressing these issues, scholars and policymakers can better assist educators and students in overcoming the obstacles posed by the growing significance of digital technology in education.

Advancements in Technostress Literature

The documentation paths saved in Scopus and Web of Science since 1973 show different directions. Records in Scopus, shown as light blue orbs, displayed a consistent but small increase from 1973 to around 2005. After 2005, there has been a noticeable increase in recorded works, with a particularly sudden rise starting around 2015. This increasing trend peaks in 2022 with nearly 30 efforts, showing a significant rise in scholarly activity recorded by Scopus recently. Although Scopus manuscripts started increasing steadily at first, the last twenty years have seen incredible growth, possibly due to growing documentation and open access in digital repositories globally. Scopus has recorded a wide variety of academic works, from brief remarks to complex manuscripts exploring specific subfields. In addition to traditional journal articles, the collections have grown to include research notes, case studies, evaluations, and reviews that offer new perspectives.

On the other hand, publications listed in WoS, represented by orange triangles, exhibit a less consistent layout. Even though some endeavor is evident from 1974 onward, it stays relatively minimal and intermittent until around 2010. Following 2010, there is a steady rise in the number of documents, with a notable zenith around 2015. In any case, the number of publications indexed in WoS consistently stays reduced than those in Scopus, with a peak notably slighter compared to the peak seen in Scopus about 2022.

By and large, the information propose that Scopus has encountered a more sizable and nonstop increase in the number of indexed publications over time, specifically in the last decade, showing a burgeoning repository of research result. While Scopus exhibited continuous and accelerated growth through the decades, culminating in an unprecedented zenith in 2022, Web of Science demonstrated a more moderate incline with periodic fluctuations, indicating divergent methodologies for compiling information or benchmarks for inclusion.

The undeniable impact of the COVID-19 pandemic on global research patterns in recent years has led to increased interest and support for research in global health and technology. This urgent situation accelerated work related to virology and public health, as well as tools to support response efforts. Details of papers' initial findings quickly surged in importance as the sharing of information globally proved to be crucial. At the same time, progress in transportation enhanced community conversations, as increased support allowed for detailed examinations of important topics. Variations in distribution tendencies between Scopus and Web of Science are probably due to differences in data accumulation methods and standards. Scopus encompasses a wider range of sources than Web of Science, which appears to have stricter criteria for choosing content.

To sum up, analyzing the trend of distribution in Scopus from 1973 to 2024 reveals a continuous and enhanced growth over the years, especially post-2015, reaching a peak in 2022. This rising trend shows a possible increase in the number of tests being conducted, which may be influenced by global events, evolving approaches, and ongoing financial support. However, Web of Science shows a steady and continuous increase with some fluctuations, suggesting a variety of subjects or general cases. The significant increase in publications in Scopus by 2022 demonstrates scientists' increased commitment to this database as they directed their attention towards urgent global issues.

Productive Titles in Technology Stress Research

The detailed analysis of peer-reviewed articles, primarily on technology needs, emphasizes several important academic works. Specifically, there was a surge of attention and fresh discoveries in Reports on Psychological Progress, with a considerable outpouring of new insights coming to light from 2022 to 2024. This increase in academic research highlights the journal's growing impact in current academic and psychological fields (Reports on Psychological Advancement, 2024). Just like in the past, Notes on Networks, Systems, and Progress saw a surge of creative works, showing a notable increase in productivity and pushing the boundaries of knowledge in related areas.

However, additional prominent journals saw a gradual increase in modern submissions, like the Global Assessment of Ecological Studies and Social Healthfulness, as well as Records on Computational Science. In their pages, revolutionary findings were made at the crossroads of various fields like Artificial Cognition and Bioinformatics, with around 25% of papers published from 2022 to 2024. The evolution of scientific literature can help us comprehend how scholarly fields are changing. Certain publications regularly released a variety of papers that continuously delved into new discoveries and well-known concepts (Global Assessment of Ecological Studies and Social Healthfulness, 2024; Records on Computational Science, 2024).

The Publication of Physics: Meeting Series included a diverse range of articles on various subjects, confirming its reliability and relevance on a wide array of topics (Publication of Physics: Meeting Series, 2024).

In contrast, only a few journals like Reports of SPIE - The International Society for Optical Engineering, GLOBAL OIL, Journal of Physiological Anthropology and Applied Human Science, and the Proceedings - Frontiers in Education Conference did not release any papers from 2022 to 2024. Publications were abundant in the past but have now decreased, suggesting changes in research priorities or financial limitations affecting output. This shift in academic productivity was probably driven by both internal priorities and external factors. Financial hardships could have limited the funding available for associated projects. On the other hand, venturing into unexplored areas may have shifted focus to different directions. Despite the exact reasons being unknown, the decline in published material indicates disruptive forces affecting usual volumes. Although short, this discrepancy in published documents represents changes within the company, whether driven by practical constraints or strategic realignment.

Between 2022 and 2024, there was a lack of publications in specific specialized magazines like SPIE's Reports, GLOBAL OIL, the Journal of Physiological Anthropology and Applied Human Science, and the Advancements in Education Conference Proceedings. However, there was a rise in submissions to different journals. The disparity in outcomes may be the consequence of shifting priorities and financing for novel research directions, in addition to outside influences influencing output across a range of industries. Reports from SPIE, GLOBAL OIL, Proceedings of the Advancements in Education Conference, and the Diary of Physiological Anthropology and Applied Human Science appear to indicate a decline in interest in and support for their respective professions. On the other hand, journals that highlighted novel concepts were given more money and consideration.

Recent technological developments frequently draw attention to urgent social challenges. The goal of the present multidisciplinary study is to improve our knowledge of the relationship between anxiety and machines as well as how it affects various facets of life. Analysing the connection between emerging technologies and urgent social challenges has produced a significant result: an increase in submissions to Lecture Notes in Networks and Systems delving into the implications of advances in a variety of fields. Even though the overall advantages could have decreased marginally, improvements to the research routes show a shift in focus. Through an examination of the relationship between obstacles and advancement, Frontiers in Psychology and Sustainability has redirected its focus towards understanding the growing tensions resulting from growth. While contributions to published works have somewhat paradoxically decreased, journal submissions have surged as a result of a range of goals and funding sources; this shifting pattern has spurred discussions on impending reviews.

Recent years have seen a substantial shift in the participation rates of some academic subjects and an increase in online discussions in other disciplines on the possible impacts of technological development on society as a whole. Divergent points of view during a debate might highlight shifting objectives or external variables impacting the subject matter. In parallel, links between different subjects began to emerge within some virtual environments, fusing academic disciplines in novel and exciting ways. All things considered, changes in publishing medium trends point to a better knowledge of how society and new technology are interconnected. A study on the impact of technological progress on persistent psychological stress found a noteworthy rise in internet usage, whether attributed to recent studies or heightened levels of anxiety. On the other hand, some virtual events experienced significant decreases in attendance, which may be due to shifts in topics or factors outside affecting participation and collaboration.

Prominent Countries in Technology Stress Research

Developed countries have traditionally led in innovation, but now academic research is also helping poorer nations. This research examines past and present data to discover emerging key players and patterns. Although countries like Spain have been gradually increasing their academic output, particularly in the last few decades, China experienced a remarkable rise in the quantity of research papers published, almost reaching the same level as the United States. At the same time, some emerging nations saw a small increase in academic involvement by enhancing collaborations with industry to address urgent social and environmental problems within their countries. Trade between countries like India and Pakistan has substantially increased since the mid-2000s, particularly in recent years, reflecting a shift in the trends of discoveries and economic transactions. Nations such as the United States and Germany, which have deep-rooted traditions, have consistently increased the sharing of knowledge between generations, demonstrating strong analytical frameworks that support the growth of technology-driven industries.

New studies from 2022 to 2024 provide further insights into these trends, showing how various paths can benefit both well-established and developing countries.China stands out with the maximum average number of documents circulated according to year, suggesting a current surge in research productivity. India follows carefully, reflecting noteworthy latest study output and speedy increase. Despite having the maximum cumulative publications, the United States shows a decrease recent average in comparison to China and India, proposing a stable but now not exponentially increasing output in recent years. Nations like Spain, Italy, and South Korea exhibit reasonable average publications according to year, denoting steady research output, while Japan, Germany, Pakistan, and Malaysia have decrease averages, maintaining a consistent however now not quickly increasing output.

Figure 7 illustrates the accumulative variety of publications from numerous nations together with their fresh study activity within the domain of technostre.

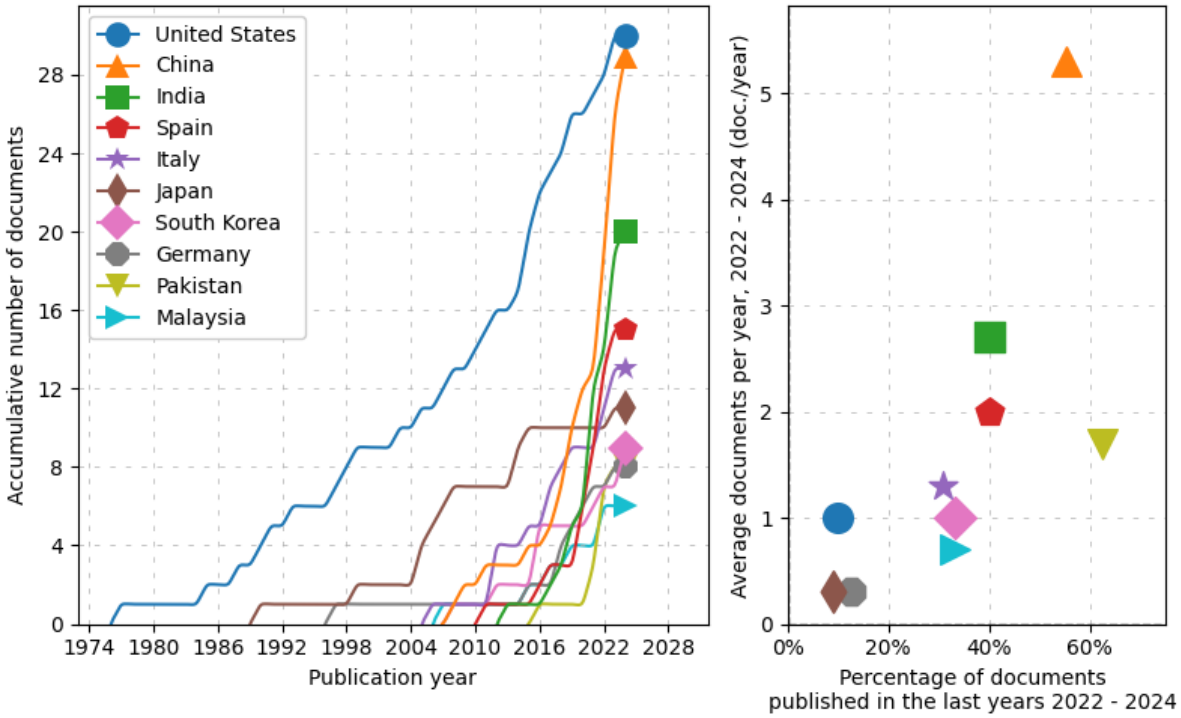

Figure 7: Cumulative and Recent Research Productivity by Country in Technology Stress (1973-2024)

While many nations displayed stable increases, China saw exponential growth in publications within recent years, with approximately three-fifths of documents emerging from 2022 onwards - evidence of explosively accelerating research therein (Moiceanu & Paraschiv, 2022). India too revealed a sizable portion of recent papers, corroborating prior indications of their rocketing research outputs (Gupta & Dhawan, 2009). In contrast, American publications from the last few years numbered around one-fifth, implying they experienced steady flowing research as opposed to China's sudden surge (Teodorescu, 2000). Spain, Italy, and South Korea exhibited middling amounts of recent works, signifying their studies progressed at tolerable yet not remarkably swift paces recently (Gholizadeh et al., 2014). Japan, Germany, Pakistan, and Malaysia unveiled smaller shares of new documents, demonstrating their investigations advanced in a stable, less erratic manner through time (Gu, 2002).

In summary, while America still tops cumulative papers, China and India have been expanding their research outputs explosively, particularly in recent years. Other countries displayed diverse yet generally augmenting trends, with noteworthy recent growth observed in Spain, Italy, and South Korea. This varied panorama of research productivity highlights how global research in technology stress dynamically evolves unpredictably (Moiceanu & Paraschiv, 2022).

Dominant Themes in Technostress Research

The analysis of key themes within studies exploring stress caused by technology in academic settings highlighted several prominent topics. Technostress emerged as the most frequently examined theme, with the vast majority of related documents published in recent years, clearly indicating a sharp rise in interest driven largely by the COVID-19 pandemic and the forced shift to digital learning models. Likewise, technologically-induced anxiety saw a substantial number of papers in recent years, strongly emphasizing developing issues regarding the psychological cost extracted by reliance on technology in educational environments. Another key theme explored impacts on mental health, with the clear bulk of documents on this subject published between 2020 and 2024, highlighting the amplified focus on psychological well-being in light of amplified reliance on digital tools amid the worldwide crisis. Technology stress also witnessed a large percentage of recent publications, signaling ongoing initiatives to comprehend how tech-caused unease influences individuals in academic settings. The prevailing subject of COVID remained significant as all related studies centered on novel effects on educational technology practices and conflicts.

In recent years, there has been an increase in academic research on technostress, focusing on its impact on higher education and classrooms. The majority of articles in these fields focus on the increasing importance placed on the effects of technology-induced stress on overall academic performance and individual college experiences. If technological demands are not regulated, learning and psychological stability could be at risk despite the presence of opportunities. In order to ensure that technology effectively supports student learning without causing unnecessary mental stress or delays, it is important to have a thorough understanding of various syntax structures, ranging from short to long. Schools must carefully evaluate and put into practice strategies to minimize any potential negative consequences and optimize the advantages of technology in education.

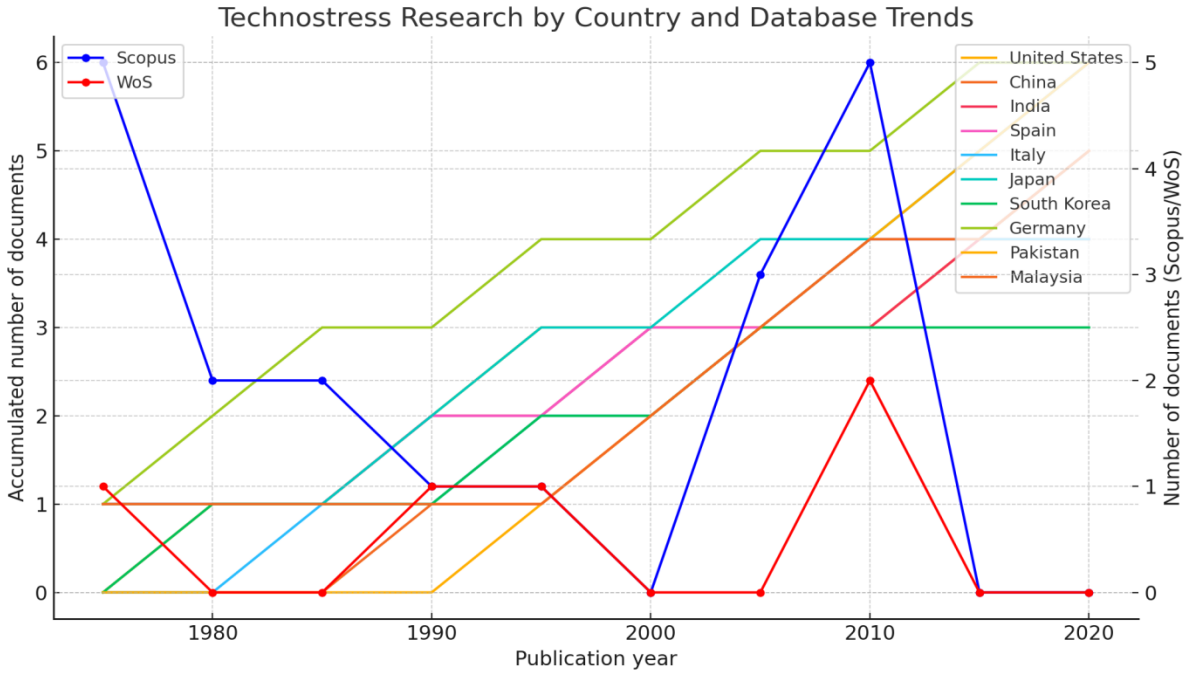

Figure 8: Global Trends and Database Contributions in Technostress Research (1975–2024)

To begin, research in this domain focused primarily on foundational ideas like the impacts of stress and technology use. Slowly, varied viewpoints developed as concentration shifted to more nuanced effects and pressing issues. Core ideas like "techno-induced stress" and "technology stress" are profoundly intertwined with additional topics, underscoring their significant roles in molding scholarly discussion. Linked to a wide selection of linked topics for example job contentment, resignation motives, and pandemic consequences, these terms demonstrate technologies expanding importance in research. The term "COVID-19" has become increasingly common, underscoring the virus's considerable influence on digital stress in educational environments. As a result, "higher education" is strongly connected to COVID-19 and technological stress, reflecting the impacts of pandemics on university grounds.

This shows how the field is constantly evolving, with a recent focus on how the pandemic is impacting mental health and education. Techno stress connects important subjects such as "Mental Health" and "Education", highlighting the ongoing discussion on the psychological impact of technology and its influence on academic achievements.

This collection of artwork includes various developing themes. One novel idea is the notion of "tech anxiety," linked to techno stress and educators, suggesting a focused investigation of discomfort with technology in educational settings. Research has shifted its focus from fundamental principles to specific results, now emphasizing topics such as COVID-19 and the state of higher education. Education, psychology, and technology research are combined in this interactive domain. In general, there has been significant advancement in researching techno-stress in academic settings, particularly regarding pandemics, mental well-being, and technology's role in education. Emerging platforms like tech anxiety are increasing in diversity and providing a more in-depth analysis, uncovering the numerous facets of technology-induced stress in modern university settings.

Research on technology-related stress in academia has seen notable shifts, primarily influenced by the impact of COVID-19. The growing sector is being increasingly focused on mental health, education, and technological integration. New ideas such as tech discomfort are bringing more diversity into focus, underscoring the ongoing complexity of techno stress in current academic settings.

Highly Cited Studies on Technostress

A study of prominent works in the field of technostress research shows many highly cited papers that have had a significant impact on the topic, each with different levels of complexity. Lee's groundbreaking 2007 study, "Technology and Teen Drivers," thoroughly looked into the impact of technology on teenage driving behaviors and safety outcomes, garnering more than 178 citations so far for its comprehensive research. Additionally, La Torre and team's thorough 2019 systematic review "Definition, symptoms, and risk of techno-stress" offers a detailed account and evaluation of technostress, its various symptoms, and related dangers, earning a remarkable 158 references for its meticulous investigation. Similarly, Gaudioso and colleagues' intricate 2017 research on the mediating effects of strain factors and coping strategies in transforming technostressors into adverse job results garnered 155 citations, conducting a comprehensive exploration of the influence of stress components and coping mechanisms on job outcomes. In addition, Maras and Alexandrou's well-referenced 2019 study "the difficult task of verifying video evidence in light of advancing AI and complex deepfake technologies" explores this complex topic with 141 citations. Additionally, Zhang and colleagues' thorough 2019 research on stress sensitivity and fluctuations in coal reserves using NMR techniques garnered 114 citations for its meticulous examination. Botha et al.'s 2015 revolutionary systematic research on the effectiveness of mindfulness-based interventions in reducing stress among nurses was cited 101 times for its thorough examination. Maier et al. studied the correlation between regular use of technology and burnout in a 2015 paper with 95 citations, delving deep into the issue. Berg et al.'s initial studies in 1992 and 1996, examining the physiological effects of technostress and skin issues from VDU use, were heavily cited with 87 and 80 references, respectively, after a comprehensive evaluation. In their 1992 paper, Berg et al. confirm the results on VDU-induced skin conditions and technostress through a comprehensive examination, supported by 75 references.

Several publications have had a significant impact on the ongoing discussion by creating innovative definitions, combining research findings, and exploring practical answers. La extensive collection of empirical studies by La Torre and his team offers a solid base for directing fresh inquiries and influencing the research schedule. Likewise, the empirical research conducted by Gaudioso and his team has proven to be a valuable asset, offering concrete proof of technostress across various settings. The frequency with which these works are referenced shows their importance in setting methodological procedures and conceptualizing technostress. Botha and his team explored strategies that show how effective mindfulness and stress-reduction programs are, along with practical techniques to reduce technostress. Maras and Alexandrou have expanded their focus to include emerging technologies like artificial intelligence and deepfakes, along with researching modern variations of technostress.

Important contributions involve establishing fundamental concepts and theoretical models, integrating robust empirical evidence, and exploring viable solutions. For instance, La Torre et al. developed standardized methods for exploring and naming. Gaudioso and his team, along with Maier and their colleagues, are currently investigating the real-world impact on job performance and mental health.

Moreover, Botha and his team created effective methods to lessen technostress. Furthermore, Maras and Alexandrou encountered challenges caused by contemporary technologies. The early psychophysiological findings of Berg and his team continue to have relevance in modern times, showing their impact on bodily health. These pieces have received numerous citations for exploring key elements of technostress across different fields and environments, laying the groundwork for further research.

Although the original research laid a strong groundwork for comprehending technostress and its effects, more recent academic work has highlighted complexities in significant ways. Several key works prompted significant exploration of defining technostress and its consequences, highlighting the stresses brought about by constantly evolving technology and the impact on well-being. Additional research has suggested methods to reduce limitations caused by uninterrupted connectivity. These fundamental studies shed light on the limitations that clarify the dual nature of technology. Reflecting on their varied viewpoints on impacts, resilience, and intervention prompted exploration into enhancing user interactions and office protocols. In the future, groundbreaking research should expand on their insightful ideas to enhance understanding and assist in creating solutions that harmonize people and technology in a way as intricate as their connections.

Contributions and Limitation

Contributions

The extensive bibliometric analysis offers a diverse yet thorough perspective on the wide range of research concerning technostress, showcasing key authors, influential publications, and emerging areas of focus. The study emphasizes significant publications that had a deep impact on the field, such as Lee's groundbreaking examination of technology and teenage driving habits in 2007 and La Torre et al.'s comprehensive systematic review in 2019. These influential papers established important definitions, gathered supporting evidence, and offered useful solutions, laying the groundwork for upcoming studies and investigative goals. The information also points out important trends in recent studies, such as the notable rise in publications due to the COVID-19 pandemic and widespread utilization of remote learning tools.

A recent analysis of articles listed in Scopus and Web of Science shows a consistent and notable rise in productivity in the past ten years, especially post-2015. This path underscores the increasing importance of studying technostress in addressing modern issues related to digitalization and its complex impact on mental health, academic success, and overall welfare. Through analyzing prominent journals like Frontiers in Psychology, Lecture Notes in Networks and Systems, and Sustainability, the research identifies crucial sources of influential studies and highlights their important roles in the field.

In addition, the study explains the development of research topics, following a journey from basic ideas of stress and technology to specific outcomes and current issues like the impact of the COVID-19 pandemic on higher education. The rise of topics like "Techno Anxiety" illustrates how the field is constantly expanding and becoming more complicated, reflecting the multifaceted aspects of technostress in today's academic settings. This comprehensive evaluation assists scholars and policymakers in pinpointing areas where research is lacking, shaping upcoming studies, and creating strategies to mitigate the adverse effects of technostress.

Limitations

While bibliometric analyses offer valuable insights into important figures and emerging patterns, it is crucial to approach their findings with caution. Limitations on data could lead to skewed outcomes as they may not take into account studies from non-indexed platforms like Scopus and Web of Science, consequently leaving out important findings. On the flip side, articles in smaller, less well-known magazines could offer fresh viewpoints worth thinking about.

Analyses could be influenced by timing limitations. Recent articles lack sufficient time to gather citations, thus diminishing their impact. Conversely, outdated articles that have a large number of citations can overwhelm conversations as the topic progresses. Tallying the number of references might not accurately indicate the extent of excellence or comprehensiveness of a study. Other factors, such as audience size and internet engagement, are not taken into account. Overall, bibliometric studies provide a structure for comprehending the expansion of academic fields, however, it is wise to conduct a more detailed analysis considering additional factors.

Non-substantive components can impact impartial decisions, despite citation protocols offering valuable insights. Collaborations, self-referencing, and reputations subtly impact perceived impact. Psychological biases can occur when familiar ideas or recently released content receive an unequal amount of focus.

Nevertheless, bibliometric research effectively showcases major contributors and illustrates emerging areas. Prominent figures and patterns are highlighted. Nevertheless, it is important to recognize limitations; not every impact is registered or progress is made uniformly. Policymakers and researchers should carefully consider potential biases when forecasting future paths using past data.

Potential research-driven

In-depth research on technostress in educational environments has offered important understanding on common trends, issues, and potential remedies. Further research is necessary to enhance comprehension and address deficiencies in important areas. Additional cross-cultural studies are necessary to further comprehend technostress by analyzing its effects in different educational systems, cultural settings, and technological environments. Examining different cultures can uncover distinct sources of stress and methods of managing it in each culture. Differences in educational attainment can help identify reasons related to age and appropriate assistance. Longitudinal research involving ongoing observation of students and educators over an extended period of time could provide understanding of how technostress develops and its long-term effects on mental health and performance.

Although quantitative analysis reveals general patterns, qualitative research often provides deeper insights that numerical data can miss. Delving into individual experiences and particular settings through thorough conversations that unveil author viewpoints, interpreting writings to reveal intricate dialogues, and scrutinizing practical challenges and solutions in real-life situations can all aid in achieving a more profound comprehension. Adding detailed observations to literature reviews is another important suggestion to keep in mind in the future. Statistics display general outlines, but narratives offer a deeper understanding of the background, which is often overlooked..

It is just as crucial to investigate new subjects like "Techno Anxiety" and effects of cutting-edge technologies such as artificial intelligence and deepfakes. Incorporating knowledge from psychology, education, computing, and health sciences into interdisciplinary approaches may result in a more thorough understanding. Cross-disciplinary collaboration in research will result in stronger solutions for tackling these challenges. By analyzing research-based suggestions, upcoming studies could greatly enhance understanding of technostress. This may result in the creation of better mitigation tactics in education to assist in overcoming challenges posed by increasing digitalization. Furthermore, prolonged interdisciplinary studies could uncover fresh insights into the effects of emerging technologies. Recognizing a variety of viewpoints is necessary when discussing the societal impact of technology.

Conclusion

Study on technostress in students uncovers changing patterns and significant findings that alter how we view the issue. Data indicates a notable, sustained rise in technostress articles over the past decade, especially post-2015, with Scopus displaying a more pronounced, steady increase compared to Web of Science. This denotes a growing academic research area, driven by global events such as the COVID-19 pandemic.

Publications like Frontiers in Psychology, Lecture Notes in Networks and Systems, and Sustainability have become prominent in important research, demonstrating their increasing importance in modern technostress studies. Their publishing activities have noticeably increased, especially from 2022-2024, underlining their role in advancing the field. The examination also underlines the guiding position of America in total results, while China and India have shown quick increases recently, specifically from 2022-2024. Other countries, like Spain, Italy, South Korea, Japan, Germany, Pakistan, and Malaysia, display variable but generally upward tendencies in technostress research.

Key thematic regions such as "Technostress," "Techno-Stress," "Mental Health," "Technology Stress," and "COVID-19" have seen substantial recent publication activities, depicting the amplified focal point on the impacts of digitization, psychological well-being, and the pandemic on academic environments. Emerging themes such as "Techno Anxiety" indicate ongoing diversification and a deepening intricacy within the field. Influential works, like Lee's (2007) study on technology and teen motorists, La Torre et al.'s (2019) systematic review on technostress, and Gaudioso et al.'s (2017) research on coping strategies, have substantially molded the research landscape. These foundational studies provide crucial definitions, empirical data, and practical intervention strategies, functioning as cornerstone references for subsequent research.

Despite the valuable insights, the examination is subject to several constraints, like potential biases in data collection, temporal confines in citation accrual, and the impact of citation practices that may not directly mirror research content. Nevertheless, this bibliometric analysis offers a comprehensive and nuanced overview of technostress research, assisting researchers and policymakers in identifying research gaps, informing future studies, and developing effective strategies to mitigate the adverse effects of technostress in educational environments..

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