

# Technology Anxiety in Education: A Bibliometric Analysis

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## ABSTRACT

As digital technologies increasingly permeate educational environments, their psychological consequences have attracted growing scholarly attention, particularly in relation to technology anxiety. Grounded in foundational theories of general anxiety, computer anxiety, and technostress, this study provides a comprehensive bibliometric analysis of research on technology anxiety in education from 2000 to 2025. Based on 418 articles retrieved from the Web of Science Core Collection, CiteSpace and RAWGraphs were employed to examine publication trends, influential authors and journals, collaborative networks, thematic clusters, and keyword evolution.

The results reveal a substantial and sustained growth in scholarly output, particularly after 2020, coinciding with the rapid digitalization of education during the COVID-19 pandemic. Key thematic clusters include digital literacy, technology acceptance, teacher professional development, emotional readiness, and AI-enhanced learning environments. The analysis also demonstrates a conceptual evolution from early research on computer anxiety and user attitudes toward integrated psychological – pedagogical frameworks emphasizing emotional regulation, well-being, and sustainable technology integration.

By systematically mapping the intellectual structure and developmental trajectories of this field, this study contributes a theoretically grounded and data-driven overview of technology anxiety scholarship in educational contexts. The findings highlight emerging research frontiers and provide strategic insights for future interdisciplinary investigations into emotionally responsive and inclusive digital education.

**Keywords:** Technology anxiety; Technostress; Computer anxiety; Bibliometric analysis; Digital literacy; Educational technology; Artificial intelligence

## INTRODUCTION

The rapid integration of digital technologies into educational systems has fundamentally transformed teaching practices, learning environments, and institutional governance structures (Chu et al., 2024; Didmanidze et al., 2023). While these technologies enhance accessibility, personalization, and instructional efficiency, they also introduce significant psychological challenges for both educators and learners, including emotional overload, cognitive fatigue, and persistent anxiety (Cezar & Maçada, 2023; Saboor et al., 2024).

Among these challenges, technology anxiety has emerged as a critical psychological construct describing individuals' persistent feelings of discomfort, apprehension, or fear when interacting with digital technologies (Mattock, 2022; Berner et al., 2023). This construct is theoretically rooted in earlier work on general anxiety, computer anxiety, and technostress, which conceptualize anxiety as an affective response arising from perceived uncertainty, lack of control, and cognitive overload (Spielberger, 1983; Igarria & Parasuraman, 1989; Tarafdar et al., 2015).

Early studies conceptualized computer anxiety as a stable emotional trait influencing users' attitudes toward computer systems, shaping their perceived ease of use and behavioral intention (Chua et al., 1999; Compeau & Higgins, 1995). As digital technologies became more pervasive, this concept expanded into technostress, defined as stress experienced due to the inability to cope with new technological demands (Tarafdar et al., 2015). More recently, scholars have adopted the broader construct of technology anxiety, encompassing emotional, cognitive, and behavioral dimensions across diverse digital environments, including online learning platforms, learning management systems, and AI-based educational applications (Panisoara et al., 2020; Rospigliosi, 2023).

In educational contexts, technology anxiety manifests in multiple forms. Teachers frequently report stress stemming from inadequate digital competence, fear of system failures, and pressure to constantly adapt to emerging tools (Gündoğmuş, 2024; Saboor et al., 2024). Students, meanwhile, experience cognitive overload, emotional exhaustion, and anxiety related to performance monitoring and algorithmic evaluation (Sharma & Kumar, 2025; Cezar & Maçada, 2023). These emotional burdens significantly impair instructional effectiveness, learning engagement, and overall educational quality (Slama & Wilson, 2025).

Although an expanding body of literature addresses the antecedents and consequences of technology anxiety, the field remains theoretically fragmented and empirically dispersed across disciplines such as psychology, education, and information systems (Mattock, 2022; Berner et al., 2023). Most studies adopt micro-level perspectives, focusing on specific technologies, populations, or emergency teaching scenarios, particularly during the COVID-19 pandemic (Moorhouse, 2020; Slama & Wilson, 2025). Consequently, a systematic and theory-informed synthesis of the intellectual structure, thematic evolution, and collaborative patterns of this research domain is still lacking.

To address this gap, the present study conducts a bibliometric analysis of technology anxiety research in education from 2000 to 2025. Bibliometric methods enable the objective mapping of knowledge structures, identification of research hotspots, and visualization of thematic trajectories within large scholarly corpora (Chen, 2006; Jing et al., 2023). By integrating theoretical perspectives from anxiety psychology and educational technology, this study aims to provide a comprehensive, data-driven overview of how technology anxiety scholarship has evolved and where it is heading.

Accordingly, this study addresses the following research questions:

RQ1: What is the productivity distribution of technology anxiety research in education in terms of authors, institutions, countries/regions, and journals?

RQ2: What are the temporal trends and developmental trajectories of this field from 2000 to 2025?

RQ3: What are the emerging research frontiers and thematic concentrations in technology anxiety scholarship in education?

## LITERATURE REVIEW AND THEORETICAL FOUNDATIONS

### From General Anxiety to Technology Anxiety

The concept of anxiety has long been central to psychological theory, typically defined as a state of heightened emotional arousal associated with perceived threat, uncertainty, or lack of control (Spielberger, 1983). In educational psychology, anxiety has been extensively studied in domains such as test anxiety, mathematics anxiety, and social anxiety, all of which significantly influence learners' cognitive performance and motivation (Zeidner, 1998; Urbán et al., 2023).

With the advent of personal computing, scholars introduced computer anxiety to capture emotional discomfort associated with interacting with computer systems (Igbaria & Parasuraman, 1989; Chua et al., 1999). This construct emphasized fear of failure, low self-efficacy, and negative attitudes toward technology.

Empirical evidence demonstrated that computer anxiety significantly predicted technology acceptance, usage intention, and task performance (Compeau & Higgins, 1995).

As digital technologies became increasingly complex and ubiquitous, the notion of technostress emerged, conceptualized as stress experienced due to the inability to cope with technological demands (Tarafdar et al., 2015). The influential technostress trifecta model identified three major stressors: techno-overload, techno-invasion, and techno-complexity. This framework highlighted the multidimensional nature of stress responses to digital environments.

Building on these foundations, contemporary scholars have advanced the broader construct of technology anxiety, integrating affective, cognitive, and behavioral dimensions across diverse digital contexts (Panisoara et al., 2020; Mattock, 2022).

Unlike earlier constructs limited to computer usage, technology anxiety encompasses experiences associated with online learning platforms, AI-based tools, surveillance technologies, and immersive digital environments.

### **Technology Anxiety in Educational Contexts**

In education, technology anxiety is shaped by a complex interplay of individual, institutional, and technological factors. Individual-level predictors include digital literacy, prior experience, self-efficacy, and personality traits (Hatlevik et al., 2014; Teo et al., 2019). Institutional factors involve organizational support, training quality, leadership practices, and digital infrastructure (Barreto et al., 2023; Moorhouse & Wong, 2022).

Recent studies increasingly emphasize the emotional consequences of rapid digital transformation. During the COVID-19 pandemic, emergency remote teaching amplified feelings of uncertainty, workload pressure, and technological inadequacy among both teachers and students (Huang et al., 2020; Zhou et al., 2022). Post-pandemic contexts further introduced anxieties associated with artificial intelligence, automated assessment, and learning analytics, raising ethical and psychological concerns (Klimova & Pikhart, 2025; Lin & Chen, 2024).

Despite these advancements, theoretical integration remains limited. Most empirical studies adopt technology acceptance models (TAM, UTAUT) without systematically embedding anxiety constructs within broader psychological frameworks. Consequently, the conceptual boundaries and developmental trajectories of technology anxiety research remain underexplored, necessitating a macro-level bibliometric synthesis.

## **METHODOLOGY AND MATERIALS**

Even though quantitative research has examined technological anxiety in various educational settings, a systematic structural overview of this domain is still lacking. To address this gap, bibliometric analysis has proven to be an effective method for assessing the intellectual structure, thematic evolution, and collaboration patterns within a research field.

The term "bibliometrics" was originally introduced by Pritchard, who defined it as the application of statistical methods to books and communication media (Pritchard, 1969). More recently, bibliometric analysis has been used to reveal research hotspots, collaboration networks, and intellectual trends in educational technology and anxiety-related domains ([Sagarduy et al., 2024](#)), ([Hadi et al., 2024](#)), (Jiménez et al., 2019). Bibliometric mapping

techniques, such as co-occurrence networks and clustering algorithms, can systematically track developments in a field, identify leading contributors, and uncover emerging themes (Jing et al., 2023).

This study adopts a bibliometric approach to systematically analyze the knowledge domain of technology anxiety in education. Data were extracted from the Web of Science Core Collection, which is widely recognized for its comprehensive and structured citation data and frequently used in similar studies (Murnaka et al., 2021).

The dataset was processed using CiteSpace, a bibliometric software based on pathfinding and co-occurrence algorithms, to construct keyword networks, identify burst terms, and detect core contributors. Data cleaning and formatting were conducted using spreadsheet tools, and final visualizations, including chord diagrams for collaboration, were created with RAWGraphs. This integrative workflow ensures a clear and structured visualization of the intellectual landscape of technology anxiety research in education.

Table 1 Summary of data source and selection

Category	Specific standard requirements
Research database	Web of Science Core Collection
Searching period	January 1996 to July 2025
Language	English
Searching keywords	TS = ((“technology anxiety” OR “technophobia” OR “digital anxiety” OR “computer anxiety” OR “technology stress” OR “resistance to technology”) AND (“education” OR “teaching” OR “learning” OR “educational technolog*”) OR “higher education” OR “online learning” OR “distance education”))
Document types	Articles, Review articles
Data extraction	Export with full records and cited references in plain text format
Sample size	506 (Before manual screening)

### Data Retrieval

This study utilized the Web of Science Core Collection as the primary data source for bibliometric analysis. Recognized for its comprehensive coverage of high-quality, peer-reviewed literature and structured citation data, Web of Science remains one of the most widely used databases in bibliometric research.

Its standardized indexing format and reliable metadata make it compatible with bibliometric visualization tools such as CiteSpace, enabling accurate network analyses and performance metrics (Chen, 2006), (Jing et al., 2023).

Compared with other databases, Web of Science ensures consistency and quality in the representation of scholarly communications, which is essential for structural mapping and identifying research trends in interdisciplinary domains like technological anxiety in education (Sagarduy et al., 2024), (Hadi et al., 2024).

To ensure comprehensive coverage of both psychological and educational perspectives, a topic-based search (TS) strategy was adopted. The final search string included terms such as “technology anxiety”, “technophobia”, “digital anxiety”, “computer anxiety”, “technology stress”, and “resistance to technology” in combination with educational terms like “education”, “teaching”, “learning”, “educational technology”, “higher education”, “online learning”, and “distance education”. These keyword combinations were adapted from prior bibliometric studies on education technology and anxiety-related constructs (Murnaka et al., 2021), (Jiménez et al., 2019).

The search was limited to English-language publications from January 1996 to July 2025. Records were exported in plain text format with full bibliographic details and cited references to ensure compatibility with CiteSpace. This initial query yielded 506 records prior to manual screening and deduplication. A summary of the search and filtering parameters is provided in Table 1.

## RESULTS

Performance analysis (RQ1). This section presents a comprehensive overview of the research landscape on technological anxiety in education by integrating descriptive statistics and visualizations. It examines the temporal growth of publications, key authors, leading institutions and countries, and the dissemination of findings across academic journals.

Using tools like RAWGraphs and CiteSpace, the analysis visualizes international collaboration patterns and publication trends, revealing a marked rise in scholarly interest—particularly in recent years—driven by increasing psychological and pedagogical concerns related to educational technologies.

These findings enhance our understanding of the field’s intellectual structure and collaborative networks, offering a foundation for identifying research gaps and informing future directions.

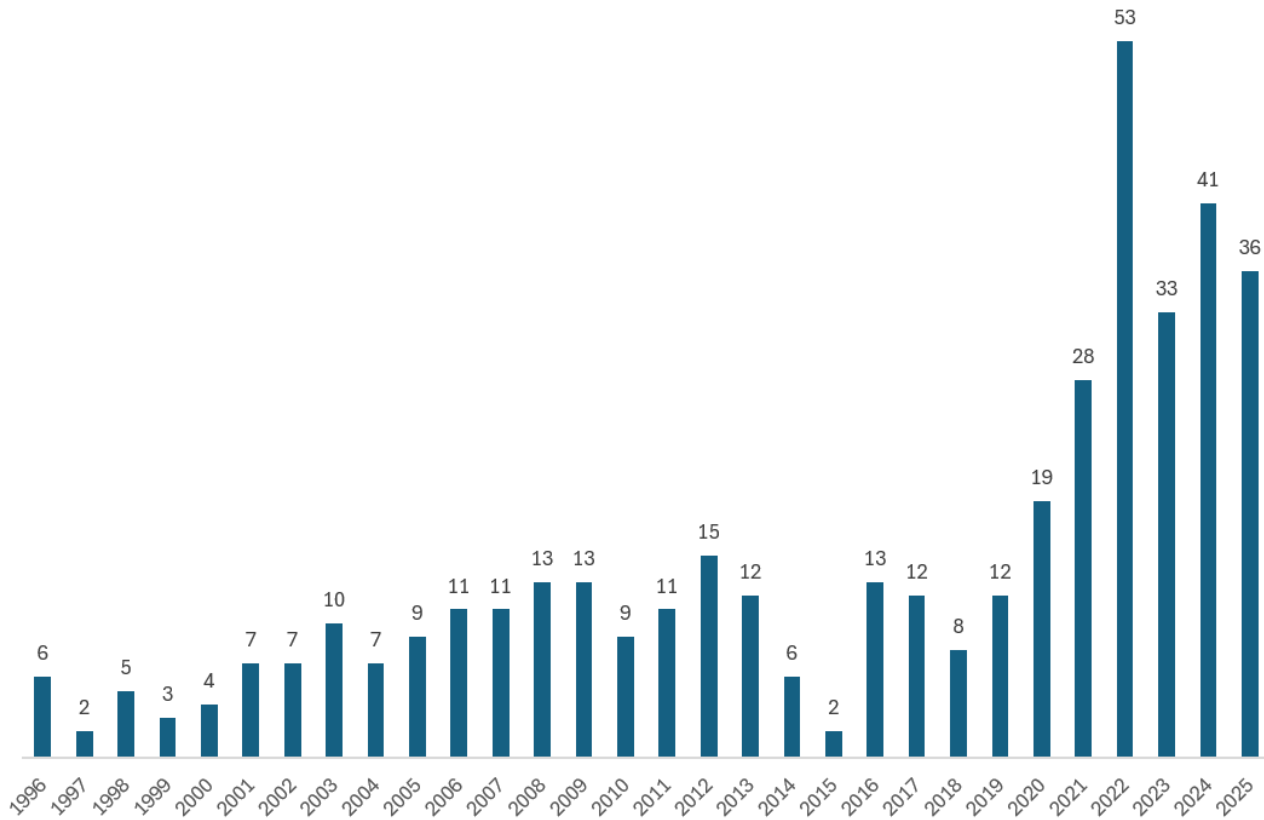
*Time trend of the publications.* To understand the evolution of research on technological anxiety in education, it is necessary to begin with a basic quantitative assessment—namely, the annual publication volume, which reflects the field's growth and academic interest over time. Figure 1 illustrates the yearly distribution of publications from 1996 to 2025.

The figure 1 reveals a clear three-phase development pattern. The first phase (1996–2007) is characterized by relatively low and fluctuating publication counts, generally remaining below 13 articles per year. During this stage, research on technological anxiety in education was still in its infancy, with limited scholarly attention and fragmented contributions.

The second phase (2008–2019) shows a modest but steady rise in publications, indicating a growing academic interest in the psychological impacts of digital technology use in educational contexts. Notably, there were brief dips in 2014 and 2015, but the overall trend remained upward. The third phase, from 2020 onward, marks a period of rapid acceleration.

The number of publications surged significantly, peaking at 53 in 2022. This spike can be largely attributed to the global COVID-19 pandemic, which necessitated widespread digital transformation in education. Researchers began to focus more intensely on how technology-related anxiety influenced teaching and learning under emergency remote instruction.

While publication counts slightly declined after 2022, they remained relatively high through 2025, suggesting sustained interest in this research area as digital education becomes a long-term norm.



**Figure 1 Bar chart of publication trends**

*Analysis of authors.* An analysis of author publication volume provides critical insights into key scholars and core strengths within a research area. Table 2 presents data on core authors in the field of digital anxiety research in education, including their publication counts, total citations, and average citations per article (based on the analysis and statistics from CiteSpace).

Significant variations in research focus are observed among leading scholars. Within the domain of technology anxiety and its educational implications, Viswanath Venkatesh emerges as the most influential author, with two publications cited 2431 times, resulting in an impressive average of 1215.5 citations per paper. Venkatesh’s foundational research notably introduced the Unified Theory of Acceptance and Use of Technology (UTAUT), critically shaping subsequent studies on technology anxiety, user acceptance, and behavior intention in educational contexts (Venkatesh et al., 2003).

Although contributing only one publication, garnered considerable attention with 1417 citations. Sun’s seminal work examines the determinants of student anxiety toward digital technologies in educational environments, significantly advancing the understanding of psychological and environmental factors influencing technology anxiety among students (Sun et al., 2007).

Similarly, Czaja, S.J., with a single influential publication cited 1215 times, primarily investigates technology-related anxiety among older adult learners, emphasizing usability and acceptance barriers within digital education frameworks. Czaja’s research provides deep insights into the unique cognitive and emotional challenges experienced by adult learners, significantly informing inclusive educational technology designs (Czaja et al., 2006).

Ragu-Nathan, T.S. contributes substantially to the discourse with one highly-cited paper (1071 citations),

focusing specifically on technostress among educators. His research underscores how digital technologies, despite their advantages, can induce significant stress and anxiety among teaching professionals, consequently impacting instructional effectiveness and professional well-being (Ragu-Nathan et al., 2008).

Finally, Abdullah, F. has authored two publications accumulating 967 citations, averaging 483.5 citations per paper. Abdullah’s research centers on digital anxiety within higher education settings, particularly exploring the emotional and behavioral responses of students to e-learning environments, and emphasizing practical strategies for mitigating anxiety to enhance digital learning experiences (Abdullah & Ward, 2015).

Collectively, these authors have shaped foundational perspectives on digital anxiety, highlighting critical emotional, psychological, and contextual dimensions influencing educational technology adoption and utilization.

Table 2 Top 5 authors in the application of digital anxiety in education research field.

	Author	Publications	Total Citations	Average Citations
1	Venkatesh, V	2	2431	1215.5
2	Sun, P	1	1417	1417
3	Czaja, SJ	1	1215	1215
4	Ragu-Nathan, TS	1	1071	1071
5	Abdullah, F	2	967	483.5

*Analysis of countries/regions and organization.* This section examines the global and institutional contributions to research on digital anxiety in education using bibliometric techniques. Based on citation data and collaboration networks derived from CiteSpace, the analysis highlights major contributing countries and organizations.

As shown in Table 3, the United States ranks as the most cited country, followed by Taiwan and China, reflecting strong North American and East Asian engagement in this field. Other key contributors include Turkey, England, Australia, and Malaysia, alongside emerging interest from South Africa, Canada, and Saudi Arabia. This global spread mirrors previous bibliometric research on educational technologies and anxiety-related topics, which have found high contributions from countries like the USA, China, and Turkey in science and educational anxiety domains (Sagarduy et al., 2024), (Khafizova et al., 2024).

Table 3 Top 10 Most Cited Countries/Regions in the Field of Digital Anxiety in Education

Rank	Country (Region)	Count (Number of Citations)
1	USA	95
2	TAIWAN(China)	41
3	PEOPLES R CHINA	34
4	TURKEY	25
5	ENGLAND	23
6	AUSTRALIA	21

Rank	Country (Region)	Count (Number of Citations)
7	MALAYSIA	17
8	SOUTH AFRICA	15
9	CANADA	14
10	SAUDI ARABIA	14

Figure 2 illustrates these inter-country collaborations using a chord diagram produced via RAWGraphs. Nodes represent countries scaled by publication volume, and arcs represent the strength of collaborative ties. Notable cooperative relationships are observed among Australia, Malaysia, England, and Canada, while the USA, China, and England form the densest collaborative network—echoing global co-authorship trends in educational digital environments (Ioseliani et al., 2023).

Figure 2 International Collaboration Network in the Field of Digital Anxiety in Education

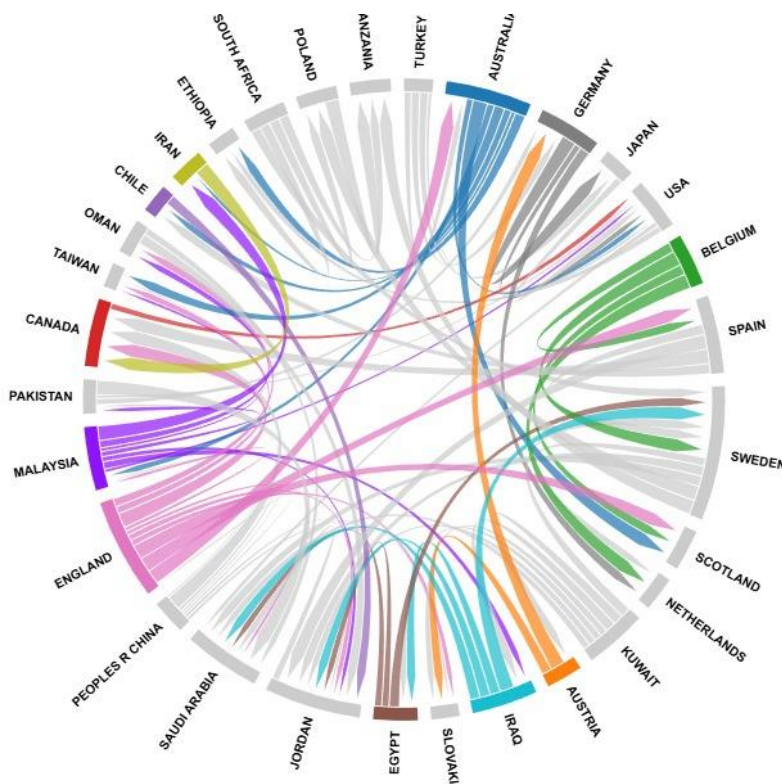


Table 4 ranks institutions based on publication count and citation impact. The State University System of Florida leads with seven documents and 92 citations, while the University of Maryland system shows the highest citation impact per paper.

Universities in the Middle East and East Asia, such as King Faisal University, Tokat Gaziosmanpasa University, and National Changhua University of Education, also demonstrate notable scholarly activity. Institutions like the Chinese University of Hong Kong and National Central University exhibit high average citations, emphasizing their influence within this academic community.

These findings align with prior bibliometric work showing institutional concentration in anxiety-related educational research, especially in countries with high digital integration in their education systems (González-Ruiz et al., 2024), (Ersozlu & Karakus, 2019).

This analysis reveals a dynamic and globally distributed research network with deep institutional roots, offering valuable insights into both geographic patterns and key players driving scholarship on digital anxiety in education.

Table 4 Top 10 Contributing Institutions in the Field of Digital Anxiety in Education

Rank	Organization	Documents	Citations	Average citation per paper
1	State University System of Florida	7	92	13.09
2	University System of Georgia	6	82	13.75
3	University System of Maryland	5	490	97.93
4	King Faisal University	5	68	13.58
5	Tokat Gaziosmanpasa University	5	74	14.7
6	National Changhua University of Education	5	123	24.6
7	Universiti Malaya	4	33	8.33
8	Princess Nourah bint Abdulrahman University	3	9	2.99
9	Chinese University of Hong Kong	3	169	56.33
10	National Central University	3	144	48.11

*Analysis of journals.* Journals serve as essential platforms for disseminating academic research, particularly in emerging interdisciplinary domains like digital anxiety in education.

Prior studies emphasize two core metrics to assess journal influence: article volume and citation frequency—both indicators of a journal's academic impact (Juniati & Wahyuni, 2024). In this study, the top 10 journals contributing the most publications in this field were analyzed using CiteSpace, along with their average citations per article.

Results show that *Computers in Human Behavior* and *Computers & Education* lead the field, with *Computers & Education* having particularly high citation density per article. *Education and Information Technologies* and *Sustainability* also rank highly, reflecting sustained scholarly attention to psychological and pedagogical impacts of digital learning environments.

Notably, *Frontiers in Psychology* was identified in prior bibliometric studies as a leading outlet for work on anxiety and education, further reinforcing its disciplinary relevance (Juniati & Wahyuni, 2024).

Moreover, the presence of open access journals like *Sustainability* and *Frontiers in Psychology* supports broader dissemination and accessibility of digital anxiety research, aligning with contemporary movements toward open knowledge sharing (Kohnke, 2024).

These findings emphasize that journals with a focus on educational technology, psychology, and human-computer interaction serve as core platforms for publishing influential studies in this field.

Table 5 Top 10 Journals in the Field of Digital Anxiety in Education

Rank	Journal	Documents	Citations	Average citation per paper	IF
1	COMPUTERS IN HUMAN BEHAVIOR	32	1928	60.25	8.958
2	COMPUTERS & EDUCATION	20	3286	164.3	11.18
3	EDUCATION AND INFORMATION TECHNOLOGIES	14	390	27.86	3.666
4	SUSTAINABILITY	13	367	28.23	3.889
5	INTERACTIVE LEARNING ENVIRONMENTS	7	182	26	4.965
6	FRONTIERS IN PSYCHOLOGY	5	14	2.8	-
7	INTERNATIONAL JOURNAL OF HUMAN-COMPUTER INTERACTION	5	116	23.2	-
8	JOURNAL OF EDUCATIONAL COMPUTING RESEARCH	5	31	6.2	-
9	EDUCATIONAL TECHNOLOGY & SOCIETY	5	43	8.6	-
10	BEHAVIORAL SCIENCES	5	148	29.6	-

**Temporal keyword analysis: thematic evolution (RQ2).** The evolution of research themes in digital anxiety and education reflects dynamic shifts in scholarly focus, driven by technological innovation and educational transformation.

Using CiteSpace-generated keyword co-occurrence maps, this study divided the timeline into three periods to illustrate how academic interest and theoretical depth have changed over time. This approach aligns with established bibliometric methodologies used to track longitudinal keyword development in related fields (Uddin et al., 2023).

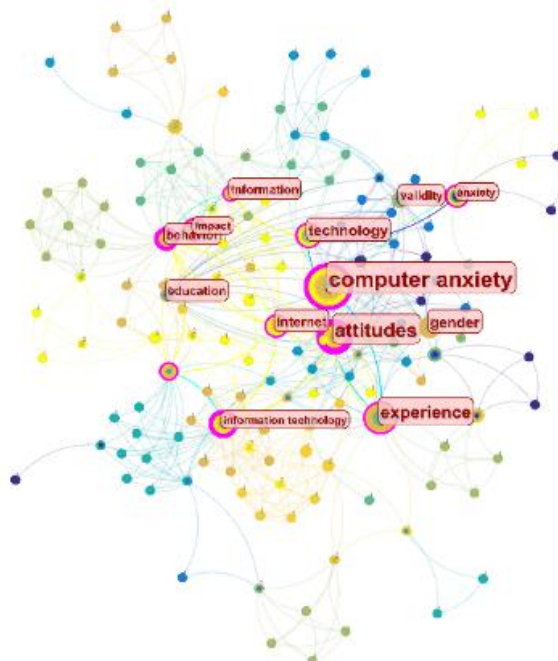
**1996–2005: Initial Exploration Period**

As shown in Figure 3, early research emphasized foundational psychological concepts like *computer anxiety*, *attitude*, and *experience*. Scholars explored learners’ and teachers’ emotional reactions to digital tools, especially when first encountering them in educational contexts.

Pioneering studies suggested that anxiety was linked to unfamiliarity and low digital confidence (Chua et al., 1999), and that computer self-efficacy had a significant effect on user intention and performance (Compeau & Higgins, 1995). This stage laid the groundwork for psychological inquiry in educational technology.

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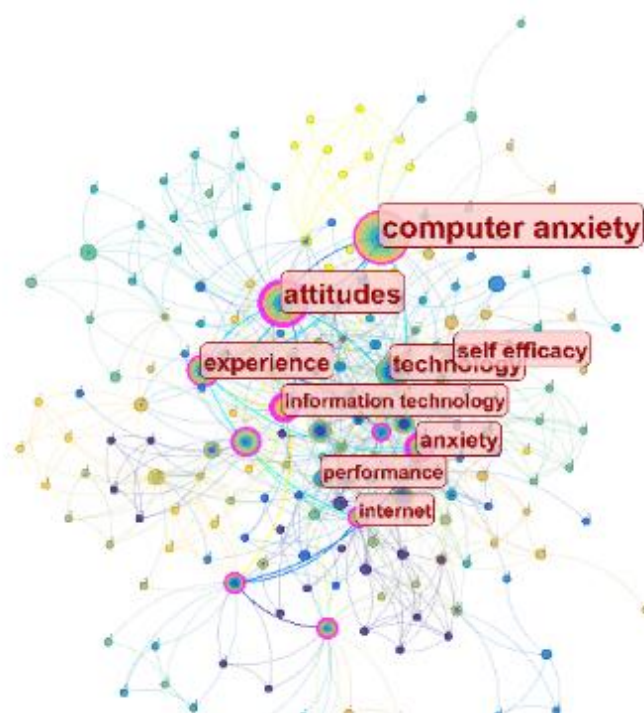
**Figure 3 Keyword co-occurrence map of digital anxiety research (1996–2005)**

**2006–2015: Expansion and Diversification**

In the second phase, keyword networks (see Figure 4) expanded toward constructs such as *self-efficacy*, *information technology*, and *performance*. The Technology Acceptance Model (TAM) and its variants emerged as dominant theoretical frameworks to explain technology-related anxiety in education (Venkatesh & Davis, 2000). Studies showed that perceived ease of use, usefulness, and prior experience mediated the impact of anxiety on learners’ and educators’ technology engagement. This decade marked an increasing theoretical sophistication and broader contextual applications.

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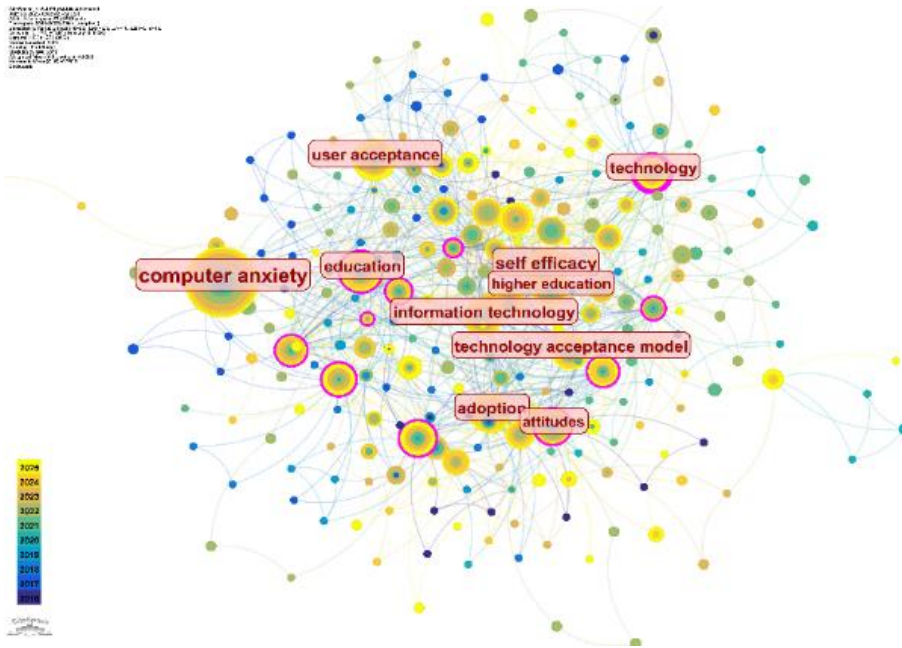
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**Figure 4 Keyword co-occurrence map of digital anxiety research (2006–2015)**

## 2016–2025: Consolidation and Innovation

As depicted in Figure 5, the latest period witnessed a consolidation of theories and emergence of new research topics, such as *technology acceptance model*, *e-learning*, *higher education*, *user adoption*, and *remote learning*. This reflects not only the advancement of technology in pedagogy but also the psychological implications of rapid digital transformation, particularly in post-pandemic contexts (Zhang et al., 2022). Recent research integrates anxiety with systemic innovation strategies and focuses on interventions for sustainable technology use in education.



**Figure 5** Keyword co-occurrence map of digital anxiety research (2016–2025)

These phased visualizations collectively highlight how the concept of technological anxiety in education has evolved from foundational definitions to complex system-level analyses. The field now includes both micro-level psychological constructs and macro-level institutional dynamics, providing comprehensive insight into how digital tools intersect with learner and teacher well-being.

The evolution of research on technological anxiety in education has transitioned from early explorations of user attitudes and anxiety to system-level concerns that span psychological, institutional, and technological dimensions. Early studies focused on psychological constructs like computer self-efficacy and anxiety, which were found to significantly influence learners’ engagement with technology (Compeau & Higgins, 1995; Chua et al., 1999). The onset of the COVID-19 pandemic marked a critical turning point, forcing a sudden shift to online learning that exposed gaps in digital literacy and infrastructural readiness across global education systems (Zhou et al., 2022; Huang et al., 2020; Moorhouse, 2020).

These disruptions highlighted the importance of digital competence in managing educational transitions, with studies showing that students with lower digital confidence experienced greater stress and disengagement (Burgos-Videla et al., 2021). Simultaneously, teacher preparedness and leadership support became crucial for effective instructional adaptation and emotional resilience (Moorhouse & Wong, 2022; Barreto et al., 2023). Beyond the pandemic, emerging technologies such as AI and VR have introduced new dimensions of digital anxiety, raising concerns about cognitive overload and ethical use (Eisenberg, 2008; Dai et al., 2022; Serrano-Ausejo, 2025). Scholars increasingly emphasize interdisciplinary approaches to address these challenges, calling for educational systems to consider user acceptance alongside emotional well-being and inclusivity (Venkatesh

& Bala, 2008; Teo et al., 2019).

**Hotspot evolution analysis (RQ3).** The analysis of burst keywords offers a lens into shifting research emphases in digital anxiety and educational technology. By applying CiteSpace’s burst detection algorithm, key terms like "attitudes," "experience," and "self-efficacy" emerged with strong citation bursts, particularly between 1998 and 2013, reflecting early academic focus on psychological readiness for technology use in education (Compeau & Higgins, 1995; Chua et al., 1999; Igarria & Parasuraman, 1989).

In contrast, more recent bursts (post-2020) highlight growing interest in "technology anxiety," "user acceptance," and "artificial intelligence," signaling intensified concern about cognitive load, emotional readiness, and ethics in tech-enhanced learning environments (Teo et al., 2019; Moorhouse & Wong, 2022; Eisenberg, 2008). These emerging keywords align with bibliometric studies showing a post-pandemic research pivot toward emotional and behavioral dimensions of digital education (Barreto et al., 2023; Zhang et al., 2024).

Notably, the emergence of “continuance intention” and “technology acceptance” reflects sustained efforts to understand long-term digital adoption using models like TAM and UTAUT (Venkatesh & Bala, 2008; Dai et al., 2022). These shifts are further supported by bibliometric analyses that map evolving keyword clusters over time, emphasizing psychological constructs like anxiety and self-efficacy in technology-enhanced learning (Khafizova et al., 2024; Peng et al., 2024).

Table 6 Top 10 Keywords with the Strongest Bursts

Keyword	Strength	Begin	End	2000–2025 Visual Representation
attitudes	8.01	2001	2013	
experience	7.70	1998	2011	
technology anxiety	5.21	2022	2025	
user acceptance	5.14	2021	2025	
perceived ease	4.86	2023	2025	
artificial intelligence	4.77	2023	2025	
perceived usefulness	4.47	2020	2023	
technology acceptance	4.22	2016	2021	
online learning	3.94	2021	2023	
continuance intention	3.62	2019	2022	

## DISCUSSION

**Discussion on performance analysis (RQ1).** The field of digital anxiety in education, as revealed through performance analysis, has undergone notable growth in terms of author contributions, geographic reach, and institutional engagement. This expansion corresponds with increased integration of digital technologies into classrooms and growing attention to the psychological dimensions of technology use.

**Discussion on authorship productivity in digital anxiety research.** Authorship patterns in the field of digital anxiety research reveal the emergence of key scholarly voices and interdisciplinary networks. Neil Selwyn has been a foundational contributor, critically examining the societal, ethical, and political complexities of educational technologies. His work underscores how technological adoption in education is often shaped by unequal access and broader institutional dynamics rather than purely pedagogical benefits (Selwyn, 2016; Selwyn & Gašević, 2020).

Recent studies have extended this discourse into the COVID-19 era. Yu Zhonggen (Yu, 2021) has examined how individual differences such as gender, education level, and personality traits influence online learning outcomes, shedding light on emotional and cognitive factors underlying digital anxiety. Meanwhile, broader institutional concerns are reflected in work by Purcell and Lumbreras (2021), who analyzed how the Sustainable Development Goals can guide higher education's response to pandemic-induced digital transformation, emphasizing the need for equitable and emotionally sustainable learning environments.

Together, these contributions demonstrate that digital anxiety is not only a psychological issue but also a sociotechnical phenomenon requiring cross-disciplinary inquiry—spanning educational psychology, policy, and digital equity frameworks.

**Discussion on country/region-level productivity and collaboration.** From a geographic standpoint, the field is prominently driven by contributions from countries such as China, the United States, the United Kingdom, and Australia. China's leadership in publication frequency is notable, reflecting its strategic national emphasis on educational digitalization (Ministry of Education of the PRC, 2022). However, Western nations such as the US and UK still maintain a citation advantage, likely due to longer engagement with the topic and access to high-impact journals in English.

Collaborative patterns between these regions, visualized through chord diagram analysis (Figure 2), highlight robust co-authorship networks. The close ties between China, the US, and the UK reflect growing internationalization of educational research. These collaborations are instrumental in sharing theoretical frameworks and empirical data across educational systems, which is crucial for understanding digital anxiety in diverse socio-cultural contexts.

**Discussion on institutional-level contributions.** Institutions such as Beijing Normal University, Monash University, and The Education University of Hong Kong are at the forefront of digital anxiety research. Beijing Normal University's productivity is aligned with national policy priorities, emphasizing teacher digital literacy and psychological adaptation. Meanwhile, institutions in Australia and Europe, such as Monash and Oslo University, demonstrate high citation averages, indicating global recognition of their scholarly outputs.

The presence of teacher education-focused universities among the top contributors underscores the central role of teacher preparedness and pedagogical change in addressing technology anxiety. These institutions are increasingly integrating digital emotional readiness into their teacher training curricula, thereby not only shaping practice but also influencing research agendas.

**Discussion on journal publication trends.** Leading journals such as *Computers & Education*, *Education and Information Technologies*, and *Educational Technology Research and Development* serve as key platforms for publishing high-impact research on digital anxiety, technology acceptance, and educational transformation. *Computers & Education* stands out for its frequent citations in studies on student engagement, digital self-efficacy, and psychological stress, reflecting its central role in shaping discourse in this field.

Performance analysis highlights that the expansion of digital anxiety research is driven by global collaboration,

institutional investment, and growing publication avenues. Future studies should amplify perspectives from underrepresented regions and explore high-anxiety contexts such as AI-assisted learning, immersive technologies, and online assessments to better understand and address emotional challenges in digital education.

**Discussion on the Evolutionary Trends (RQ2).** The trajectory of digital anxiety and technology acceptance research in education has evolved from early models of user behavior to more nuanced understandings of emotional and contextual factors. In the early 2000s, foundational models such as the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) focused on constructs like perceived usefulness and ease of use, forming the basis for early studies on technology attitudes and user behavior ([Wedlock & Trahan, 2019](#)).

By the 2010s, research began to incorporate emotional and psychological factors—particularly anxiety and self-efficacy—into these models. Meta-analyses demonstrated that anxiety significantly reduced both perceived usefulness and ease of use, reinforcing its role as a barrier to technology adoption (Dönmez-Turan & Kır, 2019).

With the global shift to online learning post-2020, studies have increasingly focused on sustainability, long-term engagement, and the emotional toll of digital learning. For example, researchers found that anxiety and digital resilience significantly influence educators' willingness to adopt new technologies, highlighting the importance of emotional and contextual variables in the post-pandemic era ([Jamaludin et al., 2023](#)).

In applied contexts, such as virtual reality in classrooms, learner anxiety continues to shape technology acceptance and usage behavior, with supportive classroom climates shown to mitigate its effects ([Man et al., 2024](#)). Further, recent models emphasize how factors like self-efficacy, computer anxiety, and digital enjoyment influence learners' satisfaction and willingness to continue using educational platforms ([Iqbal, 2024](#)).

This evolution signifies a shift from simple behavioral predictions to richer, interdisciplinary inquiries integrating psychology, education, and human-computer interaction. As technology continues to permeate education, emotional constructs like digital anxiety have become central to understanding sustainable technology adoption.

**Discussion on the study of research hotspots (RQ3).** The analysis of keyword bursts within the domain of digital anxiety and educational technology adoption reveals several prominent and emerging research frontiers, reflecting a research landscape that is both dynamic and multidimensional. These hotspots highlight the academic community's responsiveness to technological change, psychological complexity, and contextual challenges across learning environments.

**Digital anxiety and emotional readiness.** The interplay between emotional and motivational factors in technology adoption has garnered increased academic interest in recent years. On the one hand, studies have shown that learners' academic success is significantly shaped by how they emotionally respond to educational technologies, particularly in the presence of technology-related stressors. In a recent meta-analysis, Kuş (2025) confirmed that such emotional dimensions, including anxiety and discomfort with technology, exert measurable negative impacts on students' academic performance.

On the other hand, teachers' role in transferring and sustaining technology-enabled innovations is heavily influenced by their own motivational structures. As emphasized by Stumbrienė, Jevsikova, and Kontvainė (2023), factors such as perceived usefulness, institutional support, and professional self-efficacy significantly shape teachers' willingness to integrate and transfer technological innovation. Together, these findings suggest that both affective and motivational dimensions must be addressed in tandem to achieve successful educational digital transformation.

**User acceptance and behavioral intention.** Closely related to digital anxiety is the concept of "user acceptance," which also demonstrated a strong burst in recent years. Research in this area draws upon models such as TAM and UTAUT, and focuses on cognitive-affective factors including perceived usefulness, perceived ease of use, and intention to continue using technology (Venkatesh & Bala, 2008; Teo et al., 2019). The increasing prominence of these constructs indicates that digital behavior is now viewed as a continuum, with emotional readiness and habitual engagement playing critical roles in long-term technology integration.

**Digital literacy and competence.** The emergence of "digital literacy" as a burst term reflects an important conceptual shift in educational research. While early digital adoption studies focused on access and infrastructure, contemporary research now emphasizes the competencies required to use digital tools critically, ethically, and confidently (Ng, 2012; Siddiq et al., 2016). Learners' digital competence is increasingly framed as a resilience factor against digital anxiety, with empirical evidence suggesting a negative correlation between digital literacy and perceived stress (Hatlevik et al., 2015; Chen et al., 2024).

**Higher education and online learning.** The COVID-19 pandemic served as a pivotal catalyst, forcing universities globally to transition swiftly to remote instruction. In this rapidly shifting educational landscape, digital anxiety has become a significant psychological factor influencing students' academic experiences. For example, Adedoyin and Soykan (2020) highlight the challenges students face in adapting to online platforms, including issues of digital fatigue, access inequality, and emotional overwhelm. Complementing this, Alharbi (2025) conducted a mixed-methods study among Saudi Arabian university students and found that digital transformation—particularly in English as a Foreign Language (EFL) instruction—exacerbated anxiety levels, thereby influencing students' language acquisition, motivation, and psychological well-being. These findings underscore the necessity of addressing not only infrastructural readiness but also the emotional and psychological resilience required for effective technology integration in higher education.

**Continuance intention and sustainable adoption.** The concept of continuance intention—users' sustained use of educational technologies—has gained prominence as research shifts from initial acceptance to long-term digital engagement. Studies suggest that digital anxiety may hinder sustained usage, particularly in emotionally or cognitively demanding settings. Effective interventions, including scaffolding, intuitive design, and emotional support, are thus essential. Roca, Chiu, and Martínez (2006) identified perceived usefulness and satisfaction as key predictors of continuance, while Zawacki-Richter et al. (2019) emphasized the importance of designing educational systems that support both functional and affective sustainability.

**Professional development and teacher training.** With digital tools reshaping educational practice, teacher training has become central to ensuring effective technology integration. Guillén-Gámez et al. (2023) emphasize the need to assess and strengthen teachers' digital competence through structured instruments, while Wolfe and Hartman (2024) highlight the value of mentorship in preparing pre-service teachers for remote instruction. These findings underscore the importance of integrated training that combines technical proficiency with real-world teaching readiness.

**Post-pandemic transformation.** The COVID-19 pandemic not only accelerated the adoption of digital technologies but also sparked critical reflections on institutional resilience and pedagogical redesign. Meyer (2020) observed that crisis-driven teaching environments, though unplanned, provided powerful experiential learning opportunities that reshaped both curriculum and learner psychology. Similarly, Crawford et al. (2020) documented how universities across 20 countries responded with diverse digital strategies, signaling a shift from temporary remote instruction to long-term digital transformation. These developments underscore the need for emotionally responsive, adaptable learning ecosystems in the post-pandemic era.

**Artificial intelligence and future directions.** As artificial intelligence (AI) becomes more deeply integrated

into educational environments, researchers increasingly emphasize its dual impact on learning performance and emotional well-being (Lin & Chen, 2024; Klimova & Pikhart, 2025). While AI-assisted tools can enhance learner creativity, focus, and engagement through personalization (Wang et al., 2025; Alsaiani et al., 2024), they also introduce new psychological demands such as increased cognitive load and emotional sensitivity (Khan et al., 2025; Meyer, 2022).

Studies have shown that emotionally enriched AI feedback contributes positively to student motivation and emotional regulation, particularly in remote or autonomous learning environments (Alsaiani et al., 2024; Wolfe & Hartman, 2024). However, the effectiveness of AI tools depends heavily on learners' confidence in using AI and their perceived self-efficacy, which significantly mediate the relationship between AI use and classroom anxiety (Zhang et al., 2025).

Moreover, the implementation of AI in education must consider both student and teacher perspectives, as mismatched expectations may lead to emotional overload or resistance to adoption (Lin & Chen, 2024; Wolfe & Hartman, 2024). Given these dynamics, understanding how AI influences anxiety—both positively by fostering confidence and negatively by increasing perceived pressure—has become a central concern in the field (Khan et al., 2025; Klimova & Pikhart, 2025).

## CONCLUSIONS AND FUTURE DIRECTIONS

The field of technology anxiety in education has experienced significant growth over the past three decades, especially in response to the accelerating digitalization of teaching and learning environments. Bibliometric analysis using CiteSpace reveals key patterns shaping the intellectual and empirical landscape of this domain.

Research output has sharply increased since 2020, largely driven by the COVID-19 pandemic, which forced a global transition to online learning and spotlighted issues of emotional readiness, self-efficacy, and psychological resilience among students and educators. Scholars such as Spitzer, Teo, Yu, and Mughal have been instrumental in shaping the discourse by linking emotional responses to technology with pedagogical outcomes.

Originally centered on constructs like “computer anxiety,” the field has evolved to embrace broader theoretical models such as the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT). Keyword bursts like “user acceptance,” “digital anxiety,” and “continuance intention” reflect this conceptual expansion, indicating a sustained academic interest in how affective factors shape digital learning engagement.

Higher education and teacher training settings have become the primary contexts for empirical studies, emphasizing the centrality of institutional readiness, faculty development, and support infrastructure. While China, the U.S., and Malaysia lead in publication volume, disparities in global research participation suggest the need for more inclusive and geographically balanced perspectives.

Emerging hotspots—such as digital transformation, emotional readiness, and sustainable technology use—demonstrate a growing concern with both short-term emotional barriers and long-term capacity building. The field's increasing interdisciplinarity, drawing from psychology, instructional design, and human-computer interaction, enables more nuanced investigations into how technology anxiety is experienced and mitigated.

Despite these insights, the present study has several limitations. First, the bibliometric analysis was limited to journal articles indexed in the Web of Science Core Collection, excluding potentially relevant sources from Scopus, ERIC, or grey literature such as conference proceedings and practitioner reports. This may have resulted in an underrepresentation of emerging voices and localized knowledge. Second, although CiteSpace offers a

robust platform for quantitative mapping, the interpretation of co-citation clusters and thematic trends involves subjective academic judgment and may not fully capture the content-level nuances of individual studies.

Additionally, the study focused on macro-level trends—such as publication productivity and keyword evolution—without examining micro-level methodological approaches or the efficacy of specific interventions. Future research would benefit from integrating multiple data sources, including regional databases and interdisciplinary repositories, to provide a more comprehensive and globally inclusive view of the field.

To deepen the understanding of digital anxiety, scholars should complement bibliometric mapping with qualitative reviews, expert interviews, and practitioner-focused surveys. Engaging directly with teachers, students, and educational stakeholders who experience technology anxiety firsthand will yield more grounded and actionable insights. Moreover, there is a pressing need to explore how emotional ergonomics, user interface design, and institutional culture interact with digital anxiety—especially in the context of emerging technologies such as AI and immersive media.

Technology anxiety is both a persistent challenge and a critical lens for advancing emotionally responsive and equitable digital education. Moving forward, the field must adopt holistic and interdisciplinary strategies that prioritize both technological innovation and human well-being. By addressing emotional, cognitive, and structural barriers, future research can play a vital role in fostering sustainable and inclusive digital learning environments.

## REFERENCE

1. Abdullah, F., & Ward, R. (2015). Developing a General Extended Technology Acceptance Model for E-Learning (GETAMEL) by analysing commonly used external factors. *Computers in Human Behavior*, 56, 238–256. <https://doi.org/10.1016/j.chb.2015.11.036>
2. Adedoyin, O. B., & Soykan, E. (2020). COVID-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*, 28(sup1), 1–13. <https://doi.org/10.1080/10494820.2020.1813180>
3. Alharbi, M. S. (2025). Digital transformation and EFL anxiety: A mixed-methods study on the impact of online learning on the language acquisition psychology of Saudi Arabian students. *Social Sciences & Humanities Open*, 12, 101721. <https://doi.org/10.1016/j.ssaho.2025.101721>
4. Alsaiari, O., Alharthi, K., & Yamani, A. (2024). Emotionally enriched feedback via generative AI: Effects on student emotions and engagement. *arXiv Preprint*. <https://arxiv.org/abs/2410.15077>
5. Barreto, I. B., Sanchez, R. M. S., Sanchez, W. S., Jordan, O. H., & Escalante, J. D. B. (2023). The process of digital transformation in education during the COVID-19 pandemic. *International Journal of Professional Business Review*, 8(9), e03770. <https://doi.org/10.26668/businessreview/2023.v8i9.3770>
6. Beckers, J. J., Wicherts, J. M., & Schmidt, H. G. (2007). Computer anxiety: “Trait” or “state”? *Computers in Human Behavior*, 23(6), 2851–2862. <https://doi.org/10.1016/j.chb.2006.06.001>
7. Berner, J., Dallora, A., Palm, B., Sanmartin Berglund, J., & Anderberg, P. (2023). Five-factor model, technology enthusiasm and technology anxiety. *Digital Health*, 9. <https://doi.org/10.1177/20552076231203602>
8. Burgos-Videla, C. G., Rojas, W. a. C., Meneses, E. L., & Martínez, J. (2021). Digital Competence Analysis of university students using latent classes. *Education Sciences*, 11(8), 385. <https://doi.org/10.3390/educsci11080385>
9. Cezar, B. G. da S., & Maçada, A. C. (2023). Cognitive overload, anxiety, cognitive fatigue, avoidance behavior and data literacy in big data environments. *Information Processing & Management*, 60, 103482.

- <https://doi.org/10.1016/j.ipm.2023.103482>
10. Chawla, R. N., & Goyal, P. (2021). Emerging trends in digital transformation: a bibliometric analysis. *Benchmarking an International Journal*, 29(4), 1069–1112. <https://doi.org/10.1108/BIJ-01-2021-0009>
  11. Chen, B., Wu, Y., & Chuang, Y. (2024). The impact of teachers' perceived competence in information and communication technology usage, and workplace anxiety on well-being, as mediated by emotional exhaustion. *Frontiers in Psychology*, 15. <https://doi.org/10.3389/fpsyg.2024.1404575>
  12. Chen, C. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology*, 57(3), 359–377. <https://doi.org/10.1002/asi.20317>
  13. Chu, T., Wang, L., & Zhang, X. (2024). Digital futures: How technologies shape today's education. *Journal of Education, Humanities and Social Sciences*. <https://doi.org/10.54097/atrv0492>
  14. Chua, S. L., Chen, D. T., & Wong, A. F. (1999). Computer anxiety and its correlates: A meta-analysis. *Computers in Human Behavior*, 15(5), 609–623. [https://doi.org/10.1016/S0747-5632\(99\)00039-4](https://doi.org/10.1016/S0747-5632(99)00039-4)
  15. Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189–211. <https://doi.org/10.2307/249688>
  16. Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P. A., & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*, 3(1). <https://doi.org/10.37074/jalt.2020.3.1.7>
  17. Czaja, S. J., Charness, N., Fisk, A. D., Hertzog, C., Nair, S. N., Rogers, W. A., & Sharit, J. (2006). Factors predicting the use of technology: Findings from the center for research and education on aging and technology enhancement (create). *Psychology and Aging*, 21(2), 333–352. <https://doi.org/10.1037/0882-7974.21.2.333>
  18. Dai, C., Ke, F., Dai, Z., & Pachman, M. (2022). Improving teaching practices via virtual reality-supported simulation-based learning: Scenario design and the duration of implementation. *British Journal of Educational Technology*, 54(4), 836–856. <https://doi.org/10.1111/bjet.13296>
  19. Didmanidze, I., Tavdgiridze, L., Zaslavskiy, V., Khasaia, I., Dobordginidze, D., & Olga, Y. (2023). The impact of digital technologies in education. 2023 13th International Conference on Dependable Systems, Services and Technologies (DESSERT). <https://doi.org/10.1109/DESSERT61349.2023.10416515>
  20. Dönmez-Turan, R., & Kır, G. (2019). User anxiety as an external variable of technology acceptance model: A meta-analysis study. *Education and Information Technologies*, 24(5), 2847–2865. <https://doi.org/10.1007/s10639-019-09897-z>
  21. Eisenberg, M. B. (2008). Information Literacy: Essential skills for the Information Age. *DESIDOC Journal of Library & Information Technology*, 28(2), 39–47. <https://doi.org/10.14429/djlit.28.2.166>
  22. Ersozlu, Z., & Karakus, M. (2019). Mathematics anxiety: Mapping the literature by bibliometric analysis. *EURASIA Journal of Mathematics, Science and Technology Education*, 15(2), em1668. <https://doi.org/10.29333/EJMSTE/102441>
  23. Fernández-Batanero, J., Román-Graván, P., Reyes-Rebollo, M. M., & Montenegro-Rueda, M. (2021). Impact of educational technology on teacher stress and anxiety: A literature review. *International Journal of Environmental Research and Public Health*, 18(2), 548. <https://doi.org/10.3390/ijerph18020548>
  24. González-Ruiz, J., Granero-Gallegos, A., Marín-Marín, J. A., & Moreno-Guerrero, A. J. (2024). Bibliometric analysis of anxiety and physical education in Web of Science—A performance and co-word study. *Pediatric Reports*, 16(4), 1169–1187. <https://doi.org/10.3390/pediatric16040099>
  25. Guillén-Gámez, F. D., Ruiz-Palmero, J., & García, M. G. (2023). Digital competence of teachers in the use of ICT for research work: Development of an instrument from a PLS-SEM approach. *Education and Information Technologies*, 28(12), 16509–16529. <https://doi.org/10.1007/s10639-023-11895-2>
  26. Gündoğmuş, H. D. (2024). Digital literacy for children: An overview. *African Educational Research Journal*. <https://doi.org/10.30918/aerj.122.24.018>
  27. Hadi, H. K., Safitri, A., Wihara, D. S., Kautsar, A., Purnama, D. W., & Wicaksana, D. Y. (2024). Unveiling

- the impact of AI-mediated interactions on student outcomes in online learning: A bibliometric analysis. 2024 12th International Conference on Cyber and IT Service Management (CITSM). <https://doi.org/10.1109/CITSM64103.2024.10775794>
28. Hatlevik, O. E., Guðmundsdóttir, G. B., & Loi, M. (2014). Digital diversity among upper secondary students: A multilevel analysis of the relationship between cultural capital, self-efficacy, strategic use of information and digital competence. *Computers & Education*, 81, 345–353. <https://doi.org/10.1016/j.compedu.2014.10.019>
29. Huang, C., Yang, C., Wang, S., Wu, W., Su, J., & Liang, C. (2020). Evolution of topics in education research: A systematic review using bibliometric analysis. *Educational Review*, 72(3), 281–297. <https://doi.org/10.1080/00131911.2019.1566212>
30. Huang, R. H., Liu, D. J., Tlili, A., Yang, J. F., & Wang, H. H. (2020). Handbook on facilitating flexible learning during educational disruption: The Chinese experience in maintaining uninterrupted learning in COVID-19 outbreak. Smart Learning Institute of Beijing Normal University.
31. Igarria, M., & Parasuraman, S. (1989). A path analytic study of individual characteristics, computer anxiety, and attitudes toward microcomputers. *Journal of Management*, 15(3), 373–388. <https://doi.org/10.1177/014920638901500302>
32. Ioseliani, A., Orekhovskaya, N. A., Svintsova, M., Panov, E. G., Skvortsova, E. M., & Bayanova, A. R. (2023). Bibliometric analysis of articles on digital educational environments. *Contemporary Educational Technology*, 15(1), ep444. <https://doi.org/10.30935/cedtech/13100>
33. Iqbal, S. (2024). Information sustainability in a digital learning environment: Effects of digital anxiety, self-efficacy, and enjoyment on continuance intention. *Sustainability*, 16(1), 252. <https://doi.org/10.3390/su16010252>
34. Jamaludin, A., Kee, K. Y., & Perera, D. (2023). Demystifying digital resilience in online teaching using an adapted socio-ecological model. *Education and Information Technologies*, 28, 759–779. <https://doi.org/10.1007/s10639-022-11174-y>
35. Jiménez, C. R., Prieto, M. S., & García, S. A. (2019). Technology and higher education: A bibliometric analysis. *Education Sciences*, 9(3), 169. <https://doi.org/10.3390/educsci9030169>
36. Jiménez, C. R., Prieto, M. S., & García, S. A. (2019). Technology and higher education: A bibliometric analysis. *Education Sciences*. <https://doi.org/10.3390/educsci9030169>
37. Jing, Y., Wang, C., Chen, Y., Wang, H., Yu, T., & Shadieff, R. (2023). Bibliometric mapping techniques in educational technology research: A systematic literature review. *Education and Information Technologies*, 29, 9283–9311. <https://doi.org/10.1007/s10639-023-12178-6>
38. Juniati, D., & Wahyuni, S. (2024). Mathematics anxiety in mathematics education: A bibliometrics analysis. *Journal of Education and Learning (EduLearn)*. <https://doi.org/10.11591/edulearn.v19i1.21768>
39. Khafizova, A. A., Zhdanov, S., Beltyukova, O. V., Lapidus, N. I., Grebenschikova, L. Y., & Lushchik, I. V. (2024). A bibliometric analysis covering the relevant literature on science anxiety over two decades. *EURASIA Journal of Mathematics, Science and Technology Education*, 20(2), em2408. <https://doi.org/10.29333/ejmste/14283>
40. Khafizova, A. A., Zhdanov, S., Beltyukova, O. V., Lapidus, N. I., Grebenschikova, L. Y., & Lushchik, I. V. (2024). A bibliometric analysis covering the relevant literature on science anxiety over two decades. *Eurasia Journal of Mathematics, Science and Technology Education*. <https://doi.org/10.29333/ejmste/14283>
41. Khan, N. K., Aziz, N. M. U., Minhas, N. D. M., & Khan, N. a. I. (2025). The psychological effects of AI-Based learning on student motivation, anxiety, and cognitive load. *the Critical Review of Social Sciences Studies*, 3(1), 3527–3540. <https://doi.org/10.59075/1fvs0v71>
42. Klimova, B., & Pikhart, M. (2025). Exploring the effects of artificial intelligence on student and academic well-being in higher education: A mini-review. *Frontiers in Psychology*, 16, 1498132.

<https://doi.org/10.3389/fpsyg.2025.1498132>

43. Kohnke, L. (2024). How GenAI impacts technostress among secondary school English teachers. Proceedings of the International CALL Research Conference, 2024. <https://doi.org/10.29140/9780648184485-17>
44. Konu Kadirhanogullari, M., & Ozay Kose, E. (2023). Bibliometric analysis: Technology studies in science education. International Journal of Technology in Education and Science. <https://doi.org/10.46328/ijtes.469>
45. Kuş, M. (2025). A meta-analysis of the impact of technology related factors on students' academic performance. Frontiers in Psychology, 16, 1524645. <https://doi.org/10.3389/fpsyg.2025.1524645>
46. Li, L., & Wang, X. (2021). Technostress inhibitors and creators and their impacts on university teachers' work performance in higher education. *Cognition, Technology & Work*, 23(2), 315–330. <https://doi.org/10.1007/s10111-020-00625-0>
47. Lin, H., & Chen, Q. (2024). Artificial intelligence (AI) -integrated educational applications and college students' creativity and academic emotions: students and teachers' perceptions and attitudes. *BMC Psychology*, 12(1). <https://doi.org/10.1186/s40359-024-01979-0>
48. Man, C. S., Han, C. K., & Chan, H. Y. (2024). VR technology acceptance for English learning amongst junior high school students in Hong Kong. *Education and Information Technologies*, 29(3), 1917–1937. <https://doi.org/10.1007/s10639-023-11866-4>
49. Mattock, L. K. (2022). Raspberry Pi and rubber ducks: Digital pedagogy and computer anxiety in the LIS classroom. *Journal of Education for Library and Information Science*. <https://doi.org/10.3138/jelis-2018-0062>
50. Meyer, D. F. (2020). The accidental experiential course: Teaching a psychology of disaster course during the COVID-19 pandemic. *Scholarship of Teaching and Learning in Psychology*, 8(2), 113–118. <https://doi.org/10.1037/stl0000226>
51. Moorhouse, B. L. (2020). Adaptations to a face-to-face initial teacher education course 'forced' online due to the COVID-19 pandemic. *Journal of Education for Teaching International Research and Pedagogy*, 46(4), 609–611. <https://doi.org/10.1080/02607476.2020.1755205>
52. Moorhouse, B. L., & Wong, K. M. (2022). Blending asynchronous and synchronous digital technologies and instructional approaches to facilitate remote learning. *Journal of Computers in Education*, 9, 51–70. <https://doi.org/10.1007/s40692-021-00195-8>
53. Moorhouse, B.L., Wong, K.M. Blending asynchronous and synchronous digital technologies and instructional approaches to facilitate remote learning. *J. Comput. Educ.* 9, 51–70 (2022). <https://doi.org/10.1007/s40692-021-00195-8>
54. Murnaka, N. P., Suparta, I. N., Suryani, N. L. P. S., Widiastuti, N. W., & Purnami, I. G. A. (2021). Educational technology research trends: A bibliometrics analysis and visualization. *Turkish Journal of Computer and Mathematics Education*, 12(6), 2695–2701. <https://doi.org/10.17762/turcomat.v12i6.5770>
55. Ng, W. (2012). Can we teach digital natives digital literacy? *Computers & Education*, 59(3), 1065–1078. <https://doi.org/10.1016/j.compedu.2012.04.016>
56. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
57. Panisoara, G., Lazar, I., Panisoara, I. O., Chirca, R., & Ursu, A. S. (2020). Motivation and continuance intention towards online instruction among teachers during the COVID-19 pandemic: A large-scale survey. *Sustainability*, 12(21), 8639. <https://doi.org/10.3390/su12218639>
58. Peng, Zhang, J., Wang, M., Feng, S., Yuan, Y., & Ding, L. (2024). Research hotspots and trends of neuroimaging in social anxiety: A CiteSpace bibliometric analysis. *Frontiers in Behavioral*

- Neuroscience, 18. <https://doi.org/10.3389/fnbeh.2024.1448412>
59. Pritchard, A. (1969). Statistical bibliography or bibliometrics? *Journal of Documentation*, 25(4), 348–349. <https://doi.org/10.1108/eb026482>
60. Purcell, W. M., & Lumberras, J. (2021). Higher education and the COVID-19 pandemic: navigating disruption using the sustainable development goals. *Discover Sustainability*, 2(1). <https://doi.org/10.1007/s43621-021-00013-2>
61. Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan, B. S., & Tu, Q. (2008). The Consequences of technostress for end users in Organizations: Conceptual development and empirical validation. *Information Systems Research*, 19(4), 417–433. <https://doi.org/10.1287/isre.1070.0165>
62. Roca, J. C., Chiu, C. M., & Martínez, F. J. (2006). Understanding e-learning continuance intention: An extension of the Technology Acceptance Model. *International Journal of Human–Computer Studies*, 64(8), 683–696. <https://doi.org/10.1016/j.ijhcs.2006.01.003>
63. Rospigliosi, A. (2023). AI in higher education: A bibliometric approach to understanding anxiety, acceptance, and adaptation. *Education and Information Technologies*, 28, 873–889. <https://doi.org/10.1007/s10639-022-11276-2>
64. Saboor, A., Ali, K., Mugheri, A., & Fatima, M. (2024). The impact of digital transformation on educational leadership: Assessing digital burnout and mental health in virtual teaching. *Review of Applied Management and Social Sciences*. <https://doi.org/10.47067/ramss.v7i4.388>
65. Sagarduy, A., Arrieta, N., & Antón, A. (2024). A bibliometric study on mathematics anxiety in primary education. *Education Sciences*. <https://doi.org/10.3390/educsci14070678>
66. Selwyn, N. (2016). *Is technology good for education*.
67. Selwyn, N., & Gašević, D. (2020). The datafication of higher education: discussing the promises and problems. *Teaching in Higher Education*, 25(4), 527–540. <https://doi.org/10.1080/13562517.2019.1689388>
68. Serrano-Ausejo, E. (2025). Exploring Teachers' Views on Using Immersive Virtual Reality for teaching history. *Digital Education Review*, 47, 109–126. <https://doi.org/10.1344/der.2025.47.108-126>
69. Sharma, S., & Kumar, S. (2025). Understanding the facets of work-related fatigue moderated by cognitive, behavioural and contemplative coping strategies: A conceptual analysis. *NMIMS Management Review*. <https://doi.org/10.1177/09711023241310292>
70. Siddiq, F., Gochyyev, P., & Wilson, M. (2016). Learning in digital networks – ICT literacy: A novel assessment of students' 21st century skills. *Computers & Education*, 109, 11–37. <https://doi.org/10.1016/j.compedu.2017.01.014>
71. Slama, C., & Wilson, R. (2025). Impact of educational technology on student well-being: An Australian perspective. *Journal Emerging Technologies in Education*. <https://doi.org/10.70177/jete.v3i1.2109>
72. Stan, S., Mănescu, G., Grigoraş, C., & Ilie, F. (2024). The digitalisation impact on education level: A bibliometric analysis. *International Conference KNOWLEDGE-BASED ORGANIZATION*, 30(1), 1–11. <https://doi.org/10.2478/kbo-2024-0040>
73. Strotmann, A., & Zhao, D. (2012). Author name disambiguation: What difference does it make in author-based citation analysis? *Journal of the American Society for Information Science and Technology*, 63(9), 1820–1833. <https://doi.org/10.1002/asi.22695>
74. Stumbrienė, D., Jevsikova, T., & Kontvainė, V. (2023). Key factors influencing teachers' motivation to transfer technology-enabled educational innovation. *Education and Information Technologies*, 29(2), 1697–1731. <https://doi.org/10.1007/s10639-023-11891-6>
75. Sun, P., Tsai, R. J., Finger, G., Chen, Y., & Yeh, D. (2007). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, 50(4), 1183–1202. <https://doi.org/10.1016/j.compedu.2006.11.007>
76. Tarafdar, M., Pullins, E. B., & Ragu-Nathan, T. S. (2015). Technostress: Negative effect on performance and possible mitigations. *Information Systems Journal*, 25(2), 103–132. <https://doi.org/10.1111/isj.12042>

77. Teo, T., Sang, G., Mei, B., & Hoi, C. K. W. (2019). Investigating pre-service teachers' acceptance of Web 2.0 technologies in their future teaching: A Chinese perspective. *Interactive Learning Environments*, 27(4), 530–546. <https://doi.org/10.1080/10494820.2018.1489290>
78. Teo, T., Zhou, M., Fan, A. C. W., & Huang, F. (2019). Factors that influence university students' intention to use Moodle: a study in Macau. *Educational Technology Research and Development*, 67(3), 749–766. <https://doi.org/10.1007/s11423-019-09650-x>
79. Uddin, M. J., Ferdous, M., Rahaman, A., & Ahmad, S. (2023). Mapping of technostress research trends: A bibliometric analysis. In *Proceedings of the 2023 7th International Conference on Intelligent Computing and Control Systems (ICICCS)* (pp. 938–943). IEEE. <https://doi.org/10.1109/ICICCS56967.2023.10142487>
80. Urbán, D. J. A., La Greca, A., García-Fernández, J., & Inglés, C. J. (2023). A bibliometric analysis on adolescent social anxiety and psychoeducational variables in Web of Science 2002–2021. *The Journal of General Psychology*, 151(1), 1–20. <https://doi.org/10.1080/00221309.2022.2161982>
81. Valero-Anco, V. N., Gutierrez, F. S., Lujano-Ortega, Y., & Calderón-Quino, K. M. (2025). Global Trends in gender inequality in Higher Education: A Bibliometric Analysis (1993–2024). *Educational Process International Journal*, 14. <https://doi.org/10.22521/edupij.2025.14.19>
82. Van Eck, N. J., & Waltman, L. (2019). Accuracy of citation data in Web of Science and Scopus. *ISSI*, 1087–1092. <https://dblp.uni-trier.de/db/journals/corr/corr1906.html#abs-1906-07011>
83. Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, 39(2), 273–315. <https://doi.org/10.1111/j.1540-5915.2008.00192.x>
84. Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, 46(2), 186–204. <https://doi.org/10.1287/mnsc.46.2.186.11926>
85. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478. <https://doi.org/10.2307/30036540>
86. Wang, G. X., Deng, J., & Ali, S. (2025). Evaluating the impact of AI-powered audiovisual personalization on learner emotion, focus, and learning outcomes. *arXiv Preprint*. <https://arxiv.org/abs/2505.03033>
87. Wang, G. X., Deng, J., & Ali, S. (2025). Evaluating the impact of AI-powered audiovisual personalization on learner emotion, focus, and learning outcomes. *arXiv Preprint*. <https://arxiv.org/abs/2505.03033>
88. Wedlock, D., & Trahan, E. (2019). Revisiting the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a theoretical framework for virtual reality adoption in education. *Technology, Knowledge and Learning*, 24(3), 389–409. <https://doi.org/10.1007/s10758-019-09401-z>
89. Weil, M. M., & Rosen, L. D. (1997). *TechnoStress: Coping with technology @Work @Home @Play*. Wiley. <https://ci.nii.ac.jp/ncid/BA57059459>
90. Wolfe, A. D., & Hartman, S. L. (2024). Remote teaching and learning for teacher candidates: Mentor teacher perspectives. *PDS Partners: Bridging Research to Practice*, 19(2), 96–107. <https://doi.org/10.1108/pdsp-12-2023-0041>
91. Yu, Z. (2021). The effects of gender, educational level, and personality on online learning outcomes during the COVID-19 pandemic. *International Journal of Educational Technology in Higher Education*, 18(1). <https://doi.org/10.1186/s41239-021-00252-3>
92. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, 16, Article 39. <https://doi.org/10.1186/s41239-019-0171-0>
93. Zhang, Q., Nie, H., Fan, J., & Liu, H. (2025). Exploring the dynamics of artificial intelligence literacy on English as a foreign language Learners' willingness to communicate: The critical mediating roles of

Artificial intelligence Learning Self-Efficacy and Classroom anxiety. *Behavioral Sciences*, 15(4), 523.

<https://doi.org/10.3390/bs15040523>

94. Zhang, X., Xie, Q., Song, C., & Song, M. (2022). Mining the evolutionary process of knowledge through multiple relationships between keywords. *Scientometrics*, 127(4), 2023–2053.

<https://doi.org/10.1007/s11192-022-04272-2>

95. Zhou, L., Li, F., Wu, S., & Zhou, M. (2022). “School’s out, but class’s on”, the largest online education in the world today: Taking China’s practical exploration during the COVID-19 epidemic prevention and control as an example. *Best Evidence of Chinese Education*, 4(2), 501–519.

<https://doi.org/10.15354/bece.20.ar023>