

# A 20-year evolution study of digital music communication (2004-2024): Knowledge mapping and bibliometric analysis based on SCI/SSCI/A&HCI

## *Dijital müzik iletişiminin 20 yıllık evrimi (2004-2024): SCI/SSCI/A&HCI temelli bilgi haritası ve bibliyometrik analiz*

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### ABSTRACT

Artificial intelligence has exerted a profound impact on the music industry, with digital music communication emerging as its representative core topic. To fill the research gap in comprehensive bibliometric reviews of this field, this study searched for SCI/SSCI/A&HCI-indexed articles on the theme of "digital music communication" from early 2004 to late 2024, screened literature following PRISMA standards, and finally obtained 173 sample articles. Using bibliometric tools VOSviewer and CiteSpace, this study conducted a comprehensive knowledge mapping analysis based on publication quantity, journal distribution, core authors, and hot topics. The visualized bibliometric analysis and review results aim to provide references for researchers and practitioners in related fields. The results show that research in this field has entered a mature stage, with fluctuating growth in the number of publications. The United States, the United Kingdom, and Australia are the main research forces, but a stable author collaboration network and journal system have not yet been formed. Research hotspots focus on three clusters: the sociocultural impact of digital music technology, educational applications of digital media, and information communication literacy. The development context has gone through a three-stage evolution from basic exploration of information literacy to technical education applications, and then to multi-field integration of socioculture.

**Keywords:** digital music, music communication, bibliometrics, art and culture, public service

### ÖZ

Yapay zekâ, müzik endüstrisi üzerinde derin bir etki yaratmış ve dijital müzik iletişimi, bu dönüşümün en merkezi araştırma alanlarından biri hâline gelmiştir. Bu alandaki kapsamlı bibliyometrik inceleme eksikliğini gidermek amacıyla yürütülen bu çalışma, 2004 yılı başından 2024 yılı sonuna kadar SCI/SSCI/A&HCI dizinlerinde taranan "dijital müzik iletişimi" temalı makaleleri incelemiş; PRISMA standartlarına uygun bir eleme sürecinin ardından 173 akademik yayın belirlemiştir. VOSviewer ve CiteSpace araçları kullanılarak yayın sayısı, dergi dağılımı, temel yazarlar ve araştırma eğilimleri üzerinden kapsamlı bir bilgi haritalaması gerçekleştirilmiştir. Elde edilen görselleştirilmiş bibliyometrik sonuçlar, ilgili alanlardaki araştırmacı ve uygulayıcılara referans sağlamayı amaçlamaktadır. Bulgular, bu araştırma alanının olgunluk aşamasına girdiğini ve yayın sayısının dalgalı bir artış eğrisi izlediğini göstermektedir. Amerika Birleşik Devletleri, Birleşik Krallık ve Avustralya başlıca araştırma merkezleri olmakla birlikte, henüz istikrarlı bir yazar işbirliği ağı ve oturmuş bir dergi sistemi oluşmamıştır. Araştırma odakları üç temel kümede yoğunlaşmaktadır: dijital müzik teknolojisinin sosyokültürel etkileri, dijital medya temelli eğitim uygulamaları ve bilgi-iletişim okuryazarlığı. Alanın gelişim süreci ise temel bilgi okuryazarlığı araştırmalarından, teknoloji destekli eğitim uygulamalarına ve son olarak sosyo-kültürel çok alanlı entegrasyona uzanan üç aşamalı bir evrim göstermektedir.

**Anahtar kelimeler:** dijital müzik, müzik iletişimi, bibliyometri, sanat ve kültür, kamusal hizmet

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Telif hakkı © 2026 Yazar(lar). Açık erişimli bu makale, orijinal çalışmaya uygun şekilde atıfta bulunulması koşuluyla, herhangi bir ortamda veya formatta sınırsız kullanım, dağıtım ve çoğaltmaya izin veren Creative Commons Attribution License (CC BY) altında dağıtılmıştır.

## 1. INTRODUCTION

Against the backdrop of rapid information technology iteration, digital music communication has emerged as a key indicator of epochal progress, profoundly reshaping the landscape of the music industry (Yang & Lee, 2024). Meanwhile, leveraging cutting-edge technologies such as cloud computing and big data, national public cultural service systems have achieved leapfrog development under digital empowerment. Particularly in the deep mining and innovative application of cultural data, artificial intelligence technology has comprehensively enhanced the effectiveness of cultural services (Yang, Huang et al., 2024). In the emerging field of digital music communication, frontier topics such as AI-driven music creation integration, VR-empowered music visualization, digital transformation of traditional sheet music, and value reconstruction of the music industry chain have increasingly become research hotspots for both academia and industry (Yang, Shen et al., 2024).

Against the backdrop of deepening research in digital music communication, studies using statistical methods for literature reviews remain scarce, and systematic evaluation literature in this field is insufficient (Darvish & Bick, 2024). This study intends to adopt bibliometric and knowledge mapping techniques to carry out quantitative analysis and qualitative evaluation of the research status, frontier dynamics, and development trends in the field of digital music communication. Based on the 5W1H framework proposed by American political scientist Harold Dwight Lasswell (1902-1977) in 1932, the research questions are organized as follows:

1. When: What is the temporal distribution of publication and citation counts?
2. Who: Who are the core authors?
3. Where: What is the national distribution of research organizations?
4. Why: Is it caused by the division and classification of journals?
5. What: What are the clustered themes of frontier hotspots?
6. How: How has the research context evolved?

## 2. LITERATURE REVIEW

### 2.1. Digital Music Communication

The theme of digital music communication originated in the 20th century. From the 1960s to the 1980s, the rise of personal computers and the music industry facilitated the production and dissemination of digital music content. In 1961, Max Mathews (1926-2011) successfully demonstrated *The Silver Scale*, the world's first computer-generated music, marking the beginning of digital music (Brown, 1995). In the early 21st century, with the popularization of the Internet and the rise of mobile applications, digital music communication became increasingly diversified, driving the development of a mature music industry. In the Chicago School, which emphasizes communication research paradigms, a series of international lecture tours by scholars such as John Dewey (1859-1952) and Robert Ezra Park (1864-1944) laid the foundation for the global development of communication studies (Cross, 2023).

In the field of digital music communication, a series of policies have also promoted the digital transformation of cultural industries, especially in the field of digital music. In terms of market scale, the total size of China's digital music market reached approximately 190.75 billion yuan last year, of which the online music market scale reached 23.98 billion yuan, a year-on-year increase of 33.1%, indicating the rapid growth momentum of the digital music market in China (Tang & Lyons, 2016). Globally, the market size is even more enormous. The digital music industry is actively exploring innovative integration of music and modern technology: music streaming platforms are becoming increasingly mature, paid subscription models have become one of the main music consumption patterns, and new formats such as music live broadcasting and music social networking are gradually growing. Overall, the digital music communication industry has seen continuous expansion of market scale and integrated development of diversified formats, demonstrating strong development momentum and broad prospects.

## 2.2. Bibliometrics

Bibliometrics is a discipline that studies and applies methods and principles related to the quantity, quality, and citation of literature. The three laws in bibliometrics—Price's Law, Lotka's Law, and Bradford's Law—provide theoretical foundations for bibliometric research, helping scholars understand and predict the distribution of scientific literature, patterns of scientific activities, and the development dynamics of scientific knowledge. Breakthrough development can be traced back to the 1960s when Eugene Garfield (1925-2017) founded the basis of modern bibliometrics in 1955, including innovative concepts such as the Science Citation Index (SCI) and Impact Factor (IF). This broke the monopoly of classification and subject indexing methods in retrieval, opened a new field for studying literature and scientific development from the perspective of citations, and exerted a profound influence on global scientific research (Garfield, 1955).

The bibliometric method is a common quantitative research approach in literature analysis, characterized by focusing quantitative analysis on detailed information such as authors, keywords, affiliated journals, and references. Its core lies in conducting database literature searches for the research field, organizing clear visual analysis results, and using them as supplementary explanations for literature review analysis (Mayr & Scharnhorst, 2015). Therefore, when describing the development dynamics and research progress of a discipline or research field, bibliometrics has the advantage of clear and intuitive visualization through charts. Bibliometric analysis attaches great importance to co-citation relationships, i.e., the relationship where two articles are cited by one or more articles simultaneously (Diem & Wolter, 2013). Visualized co-citation analysis facilitates data interpretation, enhances the comprehensiveness of results, and helps excavate internal connections such as clustering and coupling of information—for example, identical research themes by different authors, different research hotspots of the same theme, or distribution of different research institutions for the same hotspot.

## 2.3. Research Tools

Professional software tools are required for visual mapping. VOSviewer and CiteSpace are two primary visualization tools in bibliometric research, both capable of importing data from databases such as Web of Science (WOS), Scopus, and Google Scholar to directly generate visual maps (Shen & Yang, 2025). The two software tools complement each other in this study to visualize information on authors, keywords, and co-citation relationships in the literature.

Developed by Nees Jan van Eck and Ludo Waltman from the Centre for Science and Technology Studies (CWTS) at Leiden University in the Netherlands in 2009, VOSviewer facilitates the sorting of relationships and research hotspots among literatures, mainly used for visual analysis of literature co-citation networks (van Eck & Waltman, 2009). CiteSpace, an information visualization software developed by Chaomei Chen at Drexel University in the United States in 2006 has strong advantages in thematic evolution analysis and author collaboration network analysis, enabling better display of relationships among literatures. It is mainly used for visual mapping of the development process and research trends of literatures (Chen, 2006).

There are certain errors in directly conducting visual bibliometric analysis of retrieved data, requiring further precise screening of retrieved data. The uneven quality of literatures can lead to inaccurate data processing by software, such as keyword extraction and co-citation analysis. Based on this, this study refers to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 statement to standardize the literature screening process and gradually lock in valid literatures. PRISMA is an authoritative reporting standard for systematic literature reviews. The latest 2020 statement includes detailed instructions for a 27-item checklist and reporting suggestions for each step (Moher et al., 2009), especially providing a standard process for literature screening in databases, which can clearly present inclusion and exclusion criteria for literatures.

In summary, it is feasible to depict the research landscape of digital music communication through bibliometrics. This study uses databases to search for high-quality core literatures in the field of digital music communication since the 21st century, screens literature data with reference to PRISMA standards, relies on VOSviewer and CiteSpace for comprehensive sorting of quantitative information on authors, journals, and national institutions in this field, focuses on bibliometric analysis of high-frequency keywords and highly cited literatures, and presents the development status, hot frontiers, and evolutionary path of this field in combination with visual maps.

3. METHOD

3.1. Research Tools

This study finally selects the Web of Science (WOS) Core Collection as the authoritative data source. As an important data platform for high-quality global academic information, the WOS database has been widely accepted by researchers and is considered the most suitable database for bibliometric analysis (Wijewickrema, 2022), ensuring the accuracy and reliability of research results. The WOS database not only covers a wide range of disciplines but also contains high-quality academic resources, making it a universally recognized authoritative database in academia. The selection of this database not only provides sufficient literature support but also enhances the persuasiveness and credibility of this study.

Authoritative databases ensure the acquisition of high-quality, comprehensive, and professional literature. WOS ensures the screening of the most core and highest-quality literature, specifically selecting the Science Citation Index Expanded (SCI-E), Social Science Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI) for data collection. The retrieval combination of core journals using authoritative databases provides the greatest guarantee for the comprehensiveness and accuracy of retrieved data.

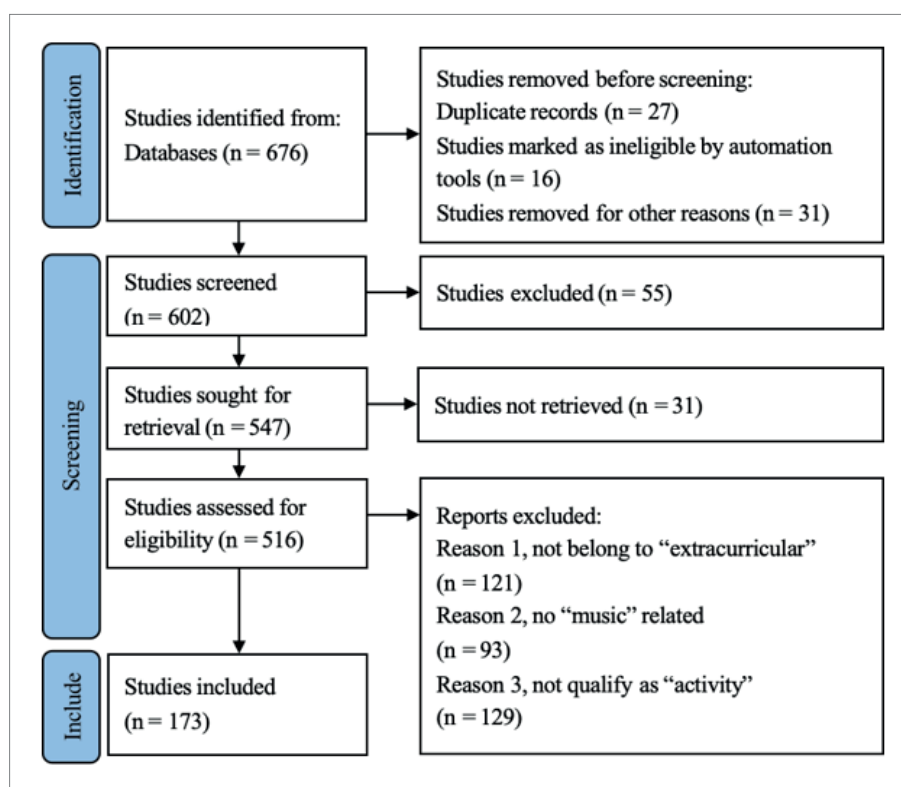
3.2. Retrieval and Inclusion Criteria

Referencing representative bibliometric studies in music and communication research (Mayr & Scharnhorst, 2015), the search formula was designed to fully cover the core connotation of "digital music communication" while ensuring the accuracy and relevance of retrieved literature. Taking "digital", "music", and "communication" as the core keywords, which cover the three core dimensions of the research topic (technical carrier, research object, and disciplinary core), we retrieved valid articles matching the theme from the WOS core database. The detailed final search formula is: TS=(Digital AND music AND communication). We further conducted a sensitivity analysis of alternative keyword combinations (e.g., "music dissemination", "digital media music", "music communication in digital age") to verify that this core formula can fully include the mainstream literature in the field, while avoiding excessive inclusion of irrelevant studies.

This study defines "document type", "retrieval time", and "retrieval language" as the core inclusion and exclusion criteria, consistent with the standardized bibliometric research paradigm. Consistent with the research scope of the 20-year evolution of digital music communication, the retrieval timeframe is set from January 1, 2004, to December 31, 2024, to align with the full development cycle of the field. Document types are limited to peer-reviewed Articles, Review Articles, and Conference Articles, with language restricted to English to ensure the academic quality of the sample. A total of 676 initial articles were retrieved from the WOS core database, with specific retrieval details shown in Table 1.

Table 1  
Summary of inclusion criteria

| Category           | Specific Standard Requirements                           |
|--------------------|----------------------------------------------------------|
| Research database  | Web of Science core collection                           |
| Citation indexes   | SCIE, SSCI, A&HCI                                        |
| Searching keywords | "digital" AND "music" AND "communication"                |
| Searching period   | 2000-01-01 to 2024-12-31                                 |
| Language           | "English"                                                |
| Document types     | "Articles" or "Review Articles" or "Conference Articles" |
| Data extraction    | Full Records and Cited References in Plain Text File     |
| Sample size        | 676                                                      |

**Figure 1***PRISMA screening flow*

### 3.3. Screening Process

Accurate and valid literature data are essential to support literature analysis, so data cleaning is performed following PRISMA standards. This process screens out duplicate literature and those inconsistent with the theme from the database, effectively avoiding analysis errors caused by data quality issues. Automated screening via software is first used to exclude duplicate, retracted, and invalid irrelevant articles. Each author then independently checks titles and abstracts to roughly filter out low-relevance literature. Multiple authors collaboratively conduct precise screening of high-quality literature through a "three-element" approach. This "three-stage" data cleaning process gradually narrows down from broad to precise, ultimately yielding 173 valid papers, as illustrated in Figure 1.

## 4. RESULTS

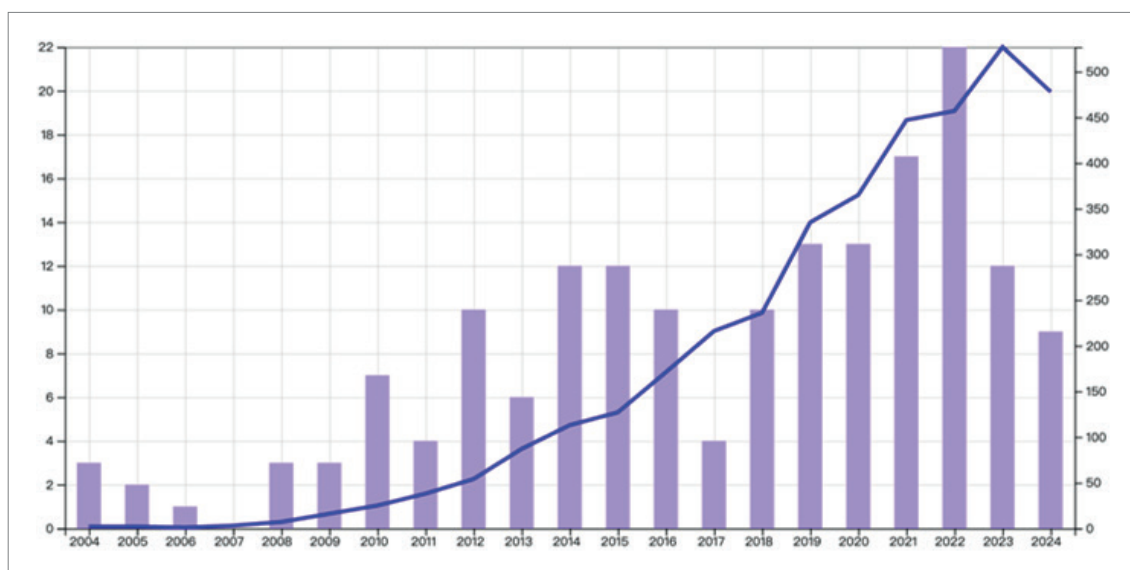
### 4.1. When: Temporal Distribution

The annual distribution of publication counts indirectly reflects the research level and developmental stage of a discipline. Figure 2 presents the publication trends in this field, with data spanning from 2004 to 2024. The graph shows that scholarly attention gradually emerged between 2004 and 2007, followed by a complete development cycle from 2008 to 2016, and a marked stable growth trend from 2017 to the present. This indicates that publication dynamics in the early 21st century exhibited fluctuating development, and the field of digital music communication has transitioned from an embryonic stage to a mature phase.



**Figure 2**

*Time statistics of publication volume and citation frequency*



## 4.2. Who: Core Authors

In-depth analysis of literature authors helps identify representative scholars and the primary research landscape of this field. Price's Law, proposed by Derek John de Solla Price (1922–1983), an American scientist and founder of scientometrics, in 1963, describes the distribution pattern of core author groups (Huang et al., 2020). Among all authors, those who have published on the same theme constitute more than half of the total, and the size of this group approximates the square root of the total number of authors, i.e.:

$$\sum_{m+1}^I n(x) = \sqrt{N} \quad (1)$$

Lotka's Law simplifies the threshold solution. Proposed by Alfred J. Lotka (1880-1949) in 1926, Lotka's Law describes the regularity of scientists' publication quantity (Huang et al., 2020). In the formula,  $n(x)$  represents the cumulative number of authors who have published  $x$  papers, totaling 458 authors.  $I$  is the number of papers by the most productive author, while  $N$  is the total number of papers on the theme ( $n_{\max}$ ), which is 105. The initial value of the cumulative summation  $m+1$  is such that  $m=0.749 \times \sqrt{n_{\max}} \approx 1$ . In this field, core authors are defined as those who have published more than 2 papers, totaling 15 individuals. The total number of papers by core authors is 32, accounting for 30% of the total publications, which is less than half. This indicates that a relatively stable author collaboration network has not yet been established in the field of digital music communication.

Further analysis of the academic contributions and research directions of core authors reveals that Vittorio Ghini and Paolo Salomoni are the most representative scholars in the field of digital music communication. Each of these two authors has published 3 relevant papers, with a total of 27 citations and an average of 9 citations per article, indicating that their research achievements have high recognition in the academic community. Content analysis shows that the research of these two scholars focuses on the development prediction and technological change of digital music. Specifically, Ghini's research explores how digital music technologies evolve in sociocultural contexts and their impacts on music creation and communication, which directly corresponds to the core theme of Cluster 1 identified in this study. Salomoni focuses on the role of technological innovation in driving the digital music industry, such as how artificial intelligence affects music production and consumption models, which is a key frontier direction of the current field.

Compared with the bibliometric characteristics of mature music research fields (e.g., music education, ethnomusicology), the core author group of digital music communication research has not yet formed a stable collaborative network. The total publication volume of core authors only accounts for 30% of the total sample, which is far lower than the 50% threshold defined by Price's Law. This phenomenon is mainly caused by three factors: first, the interdisciplinary attribute of digital music communication leads to scattered research communities across musicology, communication studies and computer science; second, the field

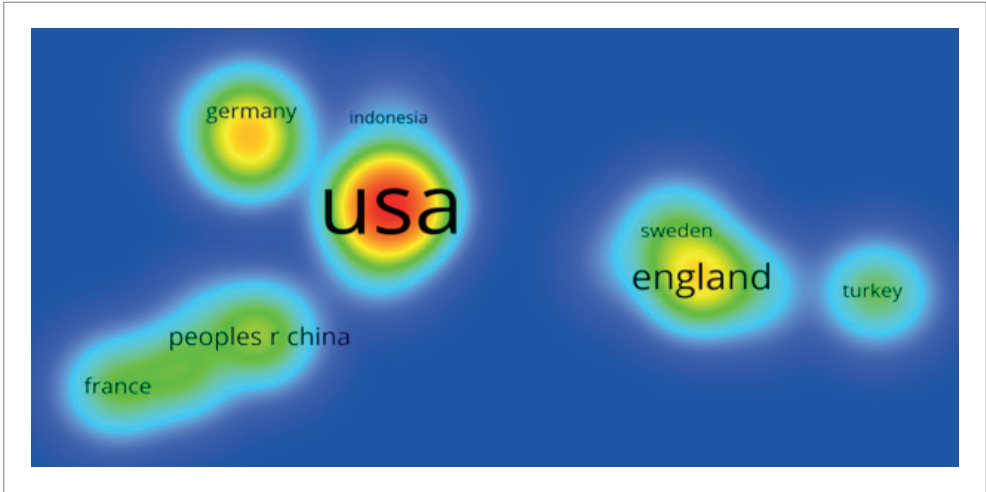
is still in the developing stage, with a short development cycle and insufficient accumulation of continuous research teams; third, the rapid iteration of digital music technology leads to scattered research hotspots, making it difficult for scholars to form long-term stable research directions. These findings further reveal the current development status and academic ecological characteristics of the field.

4.3. Where: National Distribution

Analyzing the regional affiliations of authors further reveals the research landscape of this field. This study quantified publication counts by country for 40 nations to assess the contributions of different countries. Price’s Law can be used not only to analyze core authors but also to determine the publication threshold for high-productive countries (Ma & Wang, 2025). To identify countries making the most significant contributions to digital music communication research, this study used VOSviewer to count the most productive countries, finding the number of publications to be 75. Substituting into the previously mentioned formula, the minimum publication count for high-productive countries was calculated as:  $m \approx 6$ . Therefore, countries with  $\geq 6$  publications were defined as high-productive countries in this field. The heat map in Figure 3 illustrates the intensity of national scientific contributions. Notably, the distribution of publishing countries in this field is uneven, with a significant top-heavy effect—most papers are authored by scholars from a few countries such as the United States, the United Kingdom, Australia, and China.

Figure 3

Country contribution heat map



Analyzing the publication data of top countries further measures the quality of papers from different nations. Table 2 presents the top 5 countries in terms of publication quantity in this field. As shown, American scholars contributed the most research papers (75) in this field, with 2,153 citations and an average of 28.70 citations per article, demonstrating high productivity. The United Kingdom ranks second with 22 publications, 586 citations, and an average of 26.64 citations per article, also belonging to high-quality and high-productivity countries. Andalusia has the highest average citations per article, with 20 papers receiving 872 citations and an average of 43.60 citations per article. Overall, the United States has a high publication quantity, Australia has high publication quality, and the top five countries are all representatives of high-quality and high-productivity nations.

Table 2

Top 5 Countries in the Research Field

| No. | Author         | Documents | Citations | Average Citation/Publication |
|-----|----------------|-----------|-----------|------------------------------|
| 1   | United States  | 75        | 2153      | 28.70                        |
| 2   | United Kingdom | 22        | 586       | 26.64                        |
| 3   | Australia      | 20        | 872       | 43.60                        |
| 4   | China          | 10        | 100       | 10.00                        |

|   |       |   |    |       |
|---|-------|---|----|-------|
| 5 | Spain | 8 | 81 | 10.13 |
|---|-------|---|----|-------|

4.4. Why: Journal Zoning

Analyzing the distribution of literature helps to understand the hotspots, trends, and deficiencies in the research field, providing valuable references and guidance for researchers. Bradford’s Law, proposed by British bibliographer S.C. Bradford (1878-1948) in 1934, describes the distribution law of scientific papers in journals. When journals are sorted by the number of papers published in a specific field from high to low, a core region and several subsequent regions can be divided, with the number of papers in each region being roughly equal (Ma & Wang, 2025). This distribution pattern results in a ratio of 1:a:a²:... between the number of core journals and those in subsequent regions. In the data of this study, 109 journals did not meet the geometric progression (as shown in Table 3), indicating that the research on digital music communication has not formed a stable journal structure and needs further maturation.

Table 3  
Number of core regional journals

| Area     | Publications/Journals | Journals | Publications |
|----------|-----------------------|----------|--------------|
| 1st Zoom | ≥3                    | 8        | 22           |
| 2nd Zoom | 2                     | 20       | 30           |
| 3rd Zoom | 1                     | 81       | 121          |

Over the past two decades, most journals publishing papers in this field have belonged to the education and communication sectors, except for a few comprehensive journals. Figure 4 displays the research directions of the top 20 journals in terms of publication quantity. Among them, “Educational Research” has the highest number of publications, with 44 articles. Analysis of journal citation data shows that the *International Journal of Music Education* has the highest citation count: although it has only published 3 articles, these have been cited 184 times, indicating that the journal’s publications are of high quality and have attracted significant attention in the field of digital music communication. A comprehensive analysis of the published literature reveals that research in all journals primarily relies on empirical methods and demonstrates distinct interdisciplinary characteristics.

Figure 4  
Top 20 most popular journal topic distribution



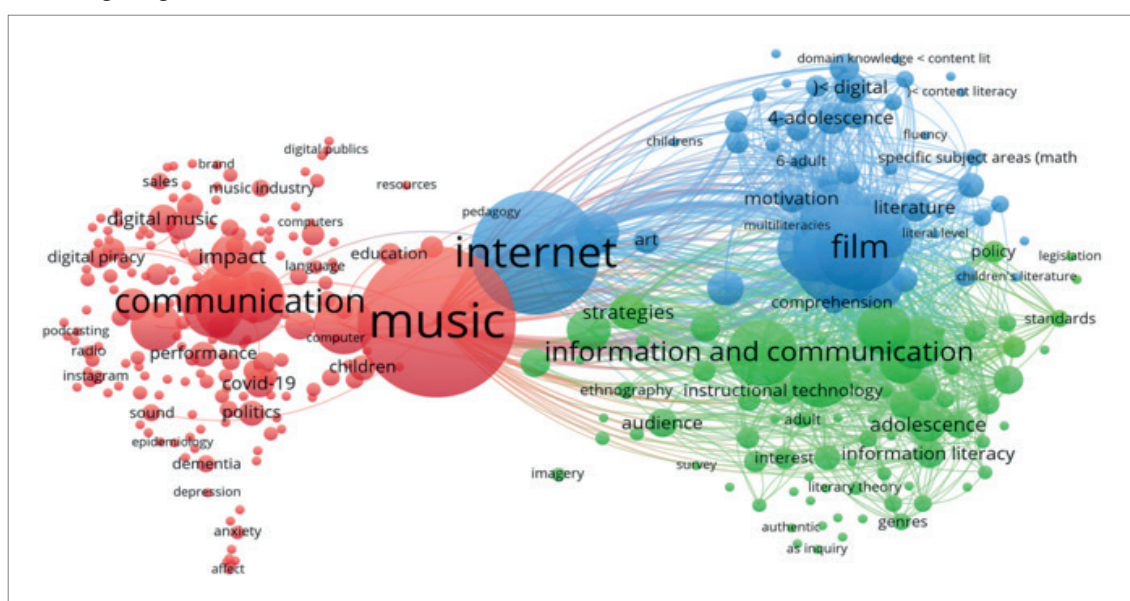


#### 4.5. What: Clustering Themes

Extracting keywords reveals the research core, while co-occurrence analysis of keywords reflects the macro-background of the research field and refines its hotspots (Sweileh, 2020). This analysis focuses on cluster analysis of high-frequency keywords. After conducting CiteSpace analysis on 173 literatures, 1,349 high-frequency keywords were obtained, and a visual co-occurrence network was drawn using VOSviewer, as shown in Figure 5. The high-frequency keyword co-occurrence network in this field consists of 82 nodes (high-frequency keywords) divided into 3 clusters (keyword clusters). In the figure, the size of circular nodes represents the occurrence frequency of keywords, thereby reflecting the hotness of the field represented by the keyword—thus, the hottest topics center on music and internet. The connecting lines between nodes represent association strength, with strong correlations exemplified by links between internet and film, as well as music and communication. Dense nodes such as digital, distribution, social, and networking represent research themes, while node colors indicate different research theme clusters. The research is clearly divided into three major clusters.

**Figure 5**

*Hot topic clustering diagram*



Through content analysis of high-frequency keyword clusters, mainstream research hotspots were further identified. As sorted by frequency in Table 4, the three keyword clusters align with three independent yet intersecting research themes: music in the digital context, information communication & literacy, and multi-dimensional exploration of media & education. The clusters are analyzed as follows:

1. Digital Music and Its Sociocultural Impact (Cluster 1): Research focuses on music, digital technologies, and their extensive effects on social, cultural, educational, and psychological dimensions. This category analyzes digital music's functions in technological innovation and social transformation, covering industry evolution, public behavior, educational reform, and psychological adaptation. Technologically and industrially, digital music's innovation is reconstructing communication channels, marketing strategies, and performance forms. In education and communication, digital teaching platforms, audio programs, and broadcasting media play key roles in music promotion and knowledge dissemination. From a social-psychological perspective, factors like the COVID-19 pandemic, depressive symptoms, and anxiety have significantly altered music demand patterns and usage habits.
2. Digital Media and Educational Research (Cluster 2): This cluster explores media forms, teaching strategies, and their relationships with individual identity construction and popular culture in digital environments. It examines new media's functions and values in cultural communication, educational practice, and personality development. From the perspective of media and self-identity, it analyzes how online platforms, films, and digital art influence identity formation across life stages (e.g., childhood, adolescence). Regarding teaching methods and media forms, research investigates optimizing educational effectiveness through digital documentaries, specific media formats, and literary texts,

focusing on applications by higher education practitioners and learners. In terms of learning motivation and growth, it delves into learners' internal drivers and engagement, committing to developing innovative educational models.

3. Information Communication and Cultural Literacy (Cluster 3): Research prioritizes information communication mechanisms and public cognitive ability enhancement, particularly through education to strengthen information interpretation and critical thinking. It examines information transmission paths and audience filtering/interpretation methods in communication and reception. For cognitive skill cultivation, it explores teaching models and theoretical frameworks to improve information processing, content comprehension, and visual interpretation. Using multi-methods like qualitative research and ethnography, it analyzes sociocultural elements in information dissemination from research paradigm and cultural dimensions.

Overall, the three keyword clusters reflect the integration of technology and culture, encompassing the complex relationships among music, information communication & literacy, and media & education in the digital context. The research themes complement each other, revealing both independent characteristics and cross-disciplinary interconnections.

#### 4.6. How: Evolutionary Path

The formation of research themes demonstrates distinct time-zone distributions across developmental stages. Keyword evolution analysis, as visualized in the time-zone map of Figure 6, shows the background color in the upper-left corner denotes the year, keyword colors correspond to specific years, and connecting lines represent co-occurrence relationships. The timeline identifies three distinct developmental phases, which precisely align with the three thematic clusters analyzed earlier.

Interpreting developmental stages corresponding to research themes through the time-zone map. Based on the distribution of high-frequency keywords across years, the field can be divided into three phases: initial stage, transition stage, and mature stage. The thematic cluster 3 (information communication and cultural literacy) served as the foundational basis of the initial stage, with humanistic inquiries into communication, reception, and literacy—predominantly through qualitative research—forming the cornerstone of research development. Subsequently, research evolved toward technological directions, with contents gradually focusing on thematic cluster 2 (digital media and educational research), deepening explorations into technical applications such as media, literacy, and educational strategies to meet hard demands. In recent years, research hotspots have transitioned to thematic cluster 1 (digital music and its sociocultural impact), expanding into detailed investigations of social changes in multiple fields including industrial development, public behavior, and mental health. The three-stage division is as follows:

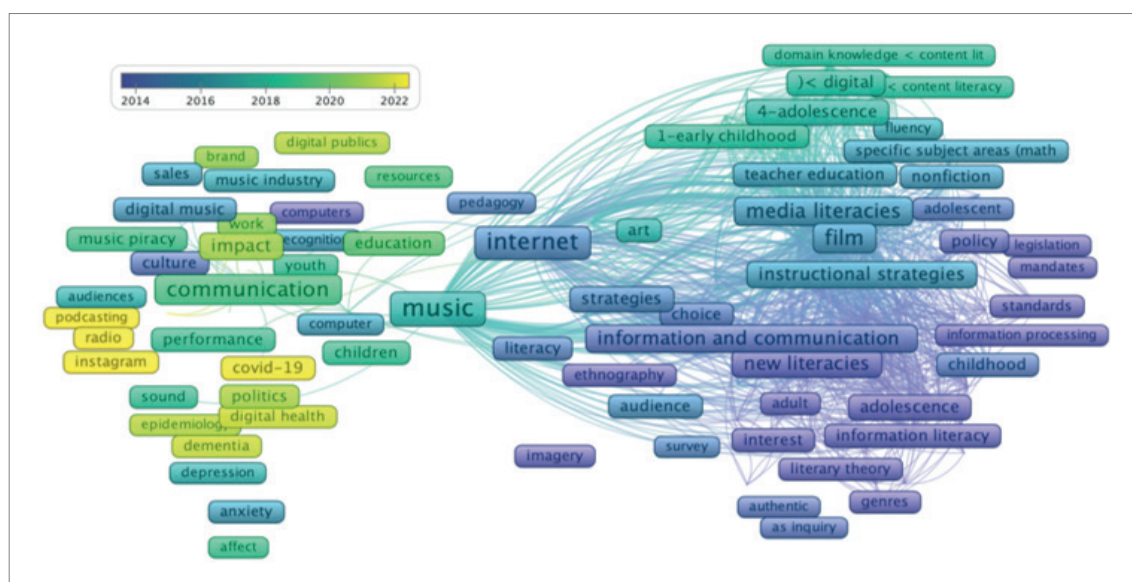
1. Initial Stage (2004–2014): As a new frontier of information communication and cultural literacy, digital music was reshaping how the public understood and engaged with musical culture. A 2003 study by Carisma Dreyer and Charl Nel demonstrated that technology enhanced the ability to read and understand music and related cultural content, which was crucial for comprehensive appreciation of digital music (Dreyer & Nel, 2003). In 2004, Sonia Livingstone emphasized that media literacy in the digital age extended beyond technical operation, involving in-depth analysis and critical evaluation of music and its cultural contexts (Livingstone, 2004). Beth E. Haverkamp's 2005 research proposed that while enjoying the convenience of digital music, it was essential to address ethical issues, respecting the cultural value of music and creators' rights (Haverkamp, 2005). These studies collectively highlighted the importance of cultivating information communication and cultural literacy in digital music communication, as well as the necessity of maintaining ethical standards and cultural diversity alongside musical enjoyment.
2. Transition Stage (2014–2016): The field of digital media and educational research deepened explorations into the application of social media and digital storytelling in music education, as well as their impacts on learning motivation and effectiveness. In a 2015 study, Paul Evans indicated that self-determination theory provided a new perspective for understanding learning motivation in music education (Evans, 2015). A 2016 study by Shaila M. Miranda et al. revealed the double-edged effect of social media in promoting musical diversity and public dialogue (Miranda et al., 2016). These studies collectively emphasized the importance of integrating new media tools in digital music education and their role in cultivating learners' critical thinking and autonomy.
3. Mature Stage (2016–2024): Digital music and social media have played pivotal roles in shaping modern education and cultural participation. Multiple studies in recent years have collectively shown that social

media and digital technologies—particularly podcasts—are assuming increasingly important roles in medical education, musical culture dissemination, and their sociocultural impacts. In 2019, Michael D. Patrick et al. demonstrated the influence of podcasts in global medical education through a popular pediatric education podcast (Patrick et al., 2019). A 2023 systematic review by Connie Keh-Nie Lim and Mingchen Zhang focused on how social media expands the audience base for Chinese ethnic music, exploring the sociocultural impacts of digital platforms on musical culture dissemination and the “influencer phenomenon” (Lim & Zhang, 2023). Overall, with the development of digital technologies, podcasts and social media have become indispensable tools in modern education and culture, transforming the landscape of knowledge transmission and cultural consumption.

The three-stage development not only reflects the deepening of research in digital music but also mirrors the profound impact of digital technologies on sociocultural participation and modern education. From initial foundational exploration to transitional technical application, and finally to mature multi-field integration, the research field of digital music has demonstrated a developmental trend from shallow to deep, from fragmented points to comprehensive coverage, continuously expanding the breadth and depth of inquiry.

**Figure 6**

*Keyword time zone evolution chart*



## 5. DISCUSSION

### 5.1. Spatiotemporal Evolutionary Characteristics of Digital Music Communication Research

This study reveals the spatiotemporal evolutionary characteristics of the digital music communication field over the past 24 years. In terms of the temporal dimension, the development of this field can be divided into three stages: the embryonic stage (2000–2014), the transition stage (2014–2016), and the mature stage (2016–2024). During the embryonic stage, the annual publication was less than 5 papers, with research primarily focusing on information communication and cultural literacy to explore fundamental issues such as technical ethics and media literacy. The studies in this stage laid the theoretical foundation for subsequent developments.

In the subsequent transition stage, the annual publication volume increased to 10 papers, and research shifted to the application of digital media and educational technologies, with a focus on the impact of social media and digital storytelling in education. Technological advancements during this period promoted the widespread application of digital music communication. In the mature stage, the annual publication volume exceeded 15 papers, and research priorities shifted to the sociocultural impacts of digital music, involving multiple fields such as industrial development and mental health. Studies in this stage not only focused on technology itself but also deeply explored the profound influence of technology on social culture.

From the spatial dimension, the geographical distribution of digital music communication research shows obvious imbalance. Northern Hemisphere countries dominate research in this field, with the United States publishing 75 papers, ranking first; the United Kingdom and Australia follow closely with 22 and 20 papers, respectively. Although China has published 10 papers, the average number of citations per article is relatively low. This unbalanced geographical distribution may be closely related to the development level of each country's digital music industry, scientific research investment, and academic resource allocation.

Furthermore, research priorities vary among countries: developed countries pay more attention to technological innovation and market analysis, while developing countries focus more on cultural inheritance and educational applications. These differences reflect the unique needs and development paths of countries in the field of digital music communication.

## **5.2. Imbalance in Research Subjects and Academic Ecology**

The research subjects in the field of digital music communication exhibit remarkable imbalance, which affects the academic ecology of this field to a certain extent. In terms of core authors, although there is a certain number of core authors in this field, their publication proportion does not exceed half, and a relatively stable author collaboration network has not yet been formed. Among 458 authors, only 15 have published more than 2 papers, with Vittorio Ghini and Paolo Salomoni tied for the highest productivity, each publishing 3 papers, focusing on technological prediction and industrial transformation. This unbalanced author distribution indicates that digital music communication research is still in a developmental stage and has not formed a mature academic community.

From the perspective of national distribution, a few developed countries dominate research in this field, while research in developing countries lags relatively behind. Such unbalanced academic ecology not only affects the diversity and comprehensiveness of research but also may lead to inequalities in knowledge production. Research achievements of developed countries hold a dominant position in the international academic community, while studies from developing countries may be marginalized due to resource constraints and insufficient academic influence. In addition, the interdisciplinary nature of digital music communication has led to scattered research—obvious intersections exist among musicology, communication, computer science, and other disciplines, with a lack of a unified academic community. Although this interdisciplinary research model enriches research perspectives, it also increases the complexity of research and the difficulty of collaboration.

## **5.3. Dual Attributes of Technical-Cultural Research Hotspots**

The research hotspots in the field of digital music communication exhibit remarkable dual attributes of technology and culture. Keyword cluster analysis reveals three major research paradigms: the first focuses on technology-driven industrial transformation, concerning how technologies such as digital music, streaming media, and artificial intelligence reconstruct music production and communication; the second centers on education and identity construction, exploring the application of digital media in adolescent education and cultural identity formation; the third addresses cultural literacy and social governance, involving topics such as information literacy, critical analysis, and ethics. These three paradigms are interwoven, reflecting the interaction between technological innovation and humanistic reflection, and promoting research to shift from a single technical perspective to social and cultural system analysis.

This dual technical-cultural attribute reflects the interdisciplinary nature of digital music communication, emphasizing the interactive relationship between technology and social culture. For example, the evolution of digital music technologies has not only reshaped music production and communication models but also exerted profound impacts on social culture, such as cultural inheritance, educational popularization, and mental health. Research hotspots with such dual attributes not only cover multiple aspects of technical applications but also deeply explore the far-reaching influence of technology on social culture, providing a rich theoretical and practical foundation for research in the field of digital music communication.



#### 5.4. Core Academic Contributions

This study makes three core academic contributions to the field of digital music communication research:

1. This study is the first to systematically sort out the complete 20-year development cycle of digital music communication research from 2004 to 2024, and constructs a three-stage evolutionary model of the field, which clarifies the development context from the basic exploration of information literacy, to the technical application in music education, and then to the multi-field integration of sociocultural research.
2. Through visualized knowledge mapping, this study identifies three core thematic clusters in the field, and reveals the imbalance of the academic ecology in terms of author collaboration network, national research distribution and journal publication system, providing a clear, systematic and replicable academic map for subsequent researchers in digital music communication.
3. This study fills the long-standing research gap of comprehensive bibliometric review in the field of digital music communication, and provides a quantitative reference and theoretical basis for the subsequent theoretical construction, interdisciplinary research and practical application of this field.

#### 5.5. Research Limitations and Future Prospects

Although this study systematically combs and visually analyzes the research landscape of digital music communication through standardized bibliometric methods, several limitations need to be clearly acknowledged. First, this study only selected the Web of Science Core Collection (SCIE/SSCI/A&HCI) as the sole data source, and did not include literature from other authoritative academic databases such as Scopus, ProQuest and Google Scholar. The reliance on a single database may lead to the omission of some relevant literature in the field, which is an important limitation of this study. Second, the research data are mainly derived from English-language core journals, which may make the research findings biased towards Western academic achievements to a certain extent, while ignoring research outputs in other languages and regional contexts. Third, this study relies primarily on quantitative bibliometric analysis with supplementary qualitative interpretation of thematic clusters, and lacks in-depth qualitative research on specific classic literature and frontier topics, which may limit further theoretical innovation of the study. Finally, the theoretical construction of digital music communication is still in the developing stage, and this study does not propose a unified theoretical framework for the field, which is also a key direction for future research to deepen.

Future research should further deepen interdisciplinary cooperation to promote theoretical and practical innovations in digital music communication. Specifically, potential future research directions may include the following:

1. Expanding data sources: Including multiple authoritative academic databases to obtain a more comprehensive and complete research landscape of digital music communication, and supplementing non-English literature to enhance the global applicability of the findings.
2. Deepening localized research: Constructing non-Western theoretical systems and focusing on the characteristics and needs of digital music communication under different cultural backgrounds.
3. Strengthening technical ethics discussions: Developing ethical evaluation indicators for AI music and addressing ethical issues in technological applications.
4. Expanding interdisciplinary approaches: Introducing neuroscience and complex network theories to analyze the mechanisms and impacts of digital music communication.
5. Promoting two-way empowerment between academia and industry: Enhancing the application and transformation of research achievements to foster the sustainable development of the digital music industry.

In summary, future research should further expand research horizons, deepen interdisciplinary collaboration, and promote theoretical and practical innovations in digital music communication to facilitate the sustained development of this field.



## 6. CONCLUSION

Using standardized bibliometric methods, based on the classic 5W1H analytical framework, and combining complementary visualization tools VOSviewer and CiteSpace, this study comprehensively combed the research status, hotspots, and development trends in the field of digital music communication from six core dimensions: temporal distribution of publications, core author groups, national research forces, journal distribution system, thematic hotspots, and evolutionary paths. Findings show that research in this field has gradually entered a mature stage, with literature publication maintaining fluctuating growth since 2004. The United States, the United Kingdom, and Australia are the core research forces in this field, yet a stable author collaboration network and specialized journal system remain unformed. Visualized through knowledge mapping, research hotspots form three core clusters: the sociocultural impacts of digital music technologies, educational applications of digital media, and information communication literacy. The developmental trajectory has completed a clear three-stage evolution: foundational exploration of information literacy, practical application of technical education, and multi-field integration of sociocultural studies.

Overall, research in digital music communication has advanced from foundational exploration to technical application, and then to multi-field integration, demonstrating a developmental trend from shallow to deep and from fragmented points to comprehensive coverage. With the development of digital technologies, podcasts and social media have become indispensable tools in modern education and culture, transforming the landscape of knowledge transmission and cultural consumption. In the future, supported by national policies, the field of digital music communication will continue to explore innovative integration of music and modern technology, promote sustained expansion of market scale and integrated development of diversified formats, showing strong momentum and broad prospects.

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### Ethical approval

This study does not require ethics committee approval as it does not involve human, animal or sensitive data.

### Author contribution

Study conception and design: YL; data collection: YL, XB, JL; analysis and interpretation of results: YL, XB, JL; draft manuscript preparation: YL, XB, JL. All authors reviewed the results and approved the final version of the article.

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### Conflict of interest

The authors declare that there is no conflict of interest.

### Etik kurul onayı

Bu çalışma insan, hayvan veya hassas veriler içermediği için etik kurul onayı gerektirmemektedir.

### Yazarlık katkısı

Çalışmanın tasarımı ve konsepti: YL; verilerin toplanması: YL, XB, JL; sonuçların analizi ve yorumlanması: YL, XB, JL; çalışmanın yazımı: YL, XB, JL. Tüm yazarlar sonuçları gözden geçirmiş ve makalenin son halini onaylamıştır.

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