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The Rise of Technology in Music Education: A Bibliometric Study of a Rapidly Growing Field

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Abstract

The aim of this study is to examine publications on the use of technology in music education between 2016 and 2025 using bibliometric methods. A total of 1,553 studies retrieved from the Scopus and Web of Science databases were analyzed using Bibliometrix 5.2 software. Performance metrics and science mapping methods were used in the analysis. The results show that the field grew at an average rate of 16.36% per year. The increase in the number of publications, especially after 2020, appears to be due to the COVID-19 pandemic, which has increased research on distance music education. The most influential journals were Music Education Research, Journal of Music Technology and Education, and International Journal of Music Education. China, the US, Spain, and the UK are the countries producing the most publications in the field. But just 7.34% of the papers were written by people from other countries. A keyword analysis shows that the research can be divided into two main categories: educational issues and technical problems. Artificial intelligence, virtual reality, and deep learning aren't large parts of the market yet, but they're becoming increasingly common in research. Technology in music education is a quickly growing topic of research that involves many different areas. To promote the field's growth, it is suggested that there be more international cooperation and that new technologies be used with educational theory and design more often.

Keywords: *Music education, educational technology, bibliometric analysis, digital learning, artificial intelligence*

Introduction

Music education is a planned process aimed at developing people's knowledge and skills related to music. This process encompasses many areas, including listening skills, sense of rhythm, playing instruments, and musical creativity. Traditional music education is usually conducted face-to-face, relying on the master-apprentice relationship and repetitive practice. However, in recent years, technology has begun to change this structure. Digital audio programs, mobile applications, online learning platforms, and artificial intelligence-supported tools are transforming both the content and delivery of music education (Ma & Wang, 2025). This shows that technology is no longer just an "auxiliary tool" but has also become a learning environment (Maharaj & Gill, 2023).

Research shows that incorporating technology into music education has various effects. A meta-analysis reveals that technology-supported music education has a moderate but significant effect on academic achievement (Kalkanoğlu, 2024). Furthermore, the use of digital software in solfege and theory classes has been found to increase student success while reducing absenteeism (Ouyang, 2023). The COVID-19 pandemic has made the advantages and disadvantages of online music education more apparent. During the pandemic, teachers were forced to suddenly switch to distance learning, which presented many obstacles. These experiences have helped hybrid models, which combine face-to-face and online education, become accepted as a permanent option (Toscano et al., 2024; Váradi et al., 2024).

Studies on the use of technology in music education are rapidly increasing. Despite this, there are few bibliometric studies that present a comprehensive overview of the field. Current research mostly focuses on a specific technology or a specific environment. Therefore, there is a need for studies that systematically examine the general structure of the field, prominent themes, collaborative relationships, and distribution among countries. Furthermore, identifying gaps in the literature and determining which topics will emerge in the future is important for the development of the field.

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The aim of this study is to analyze publications on the use of technology in music education between 2016 and 2025 using bibliometric methods. In this context, the following questions will be addressed:

- How have publication and citation trends in the field of technology in music education changed over time?
- What are the most influential sources, authors, institutions, and countries in this field?
- What is the structure of collaboration networks among authors?
- How are the main themes and conceptual structure formed according to keyword analysis?
- What are the research gaps in the literature and future research directions?

Technology in Music Education

In recent years, technology has fundamentally changed both the content and delivery methods of music education. Bibliometric studies based on Web of Science show that research at the intersection of technology and music education has steadily increased since the 1990s and gained significant momentum after 2020 (Ma & Wang, 2025). This increase is related not only to the emergence of new tools but also to pedagogical agendas such as distance learning, digital creativity, and inclusive learning. Technology is no longer merely an auxiliary material but has become a fundamental learning environment for musical knowledge, skills, and creative expression (Maharaj & Gill, 2023).

The findings from the meta-analysis indicate that the integration of technology exerts a moderate yet statistically significant positive influence on academic performance within the context of music education (Kalkanoğlu, 2024). Furthermore, it has been substantiated through empirical research that students exhibit enhanced achievement scores alongside a reduction in absenteeism during solfège and theoretical instruction sessions that are facilitated by digital software (Ouyang, 2023). Nonetheless, a plethora of studies suggests that digital tools predominantly fulfill a "supportive" role as opposed to delivering a "fully transformative" impact (Maharaj & Gill, 2023). Educators often incorporate online resources as supplementary materials in conventional instructional sessions. Typically, the primary educational objectives and assessment methodologies remain anchored in more traditional pedagogical approaches. This situation underscores the necessity for technology to be integrated into lesson design rather than merely utilized as an ancillary tool (Crawford, 2017; Gorgoretti, 2019).

Digital audio workstations (DAWs) are the most significant tools for teaching music with computers. Pendergast (2021) asserts that DAW-centric creative music creation enhances students' engagement in sound design, editing, and mixing, hence fortifying their sense of creative autonomy. Pierard & Lines (2022) analyzes DAW utilization from a constructivist perspective, illustrating that students augment their creative skills through experimentation, exploration, and collaborative learning with peers. Students from different schools can work together on songwriting projects thanks to online forums and file-sharing platforms (Clauhs, 2020). Recent studies suggest that DAW-based projects may enhance not only product-oriented success but also self-efficacy and creative thinking skills (Yanan, 2024).

Mobile technologies and applications have also become an important part of the music learning ecosystem. Demirtaş & Özçelik (2021) discovered that music education students in Turkey utilize a diverse array of mobile applications for solfege, ear training, instrument practice, and repertoire listening. Ouyang (2023)'s study demonstrates that mobile learning applications enhanced by digital software elevate motivation and retention, particularly in solfege classes. Other studies report that mobile notation software supports students' abilities to write, record, listen to, and share melodies within virtual classrooms (Özgül, 2023). These findings reveal that mobile learning offers a flexible and customizable structure that supports formal lessons.

The COVID-19 pandemic has exposed the limitations of online and distance learning in music education. During the initial shock period, music educators in many countries were forced to switch to distance learning very quickly, and policy and planning deficiencies were clearly felt during this process (Shaw & Mayo, 2022). Rucsanda et al. (2021) examined music students' attitudes toward online classes and reported that students appreciated the flexibility of online learning but experienced difficulties, particularly in the areas of ensemble performance and auditory feedback. Recent studies such as those by Toscano et al. (2024) and Váradi et al. (2024) show that teacher satisfaction is largely related to expectations of social gains and the level of institutional support, that online music education alone is not considered sufficient, but that hybrid models are emerging as a permanent option. In addition, some difficulties have been encountered. The difficulty of correcting hand, mouth, and body posture in an online environment poses an obstacle to teaching technical skills. Improving intonation and voice quality is also more difficult in an online environment (Váradi et al., 2024).

Technology also offers new learning environments and game-based approaches in music education. Music video games and game-based mobile applications offer pedagogical opportunities that can support rhythm, intonation, and listening skills (Cheng, 2024). Such environments create an experiential space where students are not afraid to take risks and do not get bored of repetition. Gamified applications can increase students' self-regulation skills and intrinsic motivation through instant feedback and progress tracking. On the other hand, the compatibility of such applications with the educational program, the measurement of learning outcomes, and the prevention of the gaming experience becoming superficial require systematic design (Ma & Wang, 2025).

In this context, technology in music education is seen not only as a pedagogical tool but also as an ecosystem element that connects with cultural production and creative industries. Artificial intelligence is emerging as a transformative force in music education. This technology promises unprecedented levels of personalization and accessibility (Merchán Sánchez-Jara et al., 2024). Generative AI tools such as ChatGPT are becoming a powerful resource for music educators. These tools have the potential to increase student engagement, improve assessment methods, and automate repetitive tasks (Holster, 2024). AI-powered chatbots integrated into piano lessons have yielded positive results in student performance. Students using this application achieved better results than those enrolled in traditional lessons. Overall, the use of AI resulted in a 15% increase in academic performance (Li & Wang, 2024). The widespread application of generative artificial intelligence presents both opportunities and challenges in music education. Students can now effortlessly compose music using simple text commands with AI music generators. This encourages innovative pedagogical approaches and democratizes creativity in the music classroom (Cheng, 2025). However, concerns about cultural bias, originality, equity, and ethical use require careful regulation. Developing AI literacy among students and teachers is recommended. It is also important to develop assessment frameworks that reflect the collaborative nature of AI-assisted music creation (Chan & Colloton, 2024; Karpouzis, 2024). The acceptance of AI among pre-service music teachers is being investigated. 96.4% of these teachers believe that technology plays a positive role in music education (Atabek & Burak, 2024). Teachers are more willing to use AI tools when they increase teaching efficiency and reduce lesson preparation difficulties.

Technology has limitations as well as opportunities. Recent studies show that despite the more widespread use of technology in music education, access inequalities persist. Factors such as access to devices and software, internet infrastructure, and institutional budgets directly affect students' technological experiences (Jing, 2024). Teacher competencies are also a critical variable. Kılınçer (2025) discovered that aspiring music educators typically possess favorable attitudes towards the utilization of technology; however, they do not perceive themselves as proficient in pedagogical integration. Studies show that teachers often see technology as a "add-on" to the curriculum, which means that these tools aren't being used to their full potential (Maharaj & Gill, 2023; Marín-Suelves et al., 2022).

Current literature suggests "internet plus music education" models for the future, meaning that digital platforms should be built with economic and institutional arrangements in mind (Y. Liu, 2025). These models view online and in-person learning as components of an interactive network, where students create, disseminate, and assess content in both synchronous and asynchronous formats. At the same time, discussions on sustainability and business models highlight the importance of collaborations between technological ventures and educational institutions (Y. Liu, 2025; Ma & Wang, 2025).

In conclusion, the field of “Technology in Music Education” has become a dynamic area of research with rapidly diversifying tools and deepening pedagogical discussions. Recent research indicates that digital tools can enhance musical achievement, motivation, and avenues for creative expression; concurrently, they introduce novel challenges regarding accessibility, educator proficiency, and policy (Kalkanoğlu, 2024; Ouyang, 2023; Shaw & Mayo, 2022). Music education programs must be designed to align with the objectives of theory, performance, and composition, integrating digital audio workstations (DAWs), mobile applications, game-based environments, and online collaboration platforms. To accomplish this, it is essential to systematically incorporate domains such as technology pedagogy, design-oriented thinking, and digital content production into teacher training programs. Studies indicate that optimal technology integration results in students assuming active producer roles, the demarcation between formal and informal learning environments becoming more fluid, and music education becoming increasingly inclusive (Demirtaş & Özçelik, 2021; Ma & Wang, 2025; Pendergast, 2021).

Method

In this study, bibliometric analysis was used to reveal the structure and development trends of the literature on the use of technology in music education. Bibliometric analysis is a research method that allows for the examination of the quantitative characteristics of publications in a specific field. This method enables the systematic evaluation of publication numbers, citation patterns, collaboration networks, and thematic trends (Donthu et al., 2021). Unlike traditional literature reviews, bibliometric analysis produces objective and reproducible results on large-scale data sets. This feature offers a significant advantage in mapping the rapidly growing and interdisciplinary field of music education technologies. Furthermore, bibliometric indicators help identify influential sources, authors, and research foci in the field (Zupic & Čater, 2015). In this context, the present study conducted a bibliometric review covering the literature from 2016 to 2025.

Data Collection Process

The study utilized the Scopus and Web of Science (WoS) databases for data collection. The combined use of Scopus and WoS reduces the potential limitations of a single database and provides a more comprehensive literature review. The search query was run on the title, abstract, and keywords fields. The search query is provided below. The search was limited to publications between 2016 and 2025. Only English publications were included. No restrictions were applied in terms of document type.

Search query

("music education" OR "music pedagogy" OR "music learning" OR "instrument learning")

AND (technology OR "digital technology" OR ICT OR "educational technology"

OR "technology integration" OR "digital tools" OR "online learning"

OR "e-learning" OR "mobile learning" OR "virtual learning"

OR "computer-assisted instruction" OR "music software" OR "digital audio workstatio)

The search of the Scopus database yielded 1480 publications. Publications without author information were excluded, leaving 1456 publications. Subsequently, 10 duplicate records were identified and deleted from the database. As a result, 1,446 publications from Scopus were included in the merging stage. A total of 833 publications were obtained from the WoS database. There were no missing author information or duplicate records in this database. The publications obtained from both databases were merged in the RStudio environment using Bibliometrix 5.2 software (Aria & Cuccurullo, 2017). During the merging process, 663 duplicate publications common to both databases were identified and removed. As a result, a total of 1553 publications were included for analysis.

Data Analysis

Bibliometrix 5.2 software (Aria & Cuccurullo, 2017) was used in the data analysis process. Bibliometrix is an open-source package that runs on the R programming language and provides comprehensive analysis tools for bibliometric research. This software combines fundamental bibliometric techniques such as performance analysis and science mapping on a single platform. It also offers the ability to combine and standardize data obtained from different databases such as Scopus and WoS.

The analyses were conducted in two main stages. Performance analysis was carried out in the first stage. In this stage, publication numbers, citation distributions, the most influential sources, authors, institutions, and countries were examined. Total citation count, average citations per year, h-index, g-index, and m-index were used as performance indicators. These indicators reveal productivity and impact patterns in the field.

In the second stage, science mapping techniques were applied. In this context, an author collaboration network and a co-occurrence network of keywords were created. The standard settings of the Bibliometrix software were used in the network analyses.In the network visualizations, the size of a node shows how often it happens, and the thickness of a link shows how strong the association is. Additionally, centrality measures such as PageRank, betweenness, and closeness were examined.

These measures help identify important nodes within the network and key participants in the flow of information.

KeyWords Plus terms were used for thematic analysis. Keywords are placed into four sections based on how central and dense they are, creating a thematic map. This map provides a visual overview of the main topics, niche themes, emerging or fading themes, and fundamental themes in the field.

Finally, content analysis was performed to identify future research directions. For this analysis, articles listed in the most influential publications table were examined. The future research suggestions section of each publication was read in detail. The suggestions obtained were grouped according to their similarities and synthesized under common themes. This process aims to complement bibliometric findings with a qualitative perspective and identify research gaps in the field.

Findings

Table 1. Descriptive statistics

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2016:2025
Sources (Journals, Books, etc)	539
Documents	1553
Annual Growth Rate %	16.36
Document Average Age	2.96
Average citations per doc	3.891
DOCUMENT CONTENTS	
Keywords Plus (ID)	2950
Author's Keywords (DE)	4180
AUTHORS	
Authors	2666
Authors of single-authored docs	523
AUTHORS COLLABORATION	
Single-authored docs	670
Co-Authors per Doc	2.35
International co-authorships %	7.341
DOCUMENT TYPES	
Article	1031
Book	130
Conference Paper	214
Editorial	7
Proceedings Paper	141
Review	30

Table 1 shows that research on the use of technology in music education increased rapidly between 2016 and 2025. A total of 1,553 documents spread across 539 sources indicate a diverse and dynamic publication environment rather than a concentration in a few key journals. The annual growth rate of 16.36% and the low average document age (2.96 years) indicate that this is a young but rapidly growing field. An average of 3.89 citations per document shows that the literature is still in a phase of quantitative expansion and is not dominated by a few highly cited landmark studies.

Keyword indicators reflect a broad thematic range. The presence of 2,950 Keyword Plus and 4,180 author keywords shows that researchers approach the topic from many different concepts and perspectives. This diversity indicates openness to interdisciplinary approaches but may also imply conceptual fragmentation. More detailed analyses of the co-occurrence of keywords are needed to see whether this diversity converges into stable thematic clusters.

Authorship patterns indicate a moderate level of collaboration. There are 2666 writers, yet there are still 670 single-authored documents and 523 single-authored works. This shows that individual academic effort is still highly frequent. There are 2.35 co-authors per document and only 7.34% of co-authors are from other countries. This suggests that most collaboration is national or local, which could limit visibility and influence on a global scale.

When it comes to document types, research outputs include 1031 journal articles, 214 conference papers, and 141 conference proceedings. The existence of 130 books indicates that broader theoretical or practical studies have developed to some extent. However, only 30 review articles have been recorded, highlighting a lack of systematic reviews and meta-analyses and indicating an opportunity for more integrative, synthesis-focused research in this area.

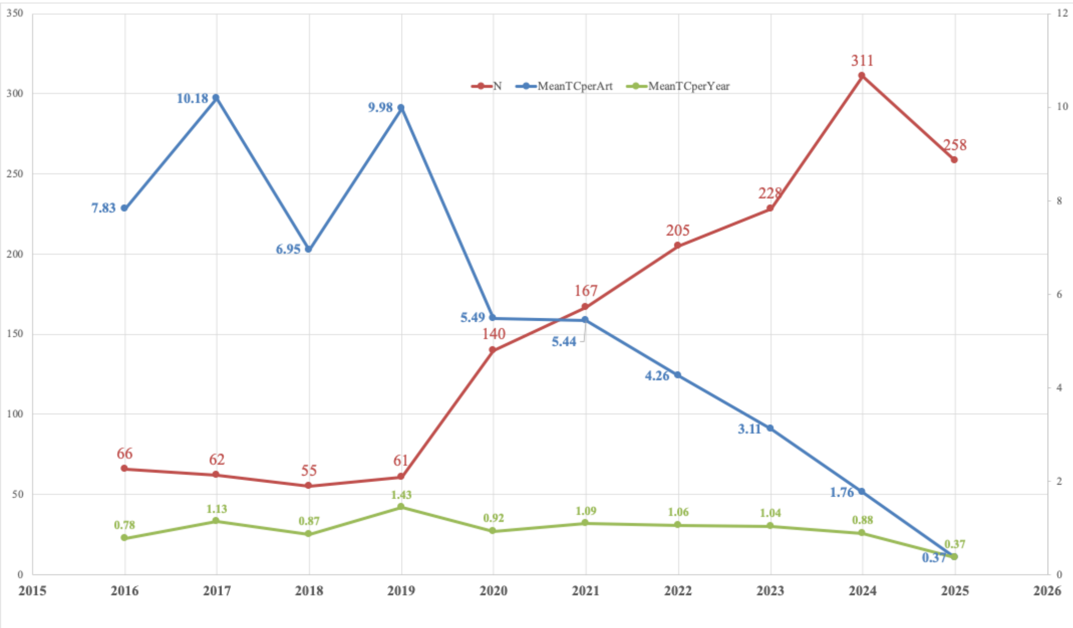

Figure 1. *Number of publications and citations*

The graph shows that the number of publications and citation dynamics differ from year to year. The number of publications (N) variable shows that the number of publications per year stayed pretty consistent and low between 55 and 66 from 2016 to 2019. But from 2020, there has been a big change. The number of publications has gone up to 140, then 167 in 2021, 205 in 2022, 228 in 2023, and 311 in 2024. Although there is a decline towards 258 in 2025, this value is still quite high compared to previous years. This trend suggests that interest in the use of technology in music education has increased rapidly, especially after 2020, and that the field has entered a period of mass production in a short time.

When looking at citations per article, the data tells a different story. From 2016 to 2019, articles were cited frequently (averaging roughly 7 to 10 times), suggesting that these early works were key building blocks for the field. After 2020, those numbers dropped sharply, hitting a low of 0.37 in 2025. However, this doesn't mean quality has declined; it simply means newer papers haven't been around long enough to get cited.

If we look at the average citations per year, the trend is much more stable. The numbers have stayed consistent since 2016, showing that interest in the field is just as strong as ever. Essentially, while the sheer volume of research on technology in music education exploded after 2020, that attention is now spread across more papers. As time goes on, we can expect standout studies from this recent boom to catch up in citation numbers.

Table 2. Most influential source

Source	h index	g index	M index	TC	NP
Music Education Research	11	18	1.1	342	24
Journal Of Music Technology & Education	9	13	0.9	245	52
International Journal of Music Education	9	15	1	249	29
Frontiers In Psychology	8	13	1.14	194	22
Education And Information Technologies	8	13	2	186	17
Interactive Learning Environments	7	12	2.33	165	21
Journal Of Physics: Conference Series	6	9	1	108	17
Journal Of Research in Music Education	6	9	0.6	128	9
Journal Of Popular Music Education	5	8	0.714	84	23
Research Studies in Music Education	5	9	0.5	98	14
Soft Computing	5	8	1.25	73	14
Wireless Communications & Mobile Computing	5	8	0.714	75	10
International Journal of Emerging Technologies in Learning	5	7	0.556	54	9
Applied Mathematics and Nonlinear Sciences	4	4	1.33	38	37
ACM International Conference Proceeding Series	4	7	0.4	67	23
Computer-Aided Design and Applications	4	8	0.667	74	14
Information And Communication Technology in Musical Field	3	3	0.3	20	30
Musical Art and Education	3	3	0.43	20	23
Entertainment Computing	3	3	1.5	23	10
International Journal of Human-Computer Interaction	3	6	1.5	46	6
European Journal of Education	2	2	2	6	6

Based on Table 2, Music Education Research is clearly a cornerstone journal, holding an h-index of 11 and a g-index of 18. Its 342 citations from 24 articles show it is both productive and highly respected. It is joined by the International Journal of Music Education and the Journal of Music Technology and Education as key players in the field. The latter is particularly noteworthy for its volume, publishing 52 articles, which underscores how active the niche of music technology has become.

However, impact isn't limited to music-specific journals. General ed-tech publications like Education and Information Technologies show high m-index values, meaning their articles start getting cited very quickly. We also see broader journals, such as Frontiers in Psychology, entering the mix, which suggests that technology in music education is attracting attention from the wider psychological and educational communities.

The list contains technical and engineering sources like Soft Computing and several ACM conference proceedings, which is probably the most intriguing thing about it. This means that things like mobile technology and computer methods are now very important to music instruction. Overall, the landscape from 2016 to 2025 is very interdisciplinary, bringing together music, education, and hard computer science.

Table 3. Most influential authors

Author	h index	g index	m index	TC	NP
Nijs L	6	8	0.60	67	8
Ludovico L	5	12	0.56	144	15
Waddell G	5	7	0.50	132	7
Li Y	5	8	0.71	71	15

Crawford R	4	4	0.40	107	4
Williamon A	4	4	0.50	104	4
Bell A	4	9	0.50	87	10
Gustems-Carnicer J	4	4	0.67	52	4
Volpe G	4	6	0.44	50	6
Volta E	4	6	0.44	50	6
Della V M	4	6	0.44	36	6
Avanzini F	3	11	0.43	131	12
Wang Y	3	10	0.50	102	14
Wang L	3	7	0.30	85	7
Joseph D	3	8	0.50	66	13
Powell B	3	8	0.30	65	8
Wang X	3	6	0.50	38	10
Zhang Y	3	4	0.30	25	12
Yang Y	3	4	0.60	16	10
Nordahl R	2	2	0.22	144	2
Serafin S	2	2	0.22	144	2
Johnson C	2	7	0.22	60	7
Merrick B	2	5	0.50	25	10
Gorbunova I	2	3	0.29	22	13
Zhang L	2	4	0.67	19	10
Degli I E	1	1	0.14	103	1
Geronazzo M	1	1	0.14	103	1
Vescovi D	1	1	0.14	103	1

Names like Nijs L, Ludovico L, Waddell G, and Li Y stand out because they have high h-indexes and a lot of publications (As shown in Table 3). Nijs has an h-index of 6 and 8 publications, which means that other researchers often cite his work and that he has made a name for himself in the field. Ludovico, with 15 publications and 144 total citations, is one of the most highly cited names, suggesting he has produced intensively and effectively, particularly within a specific thematic focus. Similarly, names such as Avanzini F, Wang Y, Joseph D, and Gorbunova I can be seen as consistently productive actors in the field, with multiple publications and mid-level h-indexes.

Authors who received very high citations with a single work present a different impact profile. Degli I E, Geronazzo M, and Vescovi D each have only one publication but appear in the table with 103 total citations, indicating that this joint article has become one of the fundamental reference sources for the field. Also, the fact that Nordahl R and Serafin S have only published two papers but have been cited 144 times shows that they are part of a strong research group and have done important work in a certain area of technology or method. This reveals that the literature on the use of technology in music education features highly cited, focused studies clustered around specific research teams.

The m-index provides a more dynamic picture as a productivity and impact measure normalized according to the authors' academic career duration. The fact that names such as Nijs L, Gustems Carnicer J, Zhang L, and Yang Y have an m-index of 0.60 or above indicates that these authors have accumulated citations rapidly and consistently within a relatively short time frame. In contrast, the m index remaining at 0.22 for names such as Nordahl R, Serafin S, and Johnson C suggests that their relationships with the field are spread over a longer period of time and that the citation rate has been relatively more balanced. Therefore, authors with high m indices can be considered researchers who have risen rapidly in recent years and have the potential to determine the future direction of the field.

Overall, the table suggests that technology-themed research in music education is concentrated around a few central authors, who are mostly connected through collaborative work and research networks. The simultaneous presence of authors with a single high-impact article and authors with multiple and regular publications reveals that the field has developed through both pioneering reference studies and follow-up research that expands upon them in different contexts. This structure points to a dynamic literature characterized by interdisciplinary collaborations and driven by a small number of strong research groups.

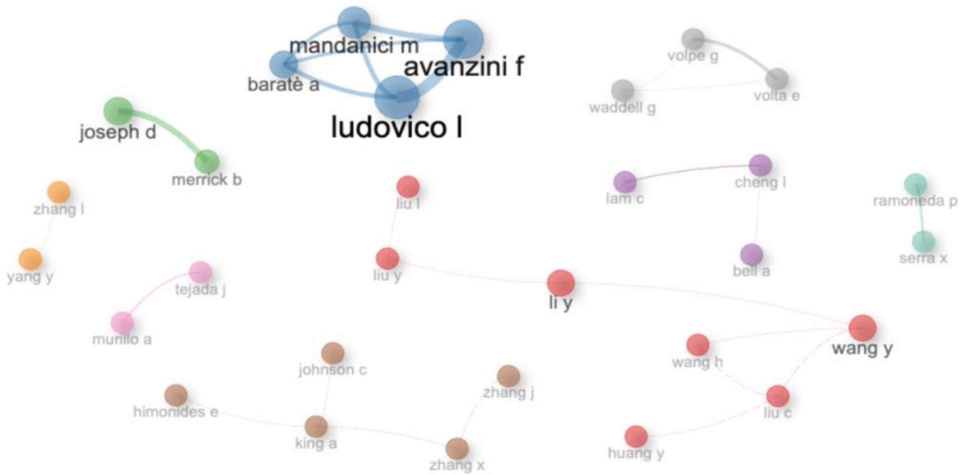

Figure 2. Network graph for authors

The network graph generally shows that collaborations in the field of technology in music education are highly clustered and localized. A significant portion of the nine clusters consists of small groups with two or three authors. This suggests that knowledge production is concentrated in a few research groups, but strong bridges between these groups have not yet been sufficiently established. Within the network as a whole, heterogeneous but tightly connected research islands stand out.

Li Y, Wang Y, Huang Y, Liu C, Liu L, Liu Y, and Wang H, who are in the first cluster, represent a broad collaboration network that appears to be centered in China. Wang Y and Li Y, as authors with the highest betweenness values, are key actors in information flow within this cluster and, to some extent, across the network. Liu C, with relatively high closeness and the highest PageRank value, is one of the most visible names in this group in terms of citations and collaboration. These findings confirm that Wang Y and Li Y, who stood out in the previous tables, are at the center of the field not only in terms of citation performance but also in terms of their structural position.

The second cluster consists of Ludovico L, Avanzini F, Mandanici M, and Baratè A, representing the Italian school. The proximity values of these authors are the same and relatively high. This indicates a small but tightly knit team structure. The PageRank values of Ludovico L and Avanzini F are also above the network average. These names, which stood out in previous analyses with their high h-index and total number of citations, are also seen to produce work based on strong teamwork. However, the limited connection of this cluster with other clusters suggests that the potential for international collaboration has not yet been fully exploited.

King A, Johnson C, Zhang J, Zhang X, and Himonides E, who are in the sixth cluster, form a more dispersed group with the potential to connect to different sub-networks. King A appears to be one of the main actors in the network, acting as a bridge with high betweenness and one of the highest PageRank values. Zhang X's relatively high PageRank value also indicates that this cluster is effective and visible in technology-based music education studies. In contrast, the pairs in the third, fifth, seventh, eighth, and ninth clusters are more isolated. Names such as Joseph D and Merrick B, Yang Y and Zhang L, Tejada J and Murillo A, Waddell G Volpe G Volta E, and Ramoneda P and Serra X have strong bonds among themselves but show limited interaction with the network as a whole.

The network structure shows that the field is organized around a few main research cores. These cores work closely together, but there aren't many connections between clusters. Authors such as Wang Y, Li Y, Liu C, King A, and Zhang X occupy structurally critical positions, and the collaborations led by these individuals appear to be decisive in shaping the research agenda regarding the integration of technology into music education. Increasing inter-cluster collaborations in the future could both strengthen the network's integration and contribute to the field's development by accelerating the flow of information.

Table 4. Most influential institutions

Affiliation	Articles
University of Valencia	26
University Pompeu Fabra	23
Deakin University	21
Herzen State Pedagogical University of Russia	21
The University of Melbourne	21
Complutense University of Madrid	18
The Education University of Hong Kong	17
Anglia Ruskin University	16
University of Barcelona	16
Monash University	14
University of Salamanca	14
University of Aveiro	13
University of South Florida	13
Carleton University	12
University of Murcia	12
University of Milan	11

Table 4 reveals that the University of Valencia holds the top position with 26 articles, pointing to a strong and continuous line of inquiry at the institution. With Pompeu Fabra University and others like Deakin and Melbourne also posting high numbers, it becomes clear that a few key institutions are responsible for a disproportionate share of the field's productivity.

The data shows a clear geographic trend: Spanish universities are particularly well-represented. This dominance may be attributed to the country's deep-rooted research culture in music education and technology, combined with highly active researcher networks. In a similar vein, the high ranking of Australian universities reflects the impact of national policies prioritizing educational technology and digital learning.

Although the presence of universities ranging from the Education University of Hong Kong to Carleton University in Canada proves that this is a global field with a multi-centered structure, the center of gravity remains in Europe. Specifically, the numerical intensity of publications suggests that Southern and Western Europe are currently leading the discourse.

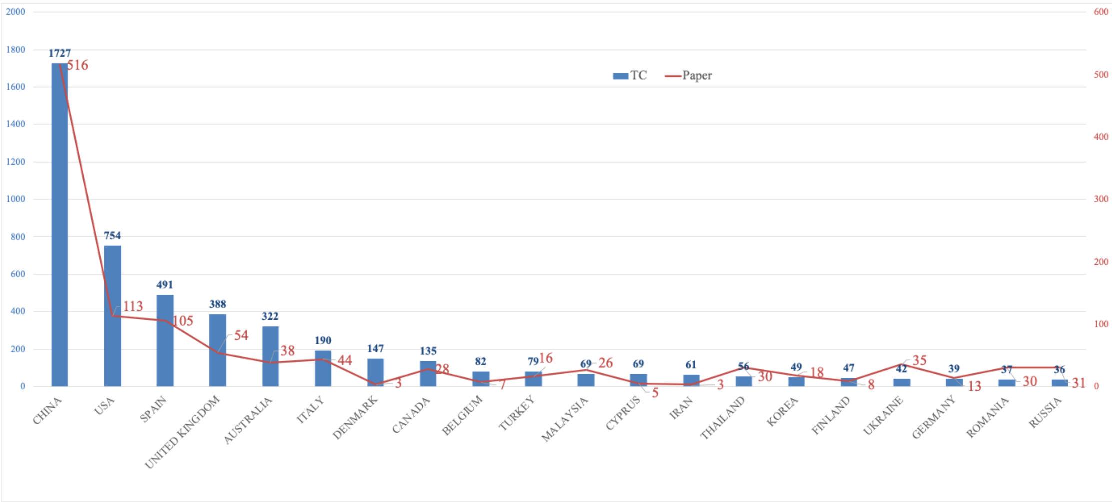

Figure 4. Total citation and article based on countries

According to Figure 4, China is far ahead in terms of publication count and total citations; it is the country that produces the most documents with 516 publications and also ranks first in terms of impact with a total of 1,727 citations. China is followed by the US, Spain, and the UK in terms of publication count and total citations; the fact that these four countries rank in the top four in both the Paper and TC rankings indicates that these countries are the production centers forming the core of the field. Australia and Italy also join this core group, maintaining their positions in the top ranks despite relatively lower publication counts.

On the other hand, the relationship between the number of publications and citation impact is not symmetrical in some countries. Denmark, Iran, Cyprus, and Belgium, in particular, stand out by receiving a high total number of citations with very few articles. For example, Denmark has accumulated enough citations to rank seventh with only three publications, indicating an extremely high average number of citations per article. Similarly, Iran and Cyprus have secured relatively high rankings with a small number of studies, suggesting that publications from these countries have become “niche” but important reference points within their fields. In contrast, countries such as Ukraine, Russia, Thailand, and Romania, despite producing a greater number of publications, remain at the lower end of the total citation ranking, indicating a stage of development where production has increased quantitatively but has not yet achieved a high citation impact.
Overall, it can be said that the areas where the field is concentrated in terms of both production and citation impact are China, Anglo-Saxon countries, and Southern and Western Europe; alongside this, some small or developing countries have carved out a place for themselves in the literature with few but highly influential publications. This situation reveals that technology research in music education is increasingly taking on a global character, but it is still concentrated around specific regional centers.

Table 5. Most influential paper in

Paper	Total Citations	TC per Year	Normalized TC
Innocenti et al. (2019)	103	14.71	10.32
Crawford (2017)	73	8.11	7.17
Yu et al. (2023)	71	23.67	22.80
Waddell & Williamon (2019)	70	10.00	7.01
Hash (2021)	65	13.00	11.94
Bell (2018)	59	7.38	8.49
Wei et al. (2022)	56	14.00	13.14
Johnson (2017)	55	6.11	5.40
Shahab et al. (2022)	54	13.50	12.67
Pei & Wang (2022)	53	13.25	12.43
Zhang et al. (2024)	29	14.50	16.52
X. Liu & Shao (2024)	26	13.00	14.81
Uzumcu & Acilmis (2024)	26	13.00	14.81
Li & Wang (2024)	24	12.00	13.67
Rexhepi et al. (2024)	21	10.50	11.96

Blanco-García et al. (2025)	5	5.00	13.58

Innocenti's 2019 article in Computers and Education is clearly the most cited of all the articles (As shown in Table 5). This study has 103 citations and an average of 14.71 citations per year. It is one of the most important sources in the field of music education and technology. Early publications such as Crawford (2017) and Johnson (2017) can be read as studies that form a conceptual and theoretical framework in the literature with their consistent citation performance over the years. The fact that the articles by Waddell & Williamon (2019) and Hash (2021) appear specifically in music education journals indicates that discussions on the integration of technology into music education have moved to the center of mainstream music education literature. The inclusion of Bell (2018)'s study "Dawn of the DAW" in the list suggests that conceptualizing the digital audio workstation as a musical instrument occupies an important place in the theoretical discussions of the field.

Looking at normalized citations and average citations per year, more recent studies stand out significantly. Yu et al. (2023)'s article technologies, despite having a relatively limited total number of citations, points to a rapidly emerging focus area with very high annual and normalized citation values, attracting intense interest in a short period. Similarly, the annual and normalized citation scores of the 2022 studies by Wei et al. (2022), Shahab et al. (2022), and Pei & Wang (2022) suggest that technology-supported learning, data-driven models, and computational approaches have rapidly gained visibility in the context of music education in recent years. The fact that the normalized citation values of Zhang et al. (2024), X. Liu & Shao (2024), Uzumcu & Acilmis (2024), Li & Wang (2024), and Rexhepi et al. (2024)'s articles are very high is even more impressive given that these articles were published recently. This indicates that these studies have created new areas of interest in the field.

Blanco-García et al. (2025)'s paper has a high normalized citation value, which is interesting given that it does not receive a large number of citations overall. This situation can be interpreted as an early signal that the study began to receive citations rapidly shortly after its publication and may rise to higher ranks among the most influential publications in the near future. Furthermore, the diversity of the journals on the list reveals that not only music education-focused journals but also multidisciplinary journals such as computer engineering, human-computer interaction, and educational technologies have become platforms for publishing the most influential works in the field. Therefore, this picture shows that the literature on the use of technology in music education is increasingly taking on an interdisciplinary character and that effective studies are now spreading across a broad academic ecosystem.

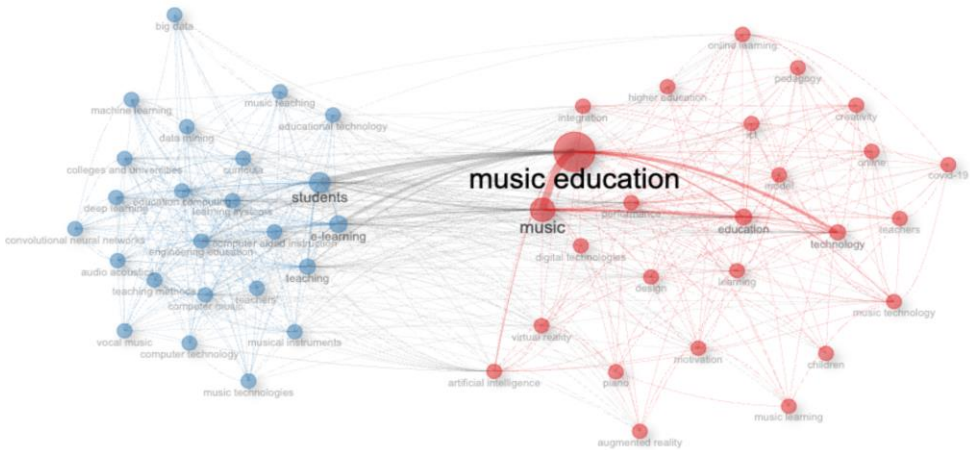

Figure 4. Network graph for keywords

This network graph shows that two main clusters have formed in the literature on the use of technology in music education. Music education, located in the first cluster, is at the center of the entire structure. This node is closely related to concepts such as education, music, technology, online learning, virtual reality, augmented reality, COVID-19, and pedagogy. The second cluster, centered around the node “students,” includes more technical and computer science-focused terms such as e-learning, teaching, engineering education, computer music, learning systems, machine learning, deep learning, big data, and convolutional neural networks. The large number of connections between the two clusters suggests that music education research has become an interdisciplinary field that bridges the pedagogical dimension with approaches rooted in computer science and engineering. Centrality measures also confirm this structure numerically. The node with the highest betweenness value is clearly music education. This result shows that almost all technology-related studies in music education are connected to each other through the concept of music education. The fact that the music and education nodes also have relatively high betweenness and PageRank values reveals that core field concepts are still more dominant than technological terms. The fact that the “students” node has quite high betweenness and PageRank values within the second cluster and across the entire network suggests that technological applications are specifically designed with students in mind and that a student-centered approach is adopted in the research. The relatively high PageRank values of the “e-learning,” “teaching,” and “engineering education” nodes show that online learning and teaching design themes occupy an important place in the literature.

Concepts directly related to technology have relatively lower betweenness values. This suggests that topics such as artificial intelligence, virtual reality, augmented reality, deep learning, and big data have not yet become central enough to define the field's core discourse on their own; rather, they are treated as sub-themes integrated into the existing pedagogical framework. However, the fact that these nodes have numerous connections with the music education and students nodes shows that these technologies are rapidly being internalized in music education, particularly in the context of enriching the student experience, assessment, and personalized learning. The fact that the Covid 19 node occupies a low but visible centrality in the first cluster implies that the pandemic has led to a temporary but noticeable concentration around the concepts of online music education, online learning, and technology.

Overall, the network structure reveals a division of labor rather than a sharp distinction between the two clusters. The first cluster represents the pedagogical, affective, and contextual dimensions of music education (creativity, motivation, teachers, pedagogy, higher education, performance), while the second cluster represents the tools, methods, and algorithms used to support these pedagogical goals (educational technology, computer-aided instruction, learning systems, machine learning, data mining). This table summarizes the fundamental orientation of music education and technology literature between 2016 and 2025 as a research ecosystem that centers on the student and combines pedagogical goals with technical innovations. Therefore, it can be said that the tighter integration of artificial intelligence, data-driven assessment, and immersive technologies with pedagogical design will be an important development path for future work.

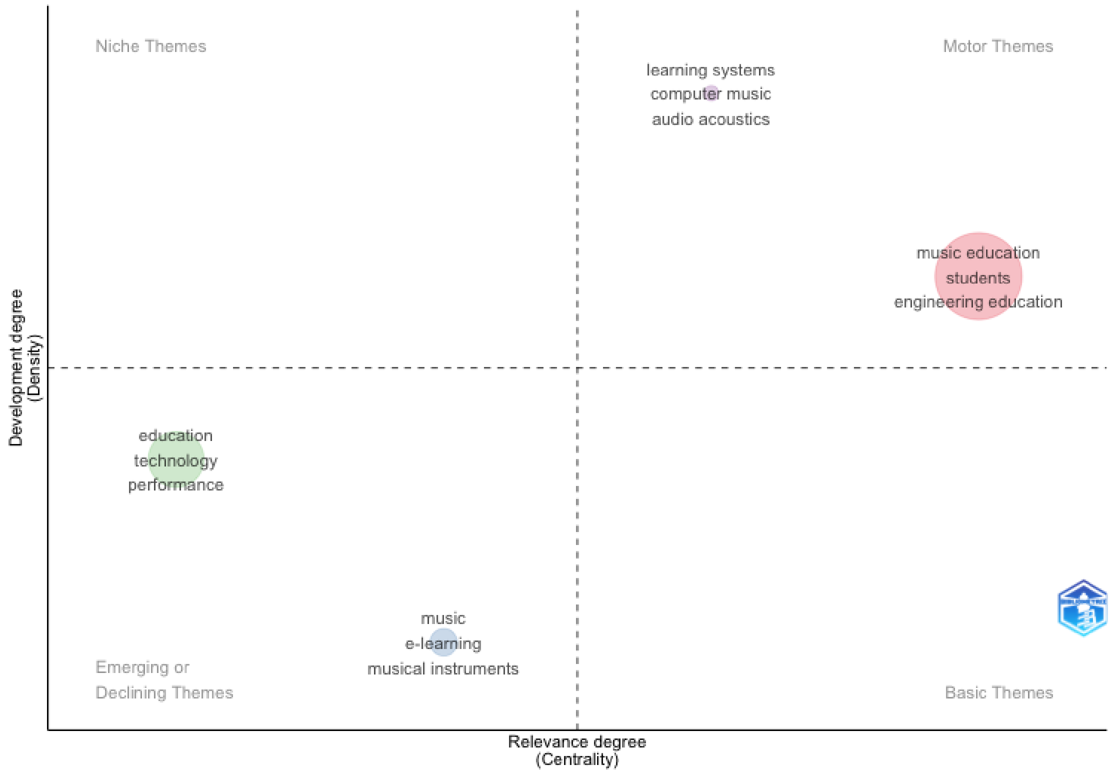

Figure 5. Thematic Analysis

The thematic map (Figure 5) clearly shows that the literature in the field of technology in music education can be divided into four main clusters during the 2016–2025 period, and these clusters clearly indicate their function in the field. The cluster "music education – students – engineering education" located in the upper right region is among the core themes. Due to its high centrality and density, these studies form the backbone of the field. Key words focus on studies conducted on students, music education applications in the context of engineering education, curriculum design, and the integration of technologies such as artificial intelligence, big data, and cloud computing. According to the table, terms such as "students," "teaching," "education computing," and "artificial intelligence" have very high betweenness and PageRank values; this shows that student-centered technology integration studies play a bridging role in the network, connecting different subfields. Therefore, it can be said that technology-supported music education has become a core area in the current literature, both pedagogically and engineering-focused.

The "learning systems – computer music – audio acoustics" cluster, also located in the upper right, points to a second driving theme with high density values. This group revolves around technical terms such as deep learning, convolutional neural networks, machine learning, adversarial learning, personalized learning, recommendation systems, and human-computer interaction. In other words, it appears that studies originating from computer science and audio processing are developing intelligent learning environments and automatic feedback systems for music education. The high density of this cluster suggests that researchers cite each other frequently and that a technical research line is consolidated. At the same time, its high centrality indicates that these technical studies do not remain isolated but establish strong links with the general music education technology literature.

The "education – technology – performance" cluster in the upper left is in the niche themes region. Words such as education, performance, teacher, design, motivation, experience, perception, creativity, TPACK, YouTube, classroom, and pedagogical content knowledge point to studies that discuss technology use more in terms of pedagogical design, teacher competencies, and performance outcomes. The high density and relatively low centrality of this cluster indicate that this area has a well-developed sub-literature but is positioned somewhat peripherally relative to the core of the music education technology network.

In other words, these studies examining the technology–pedagogy–performance relationship are quite in-depth but offer a more specific and specialized focus compared to the more general "music education–students–engineering education" core. The "music – e-learning – musical instruments" cluster located in the lower left region can be interpreted as emerging or declining themes.

Terms such as music, e-learning, online music, computer-assisted instruction, virtual and augmented reality, online education and training, and teaching–learning environments form this group. Low centrality indicates that these studies have not yet established a strong connection within the overall structure of the network; low density indicates that the subfield is relatively scattered within itself. This situation suggests that e-learning and VR/AR-based music education studies are still in their infancy and may become more centralized in the future as they intensify, or conversely, may become a truly "declining" theme as interest wanes.

Overall, the thematic map shows that technology research in music education has, on the one hand, made student- and curriculum-centered technology integration a driving theme, while on the other hand, technical studies based on artificial intelligence and learning systems have rapidly risen to become the field's second driving force. Pedagogical design and teacher-focused research are strong but progressing along a more niche line, while e-learning and virtual/online music environments appear as themes that are not yet fully institutionalized and are open to development. This picture points to the potential for e-learning and VR/AR themes to evolve into driving themes in the future, as well as the need for technical "learning systems" studies to be more closely integrated with educational theory and practice.

Future research analysis

Studies on the integration of music education and technology have identified clear challenges, gaps, and promising areas for future researchers. By synthesizing the recommendations in the publications, priority and "hot topics" for future research have been determined.

Performance Evaluation and Advanced AI Models

One of the most prominent and technology-focused hot topics for future research is the deeper use of AI in evaluating music performance and learning outcomes. Future research should focus on integrating deep learning models for student performance assessment in music education (Li & Wang, 2024; Wei et al., 2022). This offers the potential to evaluate performance and provide more information about students' musical development (Yu et al., 2023).

In this context, the development of future educational virtual reality robots (V2R) should aim to enhance their ability to evaluate children's performance and their capabilities for "automatic/self-assessment" and "adaptive teaching" (Shahab et al., 2022). This parallels findings that emphasize the importance of the interactive use of technological tools in lesson plans (Uzumcu & Acilmis, 2024). Based on the proposed algorithms used in current studies (such as the Analytic Hierarchy Process - AHP and fuzzy correlation), research should be conducted on the use of these algorithms in music applications and software for teaching instrumental techniques and music theory (Li & Wang, 2024). In addition, since artificial intelligence creates individual learning paths by identifying students' learning patterns and needs, it is important to examine the effectiveness of these AI-driven personalization mechanisms (Li & Wang, 2024).

Pedagogical Competence, Transdisciplinary Integration, and Long-Term Impact

The long-term effects of methodological changes arising from the integration of technology into the classroom and how teachers will adapt to this transformation are critical areas of research. Research is needed to evaluate the long-term impact of integrated approaches (combining digital and artistic competencies) on students' academic and professional development (Blanco-García et al., 2025). Furthermore, the degree to which musicians continue to use technology after adaptation and their ongoing satisfaction should be examined (Waddell & Williamon, 2019).

Focus should be placed on evaluating the practical application of the proposed transdisciplinary education model in various educational contexts to ensure its long-term impact on student learning outcomes (Waddell & Williamon, 2019). It is imperative to identify new assessment methods and criteria that capture the quality and quantity of transversal competencies developed in integrated learning environments, such as creativity, collaboration, and critical thinking (Blanco-García et al., 2025; Rexhepi et al., 2024). In addition, it is necessary to examine in more detail how they incorporate technology into individual teaching studio education and why musicians choose this technology (Waddell & Williamon, 2019).

Equality, Inclusion, and Special Educational Needs (SEN)

Ensuring that the opportunities offered by digital technologies reach all student groups, especially disadvantaged and special needs students, is an urgent research topic.

More effort and resources should be focused on ensuring that the inclusion of digital technologies in music education provides equal opportunities for all students (Rexhepi et al., 2024). This includes exploring how distance learning can support traditional education to provide high-quality learning resources to rural and remote schools (Hash, 2021). The impact of V2R technology on the cognitive rehabilitation of children with autism spectrum disorder should be examined more systematically (Shahab et al., 2022).

Since most current studies focus on piano education, future research should develop and test mobile-enabled learning courses for other musical instruments (X. Liu & Shao, 2024). Research should be conducted on how technology can fill gaps related to kinematic aspects such as posture and injury prevention (Waddell & Williamon, 2019).

Application and Impact of Emerging Technologies

It is important to examine the pedagogical effects of artificial intelligence tools and the outcomes of different types of digital tools on learning. Research should be conducted on how different types of digital instruments and platforms affect the development of students' musical skills, musical creativity, and learning motivation (Rexhepi et al., 2024). It should be examined how major advances in media platforms such as VR and AR can encourage innovation in teachers' use of these as learning tools (Wei et al., 2022). It can be examined how teachers' individual levels of innovation affect their interactive usage preferences when they include AI-supported tools (e.g., Google Arts and Culture) in their lesson plans on their own initiative (Uzumcu & Acilmis, 2024).

Cybersecurity and Privacy (AI and Cloud Networks)

The increasing security of online music education is a new area of research, particularly in the context of AI and deep learning models. The “black box” nature of deep learning models reduces their interpretability; therefore, future studies should explore Explainable AI methods to provide deeper insights. Methods such as unsupervised and adversarial learning should be explored to address evolving cyber threats (cyberattacks, real-time interactive audio, and ultra-low latency demands specific to music platforms). Steps should be taken to develop specialized datasets that accurately reflect the unique dynamics of cloud-based online music education platforms (Zhang et al., 2024).

These themes demonstrate that technological integration in music education goes beyond being merely a technical issue, requiring complex considerations such as pedagogical innovation, equity, ethical evaluation, and system security (Blanco-García et al., 2025; Zhang et al., 2024).

Discussion

The Rapid Growth and Maturation of Technology Use in Music Education

Findings from the 2016–2025 period indicate that the field has transformed into a rapidly growing publication ecosystem. The distribution of 1,553 documents across 539 different sources suggests that production is not concentrated in a few journals. The annual growth rate of 16.36% and the low average age of documents (2.96 years) also indicate that the literature is “young.” However, the average number of citations per document (3.89) shows that while the field is expanding quantitatively, the accumulation of impact has not yet matured at the same pace.

The number of publications by year reveals that the break occurred particularly after 2020. While the annual number of publications ranged between 55 and 66 between 2016 and 2019, it rose to 140 in 2020. The increase continued in subsequent years, reaching a high value of 311 in 2024. Although there is a drop to 258 in 2025, the level is still well above that of the 2016–2019 period. This pattern suggests that the field has entered a phase of “mass production” in a short period of time.

To explain this rise, the simultaneous emergence of the practical nature of music education and technological necessity provides an important framework. The rapid shift to remote education during the pandemic exposed gaps in planning and policy (Shaw & Mayo, 2022). Students' satisfaction with the flexibility of online classes, but their particular difficulty with ensemble performance and auditory feedback, was also a notable finding of this period (Rucsanda et al., 2021). Subsequent studies show that fully online models are not considered sufficient and that hybrid options have emerged as a permanent alternative (Toscano et al., 2024; Váradi et al., 2024). This context makes it possible to link the post-2020 increase in publications not only to technological innovation but also to the “urgent need” that emerged at the system level.

The citation pattern suggests that the field relies on both “core” sources and has produced rapidly emerging focal points in recent years. Innocenti et al. (2019)'s article stands out as the most cited work and serves as a strong reference point for the field. Among early publications, Crawford (2017) and Johnson (2017) are positioned as studies that lay more of a conceptual groundwork. The visibility of studies such as Waddell & Williamon (2019) and Hash (2021) in music education journals implies that the discussion of technology integration has been brought into the mainstream music education literature. The inclusion of Bell (2018)'s “DAW” approach in the list also reinforces a line of argument that conceptualizes technology not merely as a tool but as a musical “instrument.”

Although the total number of citations is relatively limited in more recent studies, the high annual and normalized citation values are noteworthy. The rapid emergence of studies such as Yu et al. (2023), Wei et al. (2022), Shahab et al. (2022), and Pei & Wang (2022) indicates that the field's agenda is rapidly evolving. The high normalized citation values of 2024 studies ((Li & Wang, 2024; X. Liu & Shao, 2024; Rexhepi et al., 2024; Uzumcu & Acilmis, 2024; Zhang et al., 2024) also point to an “early momentum” effect. This suggests that new themes are being rapidly adopted in the field, but that the accumulation of classic citations takes time.

Collaboration Patterns and Geographical Dynamics

The findings of this study reveal that collaborations in the field of technology in music education have certain characteristics. An average of 2.35 co-authors per document indicates a moderate level of collaboration. However, the existence of 670 single-authored documents shows that individual academic effort is still prevalent. The fact that the international collaboration rate remains at only 7.34% reveals that collaborations largely occur at the national or local level. This limitation may be a disadvantage in terms of the field's global visibility. However, as Clauhs (2020) shows, online platforms allow participants from different regions to work together on joint projects. Similar collaboration models can also be developed at the researcher level.

The author collaboration network shows that the field is organized around tightly connected small research groups. Wang Y and Li Y are key actors in a broad China-centered network with high betweenness values. Li & Wang (2024)'s work on AI-assisted piano education exemplifies the effective research produced by this network. The Italian school, represented by Ludovico L and Avanzini F, presents a different model based on small but intensive collaboration. Ludovico's prominence with 15 publications and 144 citations confirms that this team produces effective work with a specific focus. But the fact that clusters don't connect very well can make it tougher for knowledge to transfer between different fields of study. Ma & Wang (2025) emphasize that research in technology and music education has become increasingly integrated. There must be additional links between research groups to make this multidisciplinary framework stronger.

China has the most publications (516) and citations (1,727) of any country in the world. The US, Spain, and the UK make up the rest of the core. At the institutional level, the University of Valencia is the most productive, with 26 articles. The fact that there are so many Spanish and Australian universities is due to the way research is done and the way the government works in these countries. On the other hand, Denmark, Iran, and Cyprus get attention because they don't have many highly cited papers. This shows that scholars from different fields can still help the field, even though Jing (2024) pointed out the differences in access. The field is largely centered on specific regions, but it is growing more worldwide.

Technological Innovations and Pedagogical Integration

Network analysis shows that technology-related studies in music education fall into two main groups. The first group includes topics such as pedagogy (teaching), creativity, motivation, and performance. The second group includes more technical concepts such as artificial intelligence, deep learning, machine learning, and virtual reality. The strong connections between these two groups show that new technologies are being integrated with teaching objectives. However, concepts such as artificial intelligence and virtual reality are not yet at the center of the field; that is, they have not yet reached a position powerful enough to determine the main agenda of the field on their own.

The thematic map results also support this. Topics such as pedagogical design, teacher competencies, and TPACK are seen as “niche themes.” Although these topics are studied in detail within themselves, they occupy less space at the center of the general literature. In other words, although studies that address technology and pedagogy together are in-depth, they are not fully integrated with mainstream discussions.

Research reveals a similar picture regarding teachers' and teacher candidates' views on technology. Kılınçer (2025) finds that music teacher candidates have a positive attitude toward technology but do not consider themselves competent in integrating it pedagogically into their lessons. Maharaj & Gill (2023) and Marín-Suelves et al. (2022) also emphasize that teachers often view technology as an "afterthought" to the curriculum, and therefore its full potential is not being utilized. Crawford (2017) and Gorgoretti (2019) state that technology should be included in the design of the lesson from the outset; it should not remain merely an auxiliary tool.

It is noteworthy that e-learning and virtual/augmented reality themes are located in the "developing" or "declining" areas of the thematic map. This indicates that these areas are not yet fully established and may become more fundamental (motor) themes as they are further developed in the future.

For example, Shahab et al. (2022) show that educational virtual reality robots can be used to assess children's performance. Wei et al. (2022) explore the innovative use of VR and AR platforms as learning tools. Artificial intelligence applications are also rapidly emerging.

Atabek & Burak (2024) note that the vast majority of teacher candidates believe technology has a positive impact on music education. In contrast, Chan & Colloton (2024) and Karpouzis (2024) emphasize the need to develop AI literacy and establish criteria/frameworks for evaluating AI-assisted music production.

Overall, the findings indicate that integrating new technologies more closely with pedagogical design and educational theory is an important direction for development in the field.

Research Gaps and Future Directions

The findings of this study indicate that there are various research gaps in the field of technology in music education. When examining the most influential publications' recommendations for future research, five main areas stand out.

1) Artificial intelligence and deep learning in performance assessment Li & Wang (2024) state that the focus should be on how deep learning models can be integrated into the classroom to assess student performance. Yu et al. (2023) indicate that this approach can provide more comprehensive information about students' musical development. Shahab et al. (2022) emphasize the need to develop virtual reality robots for educational purposes with automatic assessment and student-adaptive teaching features.

2) Long-term effects of technology integration Blanco-García et al. (2025) state that it is necessary to measure what integrated approaches combining digital and artistic competencies contribute to students' academic and professional development in the long term. Waddell & Williamon (2019) also suggest examining whether musicians continue to use these tools for a long time after becoming accustomed to the technology.

3) Equity and inclusivity Rexhepi et al. (2024) state that equal opportunities for all students must be ensured when using digital technologies in music education. Hash (2021) suggests researching how distance learning can be used to provide quality learning resources to rural and remote schools. Furthermore, Shahab et al. (2022) recommend systematically investigating the effect of virtual reality on cognitive rehabilitation in children with autism spectrum disorder.

4) Pedagogical effects of new technologies Most current studies focus on piano education. X. Liu & Shao (2024) state that mobile-supported learning lessons should be developed and tested for other instruments as well. Uzumcu & Acilmis (2024) suggest researching whether teachers' individual levels of innovation affect how and to what extent they use AI-supported tools interactively when incorporating them into lesson plans.

5) Cybersecurity and privacy Zhang et al. (2024) note that the "black box" nature of deep learning models makes it difficult to understand the results. Therefore, they state that future studies should focus on Explainable AI methods. They also recommend developing specialized datasets that reflect the real-world conditions of cloud-based online music education platforms.

Ultimately, these themes demonstrate that the use of technology in music education is not merely a technical issue. Dimensions such as pedagogical innovation, equity, ethical evaluation, and system security must be addressed collectively (Blanco-García et al., 2025; Zhang et al., 2024).

Conclusion

This study presents a bibliometric analysis of the literature on the use of technology in music education between 2016 and 2025. A total of 1,553 publications obtained from the Scopus and Web of Science databases were examined. The findings reveal that the field is rapidly expanding at an annual growth rate of 16.36%. In particular, the publication boom after 2020 indicates that the COVID-19 pandemic triggered research on remote and online music education (Shaw & Mayo, 2022; Toscano et al., 2024).

The study's key findings can be summarized under four headings. First, the field is not yet fully mature. Low average citation values and a limited number of review articles highlight the need for synthesis studies. Second, collaboration patterns are concentrated at the national and local levels. The international collaboration rate remaining at 7.34% indicates that global knowledge flow needs to be strengthened. Third, China, the US, Spain, and the UK constitute the production centers of the field. However, highly influential publications from countries such as Denmark and Cyprus show that the field is becoming increasingly global in character. Fourth, technologies such as artificial intelligence, virtual reality, and deep learning are rapidly gaining visibility. However, integrating these technologies with pedagogical design is emerging as a critical need (Crawford, 2017; Maharaj & Gill, 2023).

This study has some limitations. First, only the Scopus and Web of Science databases were used. The exclusion of other sources such as ERIC, Google Scholar, and regional indexes may have resulted in some relevant publications being left out. Second, only English-language publications were included. Important studies published in other languages were excluded from the analysis. This may particularly result in the underrepresentation of research from countries with strong music education traditions in languages other than English. Third, the selection of the 2016–2025 time frame excluded studies that laid the early foundations of the field from the evaluation. Finally, bibliometric analysis, by its nature, focuses on quantitative patterns. The depth of content and methodological quality of publications cannot be assessed using this method.

In conclusion, the use of technology in music education continues to evolve as a dynamic and interdisciplinary field of research. The positive effects of digital tools on musical achievement, motivation, and creative expression have been proven (Kalkanoğlu, 2024; Ouyang, 2023). However, challenges such as access inequalities, teacher competencies, and ethical concerns persist (Jing, 2024; Kılınçer, 2025). For the field to mature, increased international collaboration, more synthesis studies, and closer integration of technological innovations with pedagogical theory are required.

AI Usage and Assistance

ChatGPT 5.1 was used to improve the language editing and readability of the manuscript. After AI editing, I read the content as the author and approve it.

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