OPEN ACCESS

Saudi Journal of Humanities and Social Sciences
Abbreviated Key Title: Saudi J Humanities Soc Sci
ISSN 2415-6256 (Print) | ISSN 2415-6248 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Research on the Development of Piano Education Based on Bibliometric and Visualization Analysis

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DOI: https://doi.org/10.36348/sjhss.2024.v09i10.001 | **Received:** 29.08.2024 | **Accepted:** 03.10.2024 | **Published:** 05.10.2024

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Abstract

This paper aims to employ bibliometrics and visualization analysis to investigate the current development status and research hotspots in the field of piano education. The literature data is obtained from the Web of Science Core Collection database, analyzing publication years, core journals, courtiers/regions distribution, keyword co-occurrence maps, and highly cited papers in this research area. The results indicate that the number of relevant publications began rapidly growing in 2015. The United States and China are identified as the core countries for publications; however, the level of international collaboration remains relatively low. Major research hotspots include the innovative application of artificial intelligence (AI) and augmented reality (AR) technologies in piano education, online education, cross-cultural education, etc.

Keywords: Bibliometric, visualization analysis, piano education, knowledge map.

1. INTRODUCTION

Piano education is a form of education that helps enhance students' musical skills, artistic expression, and literary literacy, significantly impacting both higher and basic education. It improves participants' technical proficiency and fosters cognitive, social, and emotional development. Research indicates that early exposure to music education can boost children's academic performance and cognitive abilities (Schellenberg, 2004). Furthermore, adults receiving music education can experience improvements in audio-visual perception as well (Che *et al*., 2022).

Bibliometric analysis is a method that employs quantitative analysis to examine the characteristics and patterns related to academic literature. By revealing trends and influences within the literature, it provides insight into the current state of development in a specific discipline and forecasts future trends (Rojas-Sánchez *et al*., 2023). This method has broad applications in fields such as information science, library science, and social sciences. However, there has yet to be a bibliometric review specifically focused on piano education.

Therefore, the purpose of this paper is to conduct a comprehensive and systematic bibliometric and visualization analysis of literature related to piano education using the open-source software VOSviewer and the R-package Bibliometrix. The study will create a knowledge map to explore the current research landscape and hotspots, providing references for researchers and practitioners in this area.

2. DATA SOURCES AND METHODS

2.1 Data Sources

The literature data is obtained from the Web of Science Core Collection database on August 14, 2024. Search strategy in Topic: “piano learning” or “piano instruction” or “piano teach*” or “piano education” or “piano pedagogy” or “piano lesson*”. The document types include articles and reviews. A total of 523 literatures were retrieved. Excluding retracted publications, 500 articles were obtained.

2.2 Methods

Excel software was used for data cleaning, normalization, and statistical analysis. The knowledge mapping software VOSviewer (van Eck & Waltman, 2010) was conducted to draw the authors’ keyword co-occurrence network and keyword heat map. The R-package bibliometrix was carried out to analyze the countries/regions’ distribution and international cooperation.

3. RESULTS AND DISCUSSION

3.1 Overall Temporal Distribution

Figure 1 illustrates the annual publication trends of documents on piano education. The earliest

related research can be traced back to 1914, with C.A. Buckmich's article titled 'The Psychology of Piano Instruction,' published in the *Journal of Educational Psychology* (Buckmich, 1914). Following this, the field experienced a period of slow development, which accelerated significantly after 2015. This indicates that the academic community's focus on piano education has progressively increased over the past decade. It is important to note that the decrease in publication numbers for the years 2024 and 2025 is due to the data retrieval being conducted in August 2024; therefore, the publication counts for these two years are incomplete and should be interpreted with caution.

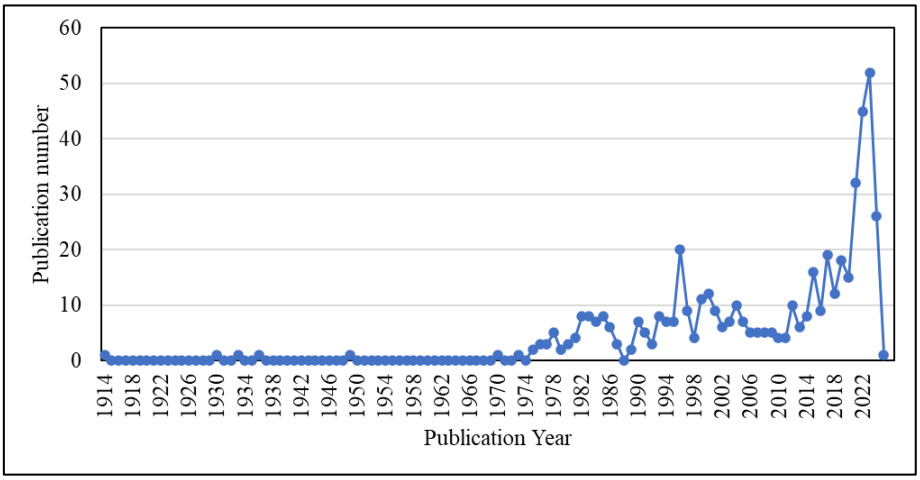

Figure 1: Temporal distribution of documents related to piano education

3.2 Core Journals

A total of 500 papers are primarily sourced from 188 journals. Figure 2 presents the top ten journals by publication volume. The journal *Clavier* has the highest number of publications (129 documents), which accounts for 25.8% of the overall publication count.

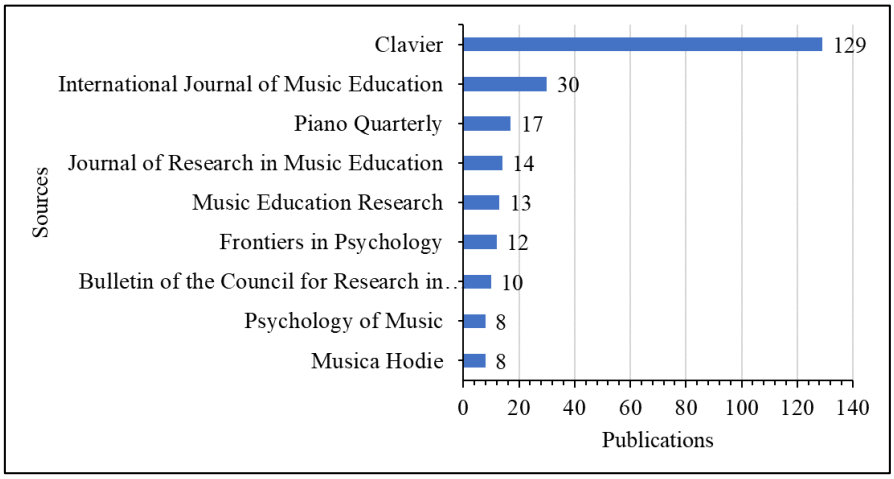

Figure 2: Top 10 journals in the piano education field

However, it is noteworthy that the publication timeline for this journal is concentrated between 1976 and 2006. Following closely is the *International Journal of Music Education* (Impact Factor 2023: 1.3) from Sage Publications Ltd, with a publication count of 30 documents.

3.3 Couriers/regions distribution

In the field of piano education, the 500 literatures originate from a total of 38 countries/regions. The countries/regions with the highest publications number are the United States (104 documents) and China (94 documents), accounting for 20.8% and 18.8% of the total publication volume, respectively, significantly surpassing other countries. This demonstrates that the promotion and teaching standards of piano education in contemporary China and the United States have become increasingly leading compared to other countries. In international piano competitions hosted by various countries, contestants from these two nations make up a large proportion and have achieved remarkable results.

Table 1: Core countries/regions in the piano education area

No	Country	Articles	Article Ratio/%	SCP[a]	MCP[b]	MCP Ratio/%
1	USA	104	20.8	100	4	3.8
2	China	94	18.8	85	9	9.6
3	Canada	21	4.2	19	2	9.5
4	Brazil	16	3.2	14	2	12.5
5	United Kingdom	12	2.4	10	2	16.7
6	Australia	12	2.4	11	1	8.3
7	Germany	9	1.8	5	4	44.4
8	Turkey	9	1.8	9	0	0
9	Japan	7	1.4	5	2	28.6
10	Spain	7	1.4	6	1	14.3
11	Korea	6	1.2	4	2	33.3
12	Switzerland	5	1	3	2	40
13	South Africa	5	1	4	1	20

[a]:SCP: single country publication;
[b]:MCP: multiple countries publication.

The multiple countries publication (MCP) Ratio can be used to measure the level of international collaboration in a research field (Gülhan & Kurutkan, 2021). Table 1 presents the single country publication (SCP) and MCP results for countries/regions (over five publications). It is evident that although the United States and China have high publication counts, both countries exhibit an MCP Ratio of less than 10%, indicating a relatively low level of international cooperation in the piano education area. In contrast, Germany and Korea demonstrate higher levels of international collaboration, with MCP Ratios of 44.4% and 33.3%, respectively.

3.4 Keyword co-occurrence map

The software VOSviewer was conducted to create the core keywords co-occurrence map, with a keyword frequency of three or more. The Overlay Visualization layout was selected to superimpose the timeline of keyword occurrences onto the map (Figure 3). In the keyword co-occurrence network, there are 49 nodes and 199 edges. Each node represents a keyword, with larger nodes indicating higher frequencies of occurrence. While the thickness of the edges correlates with the frequency of co-occurrence between two keywords. The depth of color in the nodes suggests the chronological order of keyword emergence; deeper colors signify earlier occurrences, while lighter colors represent more recent ones.

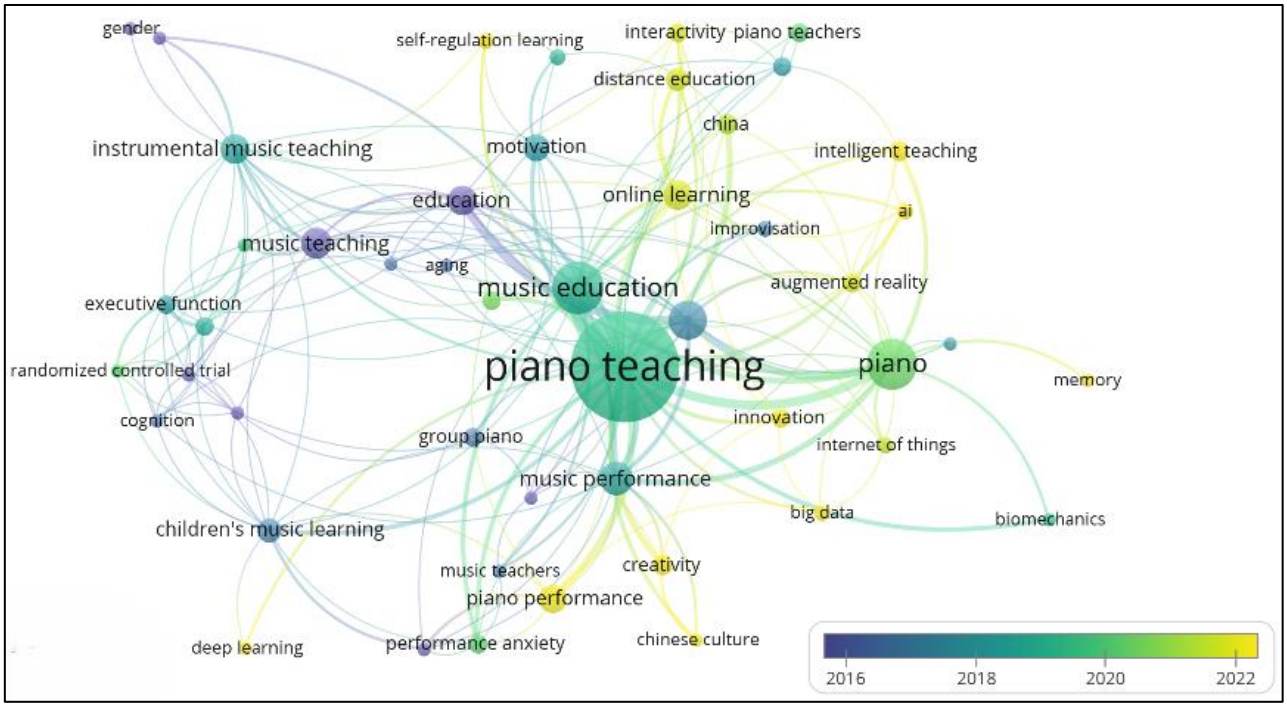

Figure 3: Overlay map of keyword co-occurrence network in the piano area

From Figure 3, it is evident that keywords such as “piano education”, “music teaching”, “music teachers”, “children’s music learning”, “aging”, and “cognition” emerged earlier. Table 2 lists the top 10 highly cited papers in piano education research. Most of these documents were published around the year 2000 and primarily focused on the impact of piano teaching on cognitive development in children, adolescents, and older adults. These suggest that the cognitive benefits of piano training have been evidenced by a large number of literature (Bezerra & Pereira Fialho, 2020; Miendlarzewska & Trost, 2014; Roman-Caballero *et al*., 2022).

In recent years, research hotspots of piano education have shifted towards “online learning”, “intelligent teaching”, and “self-regulated learning”. Notably, the application of artificial intelligence (AI) technologies such as “deep learning”, “augmented reality”, and “Internet of Things” in piano teaching has gained significant traction.

Table 2: The top 10 highly cited papers in the piano education field

No	Author	Title	Journal	Total Cites (WoSCC)	Publication Year
1	Bugos, J. A.; Perlstein, W. M.; McCrae, C. S *et al*.,	Individualized Piano Instruction enhances executive functioning and working memory in older adults	Aging & Mental Health	263	2007
2	Bangert, M; Altenmüller, EO	Mapping perception to action in piano practice: a longitudinal DC-EEG study	BMC Neuroscience	261	2003
3	Miendlarzewska, Ewa A.; Trost, Wiebke J.	How musical training affects cognitive development: rhythm reward and other modulating variables	Frontiers in Neuroscience	149	2014
4	Costa-Giomi, E	The effects of three years of piano instruction on children's cognitive development	Journal of Research in Music Education	139	1999
5	Seinfeld, Sofia; Figueroa, Heidi; Ortiz-Gil, Jordi *et al*.,	Effects of music learning and piano practice on cognitive function, mood and quality of life in older adults	Frontiers in Psychology	137	2013
6	Williamon, A; Valentine, E	Quantity and quality of musical practice as predictors of performance quality	British Journal of Psychology	103	2000
7	Shahin, Antoine J.; Roberts, Larry E.; Chau, Wilkin *et al*.,	Music training leads to the development of timbre-specific gamma band activity	Neuroimage	98	2008
8	Nutley, Sissela Bergman; Darki, Fahimeh; Klingberg, Torkel	Music practice is associated with development of working memory during childhood and adolescence	Frontiers in Human Neuroscience	91	2014
9	Holochwost, Steven J.; Propper, Cathi B.; Wolf, Dennie Palmer *et al*.,	Music Education, Academic Achievement, and Executive Functions	Psychology of Aesthetics Creativity and The Arts	67	2017
10	Siebenaler, DJ	Analysis of teacher-student interactions in the piano lessons of adults and children	Journal of Research in Music Education	66	1997

Figure 4 illustrates the heatmap of keywords in the piano education field. The intensity of color corresponds to the frequency of keyword occurrences. The lighter colors indicate higher frequencies, while darker shades denote lower frequencies. From Figure 4, it is clear that current research hotspots include online learning, instrumental music teaching, distance education, intelligent teaching, etc.

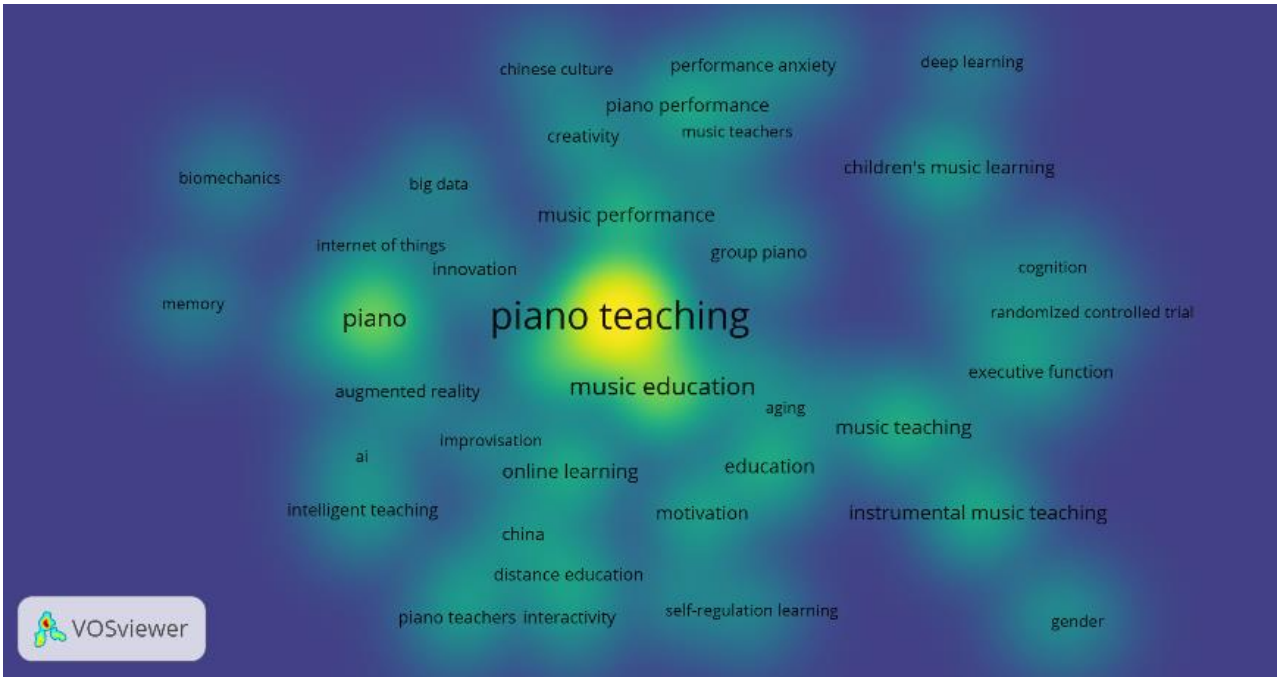

Figure 4: Heatmap of authors' keywords in the piano education field

With the advancement of AI technologies, online piano training has become a new trend, transcending geographical limitations and opening new avenues for piano instruction. For instance, the introduction of multinational connectivity, augmented reality, and other technologies in professional piano teaching has been reported (Cui, 2023; Li, 2018; Mei & Yang, 2021). Li and Zhao (2024) proposed an automatic piano fingering generation method using a temporal difference reinforcement learning model, complemented by music visualization strategies and an interactive application that enhances piano learners' understanding of music characteristics and emotional expression, while the effective online sparring in piano education requires collaborative efforts from society, platforms, teachers, and parents. Lv (2023) investigated the effectiveness of an AI-based flipped classroom model on piano education, finding that students using this method showed significantly higher knowledge levels and greater engagement compared to a control group, indicating its potential for improving learning outcomes in online learning.

Additionally, group lesson methodologies in piano learning may also emerge as a key direction for future development (Sampsel & Puscher, 2023; Sutherland & Smith, 2022). This is because traditional one-on-one piano lessons have their drawbacks, including low productivity, and lack of interaction and comparison among peers resulting in a weaker environment for mutual encouragement and fostering interest in learning.

Moreover, the applicability of Chinese national piano compositions in international education is gradually being recognized, and some excellent Chinese works are also being adopted as required study materials by many institutions, which helps to enhance students' musical literacy and understanding of Chinese traditional culture (Hu & Wang, 2024; Zou *et al.*, 2024). Consequently, the intercultural exchanges involved have become a focal point of academic interest as well.

CONCLUSION

This study employs the software VOSviewer and the R package Bibliometrix to analyze literature related to piano education from the Web of Science Core Collection database. The reach covers publication years, prominent journals, countries/regions distribution, and keyword co-occurrence network, in the relevant field. The number of publications has entered a relatively rapid development phase since 2015, indicating a promising growth trajectory. Notably, advancements in AI algorithms have provided technical support for online and distance learning in piano education, marking a significant research focus in recent years. The progress in piano education research reflects a transition from traditional to modern practices, encompassing not only updates in teaching philosophies, content, and methodologies but also the integration of new technologies. Future piano education is expected to place greater emphasis on intercultural communication, recognition of individual student differences, and innovative applications of AI techniques in teaching models.

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