Exploration of Trends and Future Under the Intersection of Music and Sports Disciplines Research

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Abstract. The development of integration between the disciplines of music and sports has not been resolved, since both the impact of music on sports and the impact on music under sports intervention are of high research value. This is in accordance with the relevant laws of bibliometrics and the connection between disciplines. To examine the state of the art of interdisciplinary research on cross-fertilization for visual analysis, data from the literature in the two fields were gathered and arranged using two visualization programs, Citespace and VOSvover. It is discovered that the cross-fertilization between music and sports is shifting from quantitative growth to qualitative improvement; the fusion of the two fields has not yet formed a stable, long-lasting, and influential group of authors and institutions; the research on the field is still in the development stage, and diversified and multidisciplinary research is receiving a lot of attention, but there are also some problems, which are primarily reflected in the fact that the research content is interdisciplinary rather than diversified. Through visualization analysis, we explore the future research directions of scholars and provide reference values.

Keywords: Multidisciplinary · Visualization · Knowledge mapping · Bibliometrics · Education · Music · Sport

1 Introduction

Crossover and integration between many disciplines and fields are required by current advances and changes. The two disciplines of music and physical education interact. This cross-fertilization process results in varying levels of impact value and brand-new discoveries, as well as the present category of interest to researchers. Both disciplines can be effectively developed at their junction to improve people's mental and physical health [1] and have a significant impact on all facets of human educational development. Especially after the influence of Covid-19, the status of music and sports has been further enhanced to meet the public's demand for a healthy life [2] and to promote the further

X. Yuan et al. (Eds.): ICEKIM 2023, AHCS 13, pp. 991–1003, 2023.
https://doi.org/10.2991/978-94-6463-172-2_104

development of multidisciplinary fields. The beneficial effects of music on sports have also been proven in many ways [3–5], through extensive literature research we can find that music has a very positive impact on the performance of athletes [6], and music is also very helpful in improving cognitive skills in physical education [7]. We can also see from the literature that sports have a significant impact on education, not only in terms of student achievement, secondary school advancement, college attendance, labor market, and all aspects of sports skills [8, 9].

The field of music and sports research continues to be explored, both in terms of the influence of music on sports and the influence of sports on musical activities. In the development process of multidisciplinary interdisciplinary research in education, music and sports are more integrated and have a high research value, both from the medical point of view [10, 11], or from a psychological point of view [12, 13], the impact on physical and musical activities is of profound significance and value, and requires ongoing research.

Standing in the context of the current globalization and multi-disciplinary integration, we analyze the hot keywords, time zone distribution, countries, and literature data of music and sports integration in the current research through content visualization analysis, clarify the current research knowledge map, and explore the current research hotspots and future development trends.

2 Materials and Methods

2.1 Data Sources

We used the Web of Science (core collection) as the primary data source for the music and sports fields to cover the connections more thoroughly between the two fields. We also decided to use the two categories of SCI-EXPANDED and SSCI for indexing to ensure the accuracy and completeness of the data. Additionally, to more closely match the cross-fertilization of the two fields we needed, we finalized the index consensus as TS = (("Sport" AND "Music") OR ("Music" AND "Physical")), and the time threshold was chosen as January 2012 to July 2022 based on research literature studies during the most recent 10-year period. After data cleaning and screening (data cleaning sessions are listed in Table 1), 309 papers were finalized.

2.2 Data Analysis

With the use of computers, bibliometrics, a measurement technique that explores the dynamics and research process of a field or discipline through literature study, may produce a clear visual knowledge map for researchers to comprehend the area or subject. The continuous research of bibliometric scholars has revealed that visual co-citation allows for a more comprehensive interpretation of the data and uncovers the intrinsic and essential connections between them [14].

Two visual analysis software, Citespace, and VOSviewer were used as research tools to complement each other to derive a clear visualization map. CiteSpace performs similarity measures through a set-theoretic approach to data normalization and obtains a

Table 1. Data cleaning and screening session

STEPS	Effects	Results
1	Enter the search formula TS = (("Sport" AND "Music") OR ("Music" AND "Physical"))	2120
2	Only research papers related to the thesis and review format are left	2074
3	Music, Sport Sciences, and Education & Educational research were selected as the primary sources of literature in three categories	325
4	Language English	318
5	Removed 1 article of the same literature	317
6	Delete 8 records that are far from the research topic and do not meet the needs	309

timezone view and a timeline view within a time slice, which allows for a This allows the evolution of knowledge and the historical span of the literature in a certain cluster to be clearly outlined in the time dimension and to understand the development process and trends in the field [15]. VOSviewer adopts a probabilistic-based data normalization approach and provides various visualization views in the fields of keywords, co-authorship, and co-organization, including Network Visualization, Overlay Visualization, and Density Visualization, with the outstanding features of easy mapping and beautiful images [16].

This study used 309 papers from 910 authors from 422 institutions in 46 countries, published in 82 source journals and citing 12,368 cited references from 5577 journals. Through Fig. 1, we can see that there is a downward trend from 2020 to 2022 but by first calculating the trend, we can see that there is an upward trend from 2012 to 2014 and a small peak of 31 papers in 2014. This is followed by a sharp upward phase in 2017–2020, reaching the highest peak of 49 papers in 2020. Overall, we discovered that it is still in a process of gradual ascent, and we arrived at the formula $Y = 1.0364X = 21.873$, which also shows that scholars are not particularly concerned about the cross-fertilization of the two fields of music and sports, and are still in a period of development, see Fig. 1.

3 Results

3.1 Visual Analysis of High-Frequency Keywords

Keywords condense the core and essence of literature, so through keyword visualization, we can discover the current research hotspots in the research field. The keyword co-occurrence network view was drawn using VOSviewer for 309 documents, and after merging the duplicate keywords, 113 key keywords with frequency ≥ 5 were selected for visualization, and the results are shown in Fig. 2.

Through Fig. 2 can find that all the studies are scattered with the keyword music as the core to start the study. The visual analysis in Fig. 2 and the keyword clustering analysis in Table 2 reveals five major clustering directions, which are divided into five clusters: red clusters, blue clusters, purple clusters, yellow clusters, and green clusters.

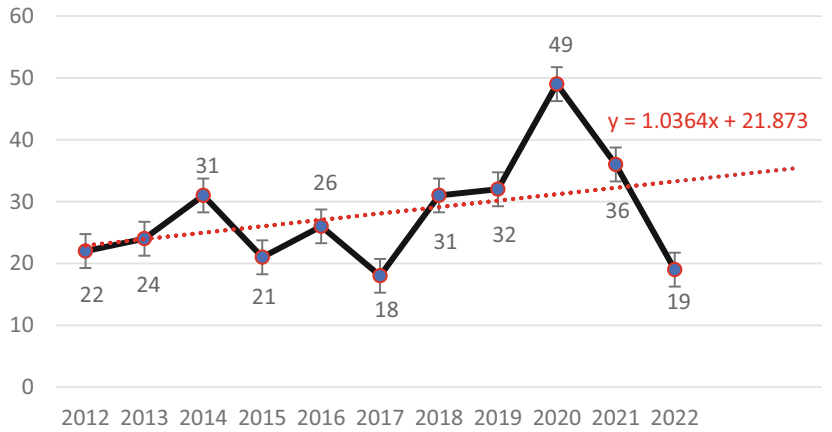

Fig. 1. Trends in the number of publications under the cross-fertilization of music and sports subject areas from 2012 to 2022

Table 2. Top 20 analysis table of high-frequency keywords

RANK	Keyword	Occurrences	Total Link Strength	RANK	Keyword	Occurrences	Total Link Strength
1	Music	76	305	11	Intensity	16	93
2	Performance	55	227	12	Perceived exertion	16	93
3	Physical Activity	48	229	13	Emotion	15	70
4	Health	25	103	14	Impact	15	51
5	Sport	23	91	15	Perception	15	50
6	Education	21	64	16	Responses	14	77
7	Anxiety	19	87	17	Pain	14	65
8	Children	19	76	18	Prevalence	13	59
9	Motivation	17	85	19	Validation	13	55
10	Stress	17	64	20	Students	13	41

The red cluster is dominated by psychology, emotions, anxiety, stress, pain, and other emotional psychology, in the intersection of music and sports, and the impact of sports interventions on musicians at the psychological level. The green cluster is dominated by research on physical exercise, physical activity, quality of movement, etc., and the impact on sports people in physical exercise through the intervention of music. The blue cluster is studies conducted concerning student teaching. The yellow cluster is the latest keyword clustering that has emerged, with a focus on the combination of

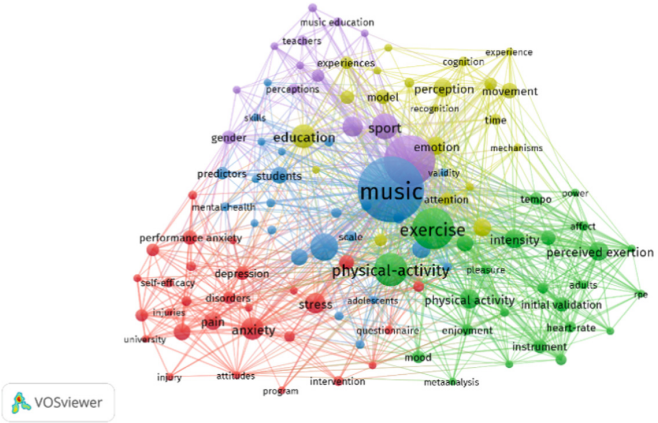

Fig. 2. Visual analysis of high-frequency keywords co-occurrence under the interdisciplinary study of music and sports

interdisciplinary areas such as models, attitudes, and education. The purple clusters are dominated by pedagogical knowledge of teacher-level performance, behavioral theory, etc. (See Table 3).

Based on the clustered literature, it was found that most of the studies on the intersection of music and physical education are empirical, with the influence of one on the other. Research on the effects of music as an auxiliary tool on sport is mostly in the empirical category, where scholars have found that music has a role in helping athletes to relieve muscle fatigue, for example, the positive effect of fast-paced music on delaying muscle fatigue [17]. The easing effect of music on muscles can lead to an increased and more efficient muscle output [18],so that the athletes show better exercise effect, which not only facilitates their physical recovery, but also facilitate athletes' regulation of competition-induced mental fatigue [19], help athletes manage their exercise anxiety from the competition [20], and after a brief period of listening, helped manage the athlete's emotional state while also bringing about positive performance [21]. Similarly, another part of scholars found positive effects on both children, and elderly groups with music training interventions, enhancing inhibition in children [22], modulating cardiac rehabilitation exercises in the elderly, and improving their lifestyle [23] all have a significant role to play. Of course, different kinds of music have different effects on exercise programs, not only in terms of influencing motivation, performance, and perceived effort [24] but also because the rhythm of the music affects the heart rate during exercise and the rhythmic frequency during exercise [25], creating stability and correlation in the exercise heart rate-music-rhythm preference relationship, which affects the athletes' exercise rhythm and does so differently for athletes with different specializations.

Conversely, the intervention of exercise also affects musical performance, first of all, it can help music learners to improve their academic performance, and the power of the fingertips of many instrument users and the psychological physical anxiety state caused by long periods of sedentariness when using the instrument can be well regulated by exercise also enhances the performance of music learners [26], and that different types

Table 3. Keyword color clusters analysis table

Clusters	Keyword
Red	anxiety, attitudes, depression, disease, disorders, health problems,pain, injuries, injury, intervention, musculoskeletal disorders, music students, musicians, performance anxiety, prevention, prevalence, professional musicians, program, questionnaire, relaxation, risk fa, sport, stress, self -efficacy, stctorsage fright, strategies, symptoms, university
Green	adults, affect, affective responses, asynchronous music, emotions,tempo, enjoyment, exercise, heart-rate, initial validation, instrument, intensity, meta analysis, mood, motivational qualities, perceived exertion, power, rpe, rhythm, pleasurerecovery, synchronous music, physical activity, validation
Blue	adolescents, background music, communication, engagement, health, identity, immunoglobulin-impact, interventions, mental health, music, music therapy, old adults, people, predictors, rehabilitation, reliability, scale, singing, students, skills, therapy, validity, wellbeing, quality-of-life
Yellow	arousal, attention brain, cognition, education, emotion, experience, gesture, language, mechanisms, memory, model, momevent, patterns, time, perception, perception, personality, recognition, responses, music performance
Purple	behavior, achievement, children, gender, motivation, sport, teachers, intrinsic motivation, perceptions, self-determination theory, performance, physical education, music education, participation

of exercise have a close relationship with the quality of music performed by musicians [27], helping musicians to better assess musical performance. Moreover, we know that the most basic purpose of exercise is to promote health, so it also positively impacts the physical health of musicians [28].

Further study of keyword co-occurrence mapping reveals that a large number of empirical studies have been conducted on four main aspects of the intersection of music and sports: psychological, physical, performance, and pedagogical, which is a combination of psychology, sports training, and medicine. However, there are still few studies on the performance effects of different athletes and musicians using different instruments. The relaxing effect of music itself and its function as a training aid has been discovered but not explored enough, and the effect of sports on music is not only limited to physical health and performance effects, there is still a long way to go.

3.2 Visual Analysis of Collaborative Networks

The visualization of the author collaboration network in this research field is carried out to deeply explore the core scholars and core research groups in the current field, and the network overlay visualization of the author collaboration network is carried out by VOSviewer.

Figure 3 shows that the current network-like structure in the field of cross-fertilization research between music and sport has taken shape, indicating that the current research teams in the field are in a continuous process of development and that a global scale has not yet been formed. The most cited author in this field between 2012 and 2022 is Karageorghis. C I from the UK with 11 articles, mostly on the psychological level, self-efficacy and psychological reactions, and sports performance related, and the most cited author is Baker. F A, an Australian scholar with 7 articles and an average citation of The most cited article is by Baker. F A, is an Australian academic, with 7 articles and

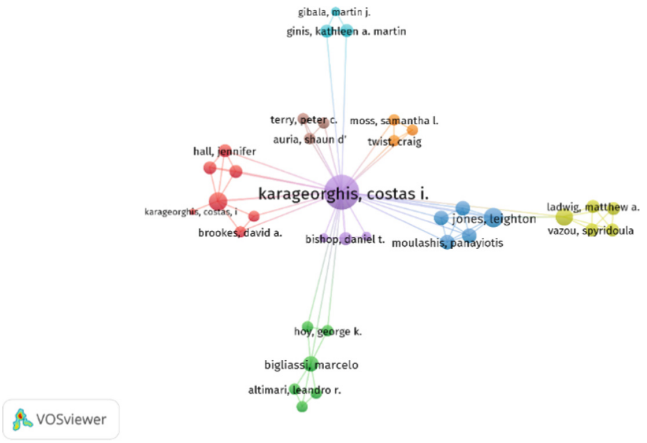

Fig. 3. Visual analysis of the authors of the articles published

35.14 citations in Table 4. According to Price's law $m = 0.749 \times \sqrt{n_{max}} \approx 2.48$, where n_{max} represents the number of articles by the most prolific authors in the current field, so we regard those with 3 or more articles as the core authors in the current field, and we show the authors in Table 3. This is not more than half of the total number of articles, which is still far from Price's law of 50% [29], so it can be seen that there is no stable collaborative group of authors in the field of music and sports intersection.

Table 4. Quantitative analysis of the authorship base of the articles published

RANK	Author	Documents	Citations	Average Citation/Publication
1	Karageorghis. C I	11	312	28.36
2	Baker. F A	7	246	35.14
3	Clark. I N	4	37	9.25
4	Taylor. N F	4	37	9.25
5	Jones. L	4	116	29
6	Ekkekakis. P	3	93	31
7	Nemet.D	3	39	13
8	Bird. J M	3	25	8.33
9	Ackermann. B J	3	41	13.67
10	Altnmueller. E	3	61	20.33
11	Eliakim.A	3	39	13
12	Evans. P	3	88	29.33
13	Oudejans. R D	3	48	16
14	Welch. G F	3	11	3.67

Table 5. Analysis of the top 5 countries in terms of number of articles issued

RANK	Country	Number of articles (articles)	Citations (times)	The total strength of the connection
1	USA	85	894	13
2	England	57	608	30
3	Australia	46	798	17
4	Germany	20	207	14
5	Canada	17	171	3

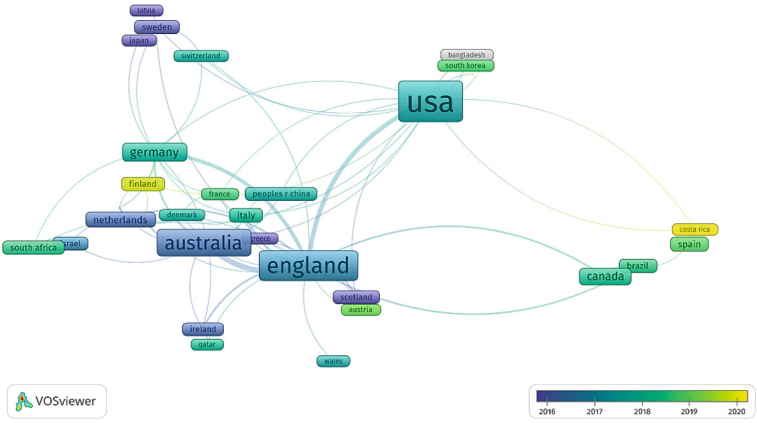

Fig. 4. Knowledge map for visual analysis of issuing countries

3.3 Visual Analysis of the Country of Origin

The visual knowledge map of countries with the most publications in Fig. 4, and the top five countries with the most publications in Table 5 show that the USA has the most publications between 2012 and 2022, with 85 publications and 894 citations, and the US scholars have more research in this field, followed by the UK, with 57 publications and 608 citations, which is related to the author with the most publications This is also related to Karageorghis. C, which has 11 individual articles, basically contributing one-fifth of the literature, followed by Australia, Germany, and Canada, which are mostly concentrated in Europe and the United States and have not formed a global research system, which also corresponds to the visual analysis of the author of the article.

3.4 Visual Analysis of Research Hotspot Timeline Graph

The keyword co-occurrence network mapping through the Timeline diagram provided by CiteSpace in order to more clearly understand the current development process of the integration of music and sports, see Fig. 5. This diagram visually represents the current research hotspots in this field in different years through the evolution and distribution

of keywords, and generally shows a trend of phase change. According to the results of the clusters, there are three main categories: one is the research on education, music education, physical education, teachers, students, music skills, physical activity, online education, behavior, exercise, health, etc.; the other is the research on the psychological level, on different types of music learners or athletes' anxiety in psychological aspects on the resolution of anxiety, musical performance, sports performance, the performance of a particular sport, etc.; The last category is some empirical studies carried out on theory construction, model construction, etc.

In the clusters at the educational level it can be noted that educational activities such as music, sports, and physical activities still occupy a prominent place, and with the shift from traditional to modern educational values [30], the innovation of education is also the level of education is constantly improving physical activities and music activities education also gradually become the main curriculum in the classroom, music teachers online education process behavior research, research on the impact of students in terms of academic performance, performance [31], avoid health problems caused by sedentary musicians. On the other hand, the influence of physical education teachers on the expressiveness of physical activity through different musical styles [32], The development of diversified educational activities between teachers and students, the educational value of music and sports activities at this time is also increasingly important; from the psychological level of clustering we can find that, over time, scholars for music and sports in the psychological level of research, but also for the physiological-psychological effects on the physiological-psychological effects of sports activities [33], for us to reduce fatigue, reduce stress and other different degrees of impact, different training methods on the mental ability of athletes [34], it has a positive impact on athletes' attention control, concentration ability and relaxation, and it has a positive impact on the psychological treatment of children and elderly people, whether it is music therapy or traditional medical treatment in helping children with psychological problems to get out of psychological barriers [35]. The analysis and validation of different perspectives also verify where the value of physical and musical activities now lies, and therefore the intersection between multidisciplinary fields of study is very necessary. The link between

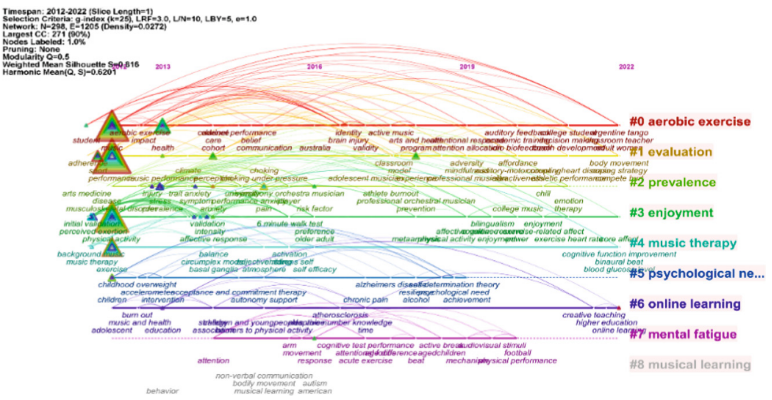

Fig. 5. Visual analysis of research hotspot timeline graph

music and sports is also explored in the keyword analysis, and their close connection is also a need for scholars to conduct research on real life, both at the educational level and at other levels, building models and exploring the potential relationships inherent in multiple paths, also reflecting scholars' concern for better human development.

4 Conclusion

Through two visualization software, Citespace and VOSviever, on the current research lineage, hotspots, and trends in the intersection of music and physical education disciplines, it can be found that: first, the primary keywords revolve around, music, physical activity, expressiveness, health and educational aspects, the impact of interventions between the two fields on the educational value between the different fields; secondary keywords are emotions, anxiety Stress and other secondary research areas, different levels of stress reduction, the impact on concentration, control and finally performance, and the development of connections in different social contexts, populations, and the evolution of development models and pathways between disciplines. Second, most of the main collaborative group authors are concentrated in Europe, America, and Australia, and no stable collaborative group has been formed yet, and the worldwide collaboration needs to be further strengthened. Third, the changing and evolving research focus, the continuous exploration from education to technical methods, and the different levels of impact under different interventions are gradually forming the evolutionary path patterns, but a lot of exploration and in-depth research on specific issues are still needed.

Based on the above findings, it is necessary to communicate between scholars in the process of interaction between music and physical education disciplines, to focus on the comprehensive development of the field in conjunction with the development of modern teaching models, online education [36], and virtual networks of educational technologies, and to improve communication and cooperation between national institutions and universities. In the process of cross-development of multiple fields of disciplines, the field of music and sports itself has the value of field research in the process of the crossover will produce new values, and the exploration of the value of these crossover areas needs to be further explored and discovered, correcting the wrong social understanding and instinctive misconceptions, solving the development problems in the process of integration and development of music and sports is the key, but also to provide scholars to study the field Detailed reference value and continued in-depth research for the public to form a correct perception of the field, to fundamentally promote the integration and sustainable development between the disciplines of music and sports.

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