

A Bibliography Study on Academic Publications about Artificial Intelligence in Music Education

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ABSTRACT

Research has indicated that the ever-changing emerging technologies have different impacts on music education from many perspectives such as; music pedagogy, instruction methods, evaluation approaches. For almost 30 years the online learning and education platforms based on Artificial Intelligence (AI) provides both teachers and students with rich personal teaching/learning environments, methods, educational tools and improve the efficiency of music education. Although there has been extensive publication in the field of AI in education and AI in the music industry, it has been observed that publications on AI in music education have gained momentum since 2019. This situation is the most important motivation for conducting this research.

In this research, a bibliographic study was conducted through the document review method. Data were obtained by scanning published scholar books/book chapters (n=1), articles (n=58) and conference papers (n=19) in selected online databases and, were grouped and presented according to certain criteria. Studies between 2019-2023 that included the terms "music education/teaching/learning" and "Artificial Intelligence (AI)" together in their titles and abstracts (including keywords) both in English and Turkish were scanned. It was determined that 18 of the 58 articles examined were retracked and, most of the publications did not contain information about the research design and method. Also it is found out that; most of the research focus on theoretical subjects such as; musical analysis, composition, algorithmic systems, and a few on instrumental-mostly piano or vocal pedagogy. It has been observed that studies on music education applications with AL are insufficient.

The importance and use of AI is increasing day by day, and research will continue to be conducted as long as this issue is on the agenda. The main aim of this research is to provide a resource for experts and academics studying in the field and shed light on future scientific studies on music education and AI. The scanning process in this study is limited, therefore, in future research, it may be recommended to examine publications in different languages and scientific theses in larger databases, within the framework of different criteria.

Keywords: Music education, Teaching Music, Artificial Intelligence, AI, Bibliography.

INTRODUCTION

Researchers have indicated that the ever-changing emerging technologies have different impacts on music education from many perspectives such as; music pedagogy, instruction methods, evaluation approaches (Liu et al., 2023; Liu et al., 2021). For almost 30 years the online learning and education platforms based on artificial intelligence (AI), which is in fact coined in 1955 by John McCarthy (Zulić, 2019; Arıcı, 2023) provides both teachers and students with rich personal teaching/learning environments, methods, educational tools and improve the efficiency of music education. It is quite clear that we have moved from the digital age to the age of AI.

AI, an emerging discipline based on computer science and integrated by computers, psychology, philosophy and other disciplines, is a new technical science that studies and develops theories, methods, techniques and application systems that simulate, and extend and expand human intelligence. (Zhang, 2023). It mainly uses computer-related technologies that can interact with human activities to imitate human thinking and some intelligent behaviors, such as search, reasoning, memory, speech recognition, knowledge expression, and processing of information, so that it can behave like humans, as well as advanced intelligence and thinking to achieve higher-level computer applications. It is an extension of human's existing ability and has high intelligent technology beyond the scope of manpower (Jiang, 2021, Dai, 2023, Manman, 2021). As for Yau and Qian (2024) AI algorithms can analyze learners' performance data and provide personalized learning paths based on their strengths, weaknesses and learning preferences. Artificial intelligence-powered chatbots and virtual assistants can provide instant support to learners, answering questions and guiding them through course material (p.811).

The integration of AI into music education is started with musical instruments, software, smart classrooms, and teaching/learning online/mobile applications. Due to the combination and development of music education, AI

technology has become the future trend of music education, exerting a huge influence on traditional teaching concepts and methods and forming a diversified and multi-level development direction (Yu et al., 2023). The implementation of AI in music education has enhanced the level of the music instruction and enlarged the music teaching model as mentioned in several resources (Zhang, 2023, Ma, 2021, Yang, 2021, Jiang, 2021, Liu, 2022, etc.). Combined with learning analytics, AI can indeed be harnessed to create powerful personalised tutoring tools, especially when self-regulated learning is desired (Chong, 2019). In this evolving paradigm, traditional music education methods are enhanced and enriched through the integration of data-driven technologies and tools. Through the collection and analysis of data, educators gain valuable insights into student progress, preferences, and needs, allowing for personalized instruction and curriculum adaptation (Bresler, 2021). Teachers can also fully integrate network resources to innovate their own courses, and with the help of new ideas, they can bring better help to students. Students can combine the complex network information to find useful content for themselves, and with the contribution of new technologies, they can create a new learning model to improve their professional quality and comprehensive ability (Jiang, 2021). AI supported tools, “deep learning models/algorithms” as mentioned in Zhang (2023), provide highly personalized feedback and guidance to individual students; making real-time assessments on musical performances, enabling students to explore composition and different musical styles and structures, fostering their creative abilities.

However, as AI becomes widespread - especially in the field of education – and AI-based methods have many advantages such as the ability to teach theoretical foundations of music teaching, it also brings some issues of concern. The use of AI in education has both positive and negative effects on both students' learning and teacher teaching. This is also mentioned in some studies whose full text is available. (Zheng & Dai, 2022). Zhang (2023) states that, most music teachers have limited computer technology, so it is difficult to combine the current teaching content with AI technology. On the other hand, it requires interactive electronic devices in music classrooms, and it is also difficult to achieve the popularization of these educational technology. Most teachers believe that the application of technology in the classroom will distract students in the classroom, and will also increase the burden of teaching content, indirectly causing students to be difficult to adapt, reducing learning efficiency and further hindering the progress of teaching. Han et al. (2023) present the restrictions and drawbacks as follows; lack of human interaction, strict restrictions on creativity and expression, cultural and historical context, technical dependencies and accessibility, ethical issues, and overreliance on technology. For Yang (2021) most music teachers still unaware of this new intelligent musical instrument, or even just that it would play a significant role in the future development of music education. He draws attention to another topic that future AI may be able to effectively comprehend a music teacher's speech and emotion, as well as follow the music teacher's humanized teaching technique. He adds that because of the constraints of music education's uniqueness AI's potential application in music education may have several limitations when it comes to emotional aspects of music teaching, such as music emotion, music content expression, and tone. Botella (2023) says that “certain elements are inherent to music learning and performing, including human expression and communication... the practices that AI promotes should always consider the intra and interpersonal aspects of music learning” and finally Wei et. Al, (2022) summarize the argument as follows: “intelligent tutoring solutions are insufficient to teach an open-ended subject” (p.3).

In the literature review on the relationship between music and AI, it was determined that publications related to the music industry, production and publishing processes and the impact of AI technologies on these processes (music production/composition, music composition/editing, music recording-editing/mixing/mastering, music printing etc.) have increased since 1992. An anthology written by a team of experts in the field is one of the first publications. 26 contributions in the book (chapters drawn from two international workshops held in 1988 and 1989) explore the intersection of music and AI on a base of musical composition, analysis, performance, perception and learning and tutoring (Balaban & Ebcioğlu, 1992). There are many books and publications with similar content published in the literature on music and AI. For instance “*Handbook of Artificial Intelligence for Music - Foundations, Advanced Approaches, and Developments for Creativity*” edited by Eduardo Reck Miranda is one of them. This book presents comprehensive coverage of the latest advances in research into enabling machines to listen to and compose new music including the development of interactive musical robots and emerging new approaches to AI-based musical creativity, brain-computer music interfaces, bio-processors and quantum computing and subjects around music industry, from management systems for recording studios to recommendation systems for online commercialization of music through the Internet (Miranda, 2021).

During the research, a book entitled "Music Education: An Artificial Intelligence Approach" published in 1994 by Smith et al. (Eds.). consisting of papers originated from the proceedings of a workshop held as part of a conference on AI was encountered. Although the title and foreword of the book indicate the relationship between music education and AI, it has been observed that the titles and contents of the 10 chapters in the book do not coincide with the publication. In an article Holland (2000) reviewed critically some of the principal problems and

possibilities of a variety of AI-ED approaches including; Intelligent Tutoring Systems for Music; Music Logo Systems; Cognitive Support Frameworks. This paper also published as a book chapter in 2013.

Although there has been extensive publication in the field of AI in education and AI in the music industry, it has been observed that publications on AI in music education have gained momentum since 2019. This situation is the most important motivation for conducting this research. As Yılmaz (2021) stated; whether science is considered a cumulative or punctuated process, previous research is of great importance in the production of scientific knowledge. In this sense, monitoring, evaluating, and reproducing previous research, even if not exactly the same, has an important function in terms of the scientific research process (p.1458). With a bibliographical literature review on AL in music education, the main aim of this research is to provide a resource for experts and academics studying in the field and shed light on future scientific studies on music education and AI. For this purpose, the research will seek answers to the following questions:

1. What is the distribution of publications by years?
2. What is the distribution of nationalities of the authors of the publications?
3. What are the keywords used in the publications?
4. What are the subject areas of the publications?
5. What is the distribution of research methods used in publications?
6. What is the distribution of research designs used in publications?
7. What is the distribution of the study groups in the publications?

METHODOLOGY

In this research, a bibliographical study was conducted through the document review method. Document review method, one of the qualitative research methods, is the process of analyzing and collecting data by examining a real-life case and written documents containing information about that case (Yıldırım and Şimşek, 2008; Karataş, 2017). Ocaña-Fernández and Fuster-Guillén (2021) define bibliographic review article as; A methodology of observational research, retrospective, systematica, oriented to the selection, analysis, interpretation and discussion of theoretical positions, results and conclusions embodied in scientific articles disclosed in recent years on a topic of choice in order to obtain relevant information that contributes to the solution of problems (p.1). This study is not a biometric study since the citation statistics of the publications or the biometric information of the journals are not included. Therefore, this is a systematic review based on a bibliographic study. Considering the classification made by Ergan while defining "bibliography"; This work is a "completed" bibliyography according to its duration (created from materials published between or by certain dates); a "special" bibliyography according to its scope (created from materials published on a subject or related subjects); and a chronologically arranged (in order to the publication dates of the materials) bibliographic study (Ergan 1994: 13).

Data selection

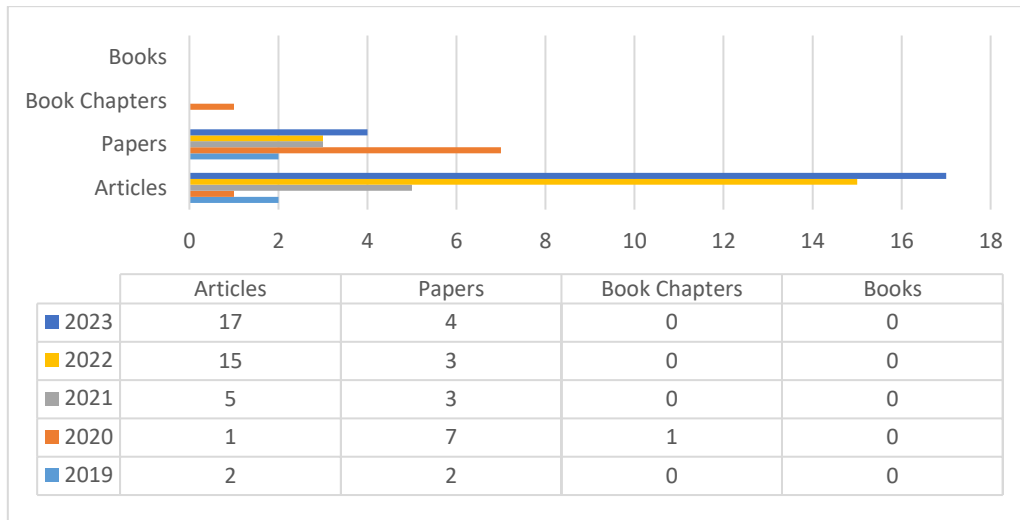
The data in the research were obtained by scanning published scholar books, book chapters, articles and conference papers in online databases; Tr-Dizin, Ulakbim Keşif, ERIC, ProQuest, Semantic Scholar, Google Scholar, Hindawi.com and IOP.org. The studies to be evaluated in the research were selected according to certain criteria. First of all; Only the studies published between 2019-2023 were examined. Since 2024 is not over yet, publications from this year are not included in the study. Second; The search includes only publications written in Turkish and English. Third; Studies that included the terms "music education/teaching/learning" and "Artificial Intelligence (AI)" together in their titles and abstracts (including keywords) both in English and Turkish were scanned; Publications that contained only the word "music" or "education" and, were not directly related to music education were excluded from the research. Fourth; Only publications whose full text or abstract was accessible were examined.

Data Analyze

In the research, data were grouped and presented in an order according to certain criteria mentioned in the problem questions. The quantitative data gathered from the publications are presented directly and with frequency (f) and percentage (%) tables. In the analysis of the data regarding the 3rd and 4th research questions (keywords and subject area distribution), the content analysis technique was used and, the data were classified under certain themes, and presented with graphic tables. The Word "Null" was used to express the data that could not be reached.

FINDINGS

Distribution of Publications by Year



Graph 1. Distribution of Publications by Year

According to Graph 1, when the distribution of publications between 2019-2023 is examined, it is seen that 32 (80%) of the 40 scientific articles were published in 2022 (n=15) and 2023 (n=17). There are 5 scientific articles published in 2021, 2 in 2019, and 1 in 2020.

Of the 19 congress papers accessed between 2019-2023, 7 were published in 2020; 4 in 2023; 3 in 2022; 3 in 2021, and 2 in 2019. Apart from 1 Book Chapter published in 2020, it is also seen that no book or book chapter was written on the subject between 2019-2023.

The distribution of nationalities of the authors of the publications

As seen in Table 1, 1 of the two articles from 2019 is from Singapore and 1 from Canada. It is seen that there was one publication from Türkiye in 2021 and 2023, and one from Spain in 2022 and 2023. Apart from these, it was determined that authors from France, Pakistan and Saudi Arabia were included twice each, and authors from India and Poland were included once each in multi-authored publications from 2022 and 2023. It is seen that 19 authors in 2022, 14 in 2023, 4 in 2021 and 1 in 2020 were of Chinese origin.

One of the papers written in 2019 was by an Italian author and one by a Chinese author. All 7 papers published in 2020 and 3 papers published in 2021 and 2022 belong to Chinese authors. While 4 out of 4 papers from 2023 include Chinese authors, one publication was found to be a joint publication of China and the United Kingdom. It was also determined that the only book chapter published in 2020 belonged to a Chinese author. According to this table; Between 2019-2023, 1 paper in 2019; 1 article, 1 book chapter in 2020 (n=2); 4 articles, 3 papers in 2021 (n=7); 19 articles, 3 papers in 2022 (n=22) and 14 articles, 4 papers in 2023 (n=18), totaling 50 publications belong to Chinese authors. This result shows that 83% of the 60 publications analyzed in the study are of Chinese origin.

Table 1. The distribution of nationalities of the authors of the publications

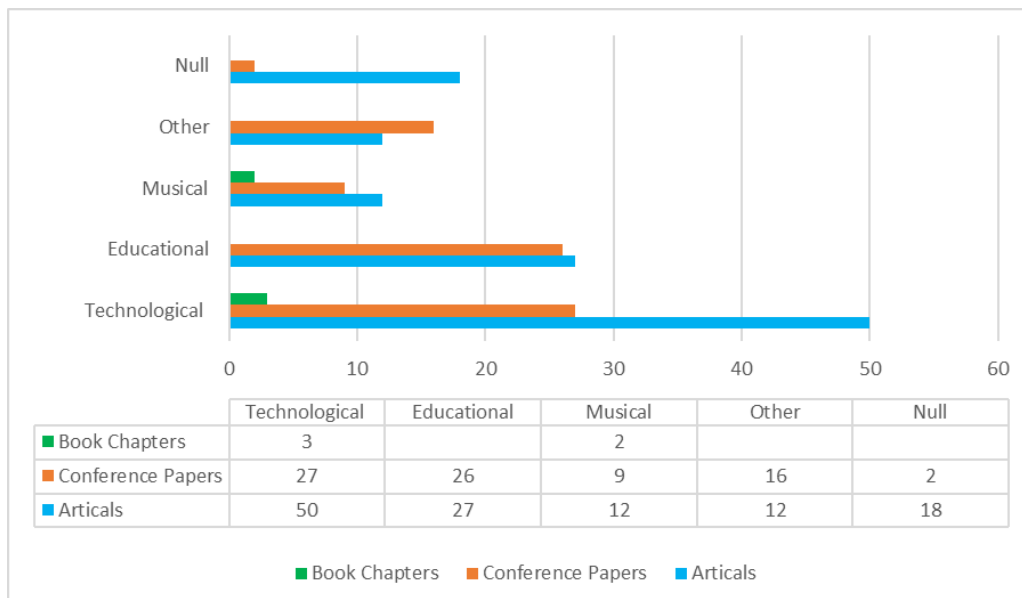
Years	Countries	Article	Paper	Book Ch.
2019	Singapore	1		
	Canada	1		
	Italy		1	
	China		1	
2020	China	1	7	1
2021	China	4	3	
	Türkiye	1		
2022	China	19	3	
	Spain	1		
	India	1		
	Saudi Arabia			
	Poland			
	France			

	Pakistan		
2023	Spain	1	
	Philippines	1	
	China	14	4
	United Kingdom		1

Keyword analysis

According to Graph 2, in the *Technological Words and Terms Category* the word “Artificial Intelligence” is used 21 times in articles and 17 times in conference papers. “Technology” is used in three forms in articles and used only in one paper as AI technology. “Vector” is used within 3 terms in articles; “Deep Learning” is used 2 times and, 22 other words and terms appear only once as follows: “Augmented Reality, Interactive Interfaces, Internet, Multimodal Network Model, Big Data Analytics, Data Fusion, Digital Learning, Intelligent Learning Systems, Clustering Algorithm, Resource Availability Algorithm, Automatic Music Generation, Co-creation, KNN Dynamic Expansion Query, Process (AHP), Whale Optimization, AI-based Decision Support Systems, Applications, Mobile Apps, Messenger, Chatbot, Gesture Interactive Robot, Heterogeneous Online. In papers the word “Intelligent (I)” is used four times as “I piano, I hearing, I systems, I Tutoring System”. The technology related words that are used once in papers are follows: Assisted System, Big Data, Cloud Computing, Internet, Online, Interactive.

The most used keyword related to educational words and terms is "Music Education (ME)", which was used 12 times in articles and nine times in papers. Three of them were used as "Rural ME", ME Perception" and “Musical Education” in articles and once as “University ME Model” in a paper. When analyzing the keywords of articles it is found out that the word “Teaching” is used five times as “Music Teaching”, “Teaching Mode”, “Teaching Virtual Reality”, “Network Teaching” and “Vocal Teaching Model” are the other terms containing “Teaching”. “Education” is used three times; both alone and in “Education Platform”, “Educational Psychology” term forms. “Training” is used two times as “Skill Training” and “Talent Training” and “Music Learning” used two times. Other words and terms that are classified as educational words in the field of education and have been used once in article keywords are as follows: “Curriculum Optimization, Flipped Classroom, Interactive Course, Online Course, Middle School Music, Literacy, Student Innovation, Student Teacher”. On the other hand when the papers analysed it was seen that “Education” and “Teaching” are the second most common word in this category (n=6). The Word “Teaching” doesn’t used alone such as; “Interactive Teaching, Chamber Music Teaching, Music Assisted Teaching, Teaching Efficiency, Teaching I system, The Quality of Teaching”. “Training” and “Learning Motivation” are also used once.



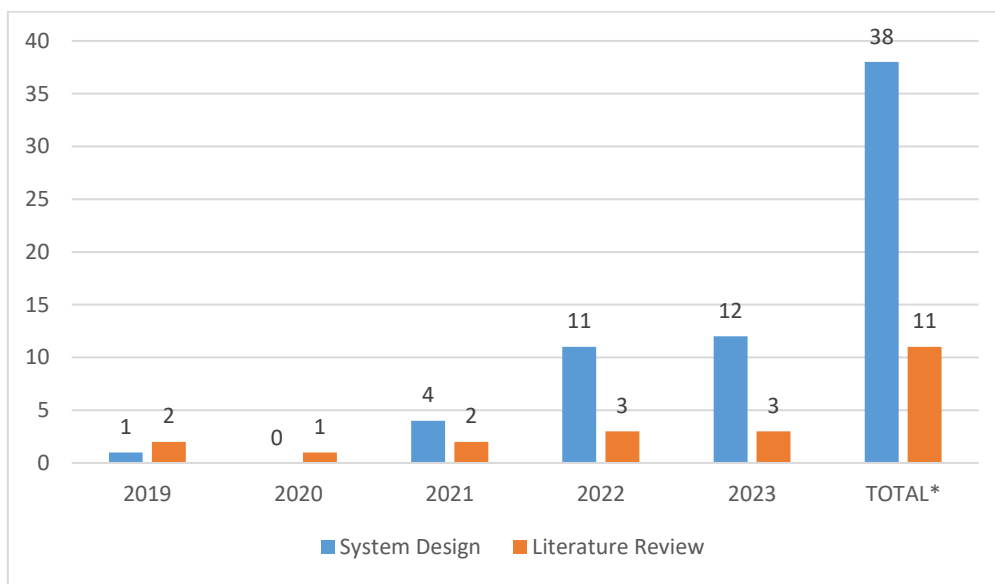
Graph 2. Key Word Analysis of the Publications

In the keyword analysis, some words were classified under the "Musical Words and Terms" category. According to this, in the articles; Word “Performance” used three times; “Composition” is used three times, both alone and in “Composing Music” and “Assisted Music Composition” term forms. Word “Makam” is used two times as; “Classical Turkish Music Makams” and “Makam Detection”. It was determined that in four studies conducted in the field of musical instruments the names of the relevant instruments were given as keywords; “Piano”, “Learning

To Play The Piano”, “Trumpet Pedagogy” and “Vocal Teaching Model”. As for the conference papers; the word “Music” is used seven times both alone and in “ Preschool Music”, “Music I System”, “Music Listening Learning”, “Music Perception” and, “Music Cognition” term forms. “Musical Composition” and “Musicology” are also appear once.

An unexpected result that was revealed from the analysis was that 18 of the 40 articles and two of the conference papers did not have keywords added to the abstract section. The fact that this number is quite high is quite thought-provoking. In this case, the data is entered as "Null". Finally, in the articles 12 and in the papers 16 words and terms that were used only once could not be classified under any category. These are: Scoping Review, Innovation Research, Analytic Hierarchy, Classification, Developments, Effect Assessment, Employability Skills, Least Squares, Personalized Recommendation, Involvement, Human, and, Human–Machine from the articles and, Comparative Experiment, Application, Optimization Analysis, Practicality, RBF algorithm, System, TPACK framework, Promotion strategies, Market research, Content Design, Convenience, Dyslexia, Pedagogical advancements, Emotional interaction, NN and, Limitations from the papers.

Subject Area Analysis



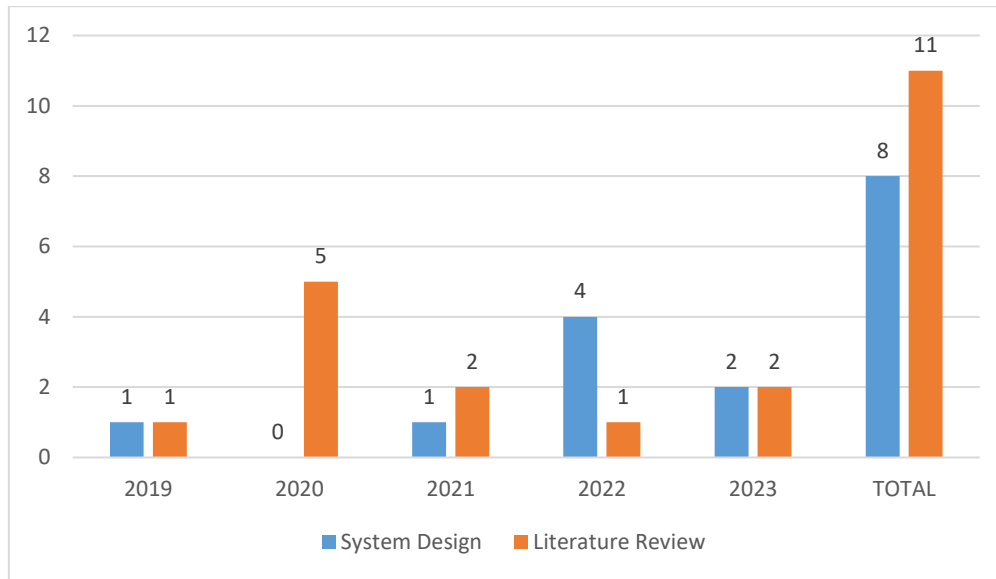
Graph 3. Distribution of the subject area of the articles

*The total value in the table is more than 40 because two or more subject areas is mentioned in some articles.

Through the years of 2019-2023 it is found that the main subject area of the articles is “designing or proposing algorithmic systems, programs or applications”. Some of those were only evaluated by data analyze (1 in 2021, 3 in 2022 and 5 in 2023); some of them were designed for general music education (4 in 2023 and 2 in 2022); 4 of them were designed for piano education (3 in 2023 and 1 in 2022); 2 of them were designed for voice education in 2022. Other subject areas the authors designed programs for and evaluated are follows; A personal tutor to learn harmonic theory in 2019; a MIR system that determines the makam of the songs in Classical Turkish Music Education, an emotion algorithm system to analyze and evaluate classroom music teaching behavior, a method for music teaching evaluation, an AI based Speech Recognition Simulation System in 2022 (n=4); And an interactive AI- supported platform for teaching country music education in 2023. In an article in 2023 a music-teaching classroom was constructed with gesture interaction based on RNN, analyzing the EEG signals to detect the physiological state of autistic children who are receiving different music perception treatment projects (Zhang atAll, 2023). The other common subject of the articles are “literature review on AI and AI technologies in music education” (2 in 2019, 1 in 2020, 2 in 2021, 3 in 2022 and 2023).

As in articles, the subject area distribution in papers is divided into two main categories. In 8 papers, studies were carried out on the construction of AI-supported algorithmic systems and programs. In one paper in 2021, 2022 and 2023, a music teaching system is proposed based on RBF algorithm. In 2 papers in 2022 and 1 paper in 2023, music teaching models and, in one paper in 2022 an intelligent piano teaching method were constructed and discussed. In a paper in 2019 the impact of the use of the software CAMA (Computer Added Musical Analysis) in the dyslexic student's learning process was investigated. In 11 papers, the possible contributions of AI technologies to music education and their current status were reviewed and discussed. Specifically, in 2023 the

place and importance of AI in chamber music teaching, and in 2020 in preschool music education and professional music education were discussed.



Graph 4. Distribution of the subject area of the papers

And finally in the book chapter written in 2020 the impact of a mobile application designed to facilitate the practising of scales and arpeggios that enables students to record themselves and view their mistakes and prepare for examinations for five instruments (violin, flute, clarinet, trumpet and saxophone) was investigated.

The Distribution of Research Methods

Table 6. Distribution of the research methods of publications

Research Methodology	Articles		Papers		Book Chapter		Pub. Total	
	n	f (%)	n	f (%)	n	f (%)	n	f (%)
Quantitative Research Method	22	55	8	42	0	0	30	50
Qualitative Research Method	10	25	4	21	0	0	14	23
Mixed Research Method	6	15	2	10	1	100	9	15
Unspecified-Null	2	5	5	27	0	0	7	12
Total	40	100	19	100	1	100	60	100

According to table 6, the most widely used research method in the publications is the quantitative research method (50%) with 22 (55%) articles; 8 papers (%42). This method is followed by the qualitative research method (23%) with 10 (25%) articles; 4 (21%) papers and the mixed research method (15%) with 6 (15%) articles, 2 papers (3%) and a book chapter. In 7 publications (12%), the reasearch method used was not stated but according to the text they were examined that the studies were conducted with a qualitative methodology.

The Distribution of Research Designs/Models

Table 7. Distribution of the research designs/models of publications

Research Design/Model	Articles		Papers		Book Chapter		Pub. Total*	
	n	f (%)	n	f (%)	n	f (%)	n	f (%)
Descriptive Model	10	50	9	45	1	5	20	100
Experimental Model	13	81	3	19	0	0	16	100
Data Analysis	15	75	4	20	1	5	20	100
Unspecified-Null	2	29	5	71	0	0	7	100

*The total value of publications in the table refers to the total number of models used because more than one model is used in some publications.

When the table is examined, it is understood that the data analysis model and descriptive model is the most used model in the publications. This model is followed by the experimental model. Although most of the descriptive research publications didn't mention about the design or model, the author of this article considered them in this category depending on the review of literature or scanning model they used. Besides them it was not specified clearly which design/model was used for 7 publications.

The Distribution of Study Groups

Table 7. The distribution of study groups of the publications

Study Groups	Articles		Papers		Book Chapter	
	n	f (%)	n	f (%)	n	f (%)
University students	10	25	7	37		
High School Students	1	2,5				
Middle School Students	1	2,5				
Children	1	2,5				
Primary School Teachers	1	2,5				
Expert teachers	1	2,5				
University Teachers University Students	4	10				
University Teachers			1	5		
App users-(Individuals)					1	100
University Teachers						
Null (unspecified)	21	52,5	11	58		
TOTAL	40	100	19	100	1	100

In the table it is obviously seen that % 52,5 (n=21) of articles and %58 (n=11) of paper didn't specified the study groups. Considering that the methodology sections of the studies are quite incomplete and insufficient, it can be said that this result is not surprising. It is also thought that this situation is due to the fact that the study group is not mentioned in most of the studies in which literature review and data analysis were conducted.

CONCLUSION & DISCUSSION

The integration of Artificial Intelligence (AI) in music education marks a transformative era, where traditional pedagogical methods are increasingly enhanced by cutting-edge technological advancements. This study provides a comprehensive review of academic publications between 2019-2023, shedding light on the progress, challenges, and future possibilities in this domain. A literature spanning from the integration of AI into music pedagogy and instructional methods to its broader implications on educational technologies was reviewed. Key themes include the enhancement of personalized learning environments; the utilization of AI in musical instrument technology and software. While acknowledging the significant advancements AI brings to music education, such as personalized feedback and enhanced instructional tools, the study also addresses concerns regarding technological limitations, teacher readiness, and the potential for reduced human interaction and creativity. The main aim of this research is to provide a comprehensive resource for academics and experts in the field, shedding light on future avenues for scientific inquiry and development in AI-enhanced music education.

Conclusion

The findings indicate that AI's role in music education is multifaceted, ranging from algorithmic tools for composition and musical analysis to interactive platforms for personalized instruction. The reviewed studies demonstrate significant advancements in implementing AI to enrich learning environments and pedagogical practices. However, the research also highlights gaps, such as limited empirical studies on instrumental pedagogy and a lack of focus on long-term impacts of AI on creativity and emotional aspects of music learning. Future research should address these gaps by incorporating diverse educational contexts, broader datasets, and multi-disciplinary approaches.

The first book on AI in music education was identified as a book of proceedings from a conference held in Edinburgh, Scotland on August 25, 1993. In the examination, it was determined that although the words "music education" and "AI" were used together in the foreword of the book, a different dimension of music (production and dissemination) was addressed in the conference; all 10 papers presented were written on music production, harmonic analysis, composition and music systems through music technologies. It was seen that the first studies

conducted in the field after 1993 and directly related to the subject were in 1999, where the name AI began to be used more widely. Types of studies varied widely and included literature reviews, qualitative and quantitative studies of various designs, mixed method studies, instrument development studies, and case studies on data-driven learning-based algorithms. Researchers analyze the data gathered from the designed AI supported algorithms and evaluate the data only. Most of the research on data analyze suggest experimental research to explore the impact of these tools and implementation of the AI aided music courses, learning methods on the activities and performances of students in music classes. More case studies, action research are needed in the field including teaching resources, course objectives, course content, course activities, course organization and implementation, course design and skills, and basic operation plans for teaching practice (Ma, 2021). In this manner this study could serve as a resource to reveal existing literature and identifying opportunities for new empirical research. Also, further research needed particularly in the assessment of the long-term effectiveness of AI-driven music instruction, the impact of web-based technologies and implementing these technologies in diverse educational settings.

It is seen that a numerous amount of study in the field is on designing and developing multimedia-assisted algorithmic systems based on AI technology to improve the scientificity and effectiveness of music teaching (Chong, 2019; Ma, 2021, Liu, 2022, Zheng & Dai, 2022 etc.). More over Xi (2023), proposed an AI technology-based training and assessment model for improving music teachers' music teaching skills. Zang (2023), found out that the "Internet plus" technology and AI has a positive role in promoting the innovation of teaching methods in middle schools music classes in improving students' interest in learning, and enriching teaching content. He also mentions about various music games and music composition tools of AI for providing music education. While, most of the research focus on theoretical subjects; analysis, composition, synthesis, and interaction, there are a few on instrumental-mostly piano- or vocal pedagogy (Huang and Ding, 2022; Jing, 2022; Li, 2022; Bai, 2022; Li & Wang, 2023, Cui, 2023, Lv, 2023; Botella, 2023). Two studies were found on special needs individuals; one is an experimental research article on Autistic children by Zang et. Al. (2022), an the other one is a conference paper about Dyslexic students by Della Ventura (2019).

A critical observation from this review is the dominance of Chinese authors in publications related to AI and music education, reflecting regional strengths in technological research. The trend underlines the necessity for more geographically diverse contributions to balance the discourse. Additionally, the prevalence of quantitative methodologies suggests a need for qualitative and mixed-method approaches to capture the nuanced interplay between technology and human creativity.

Discussion

The importance and use of AI is increasing day by day, and research will continue to be conducted as long as this issue is on the agenda. This study is limited by its focus on publications in English and Turkish and a narrow temporal scope. Despite these limitations, it offers valuable insights for educators, policymakers, and researchers aiming to harness AI's potential in music education. Expanding this research to include diverse languages and cultural contexts on a larger database will provide a more holistic understanding of AI's impact on global music pedagogy.

The implications of AI in music education extend beyond classroom settings. For instance, AI's ability to provide real-time feedback and adaptive learning paths offers opportunities for inclusive education, particularly for students with special needs. However, ethical concerns and the potential for over-reliance on AI warrant careful consideration. Teachers must remain central to the educational process, using AI as a complementary tool rather than a replacement.

Apart from the research framework, web pages providing resources on the subject were found during the extensive literature review. These web pages are also recommended as resources for researchers. *Unite.ai* is a completely decentralized organization with a team that offers news, interviews, and access to the best AI tools to inform users about progress on AI, to unify the AI community, to push forward the democratization of AI, and to assist in the development of beneficial AGI (artificial general intelligence). (unite.ai). Blog articles in NafME (National Association of Music Education) (nafme.org) are also provide information on AI and music education.

In a report by Baker and Smith (2019), about the AI technologies that are rapidly rising in the field of education, all aspects of AI in education was discussed; how it will impact on learners, on teachers, and indeed whole systems. It is stated in the report that the practical implementation of technology and its use by teachers must be prioritised, as they will ultimately choose how AI tools are used. The authers add that "AI does not mean the 'rise of the robots' in classrooms making teachers redundant (in fact, demand for teachers is set to increase, not fall). Instead, we must prepare for the role of the teacher to be augmented and evolve in partnership with the capabilities that AI brings." (p.5).

The “father of cybernetics¹” Norbert Wiener said:

“We have transformed our environment so thoroughly that we must now transform ourselves in order to survive in this new environment” (Quoted by Dai, 2021, p.1)

RESOURCES

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¹ The term "cybernetics" comes from the Greek word "kybernetes," meaning "steersman" or "governor." It was first introduced by mathematician and biologist Norbert Wiener in the mid-20th century. While cybernetics focuses on the analysis and control of complex systems, it today includes many subfields such as artificial intelligence, robotics and information theory.

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