

Digital Musical Synthesizer as a Tool For Creative Activity of a Music Teacher in a High-Tech Information Educational Environment

Irina B. Gorbunova¹, Klara B. Davletova²

¹Herzen State Pedagogical University of Russia, St. Petersburg (e-mail: gorbunovaib@rgpu.spb.ru)

(<https://orcid.org/0000-0003-4389-6719>),

²Herzen State Pedagogical University of Russia, St. Petersburg (e-mail: davletovaMKT@gmail.com)

(ORCID id 0000-0001-7349-2585)

HOW TO CITE:

Irina B. Gorbunova, Klara B. Davletova (2026). Digital Musical Synthesizer as a Tool For Creative Activity of a Music Teacher in a High-Tech Information Educational Environment. International Journal of Special Education, 41(6s), 332-342.

COPYRIGHT STATEMENT:

Copyright: © 2026 Authors.
Open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

ABSTRACT:

The article is devoted to the analysis of digital musical instruments as an element of the information educational environment of a musician teacher. Special attention is paid to the sound characteristics and structures of synthesized sound generation in digital keyboard synthesizers, where the integration of artificial intelligence is considered as their distinctive feature. The technical capabilities of modern synthesizers, which open up significant prospects for children's musical education, are analyzed. The authors of the article propose to consider a model of an information educational environment aimed at the formation of professional competencies of a musician teacher in the field of mastering the capabilities of digital musical instruments and music computer technologies. We also note the special role played by the process of mastering the capabilities of modern digital musical instruments and electronic musical synthesizers by music teachers in the system of additional professional education. A modern digital musical instrument is truly an invaluable gift in the hands of a creative teacher, an innovative teacher, who allows the teacher and his students to come into contact with the limitless possibilities of the world of music and pushes the boundaries of the audience, classroom, and the possibilities of concert halls. All these issues are also discussed in detail by the authors of this article.

Keywords: children's musical schools, children's schools of arts, informational educational environment (IEE); music teacher; music computer technologies (MCT); keyboard electronic musical synthesizer; additional education for children; advanced training courses.

I. INTRODUCTION

During the 20th century, a fundamentally new sound space was formed, of which music computer technologies (hereinafter referred to as MCT) became an integral part, in particular, digital musical synthesizers that penetrate into a wide variety of

genres. The inclusion of musical synthesizers in the scores of symphony orchestras and the formation of a new specialization - performers on digital musical instruments (synthesizers), mark a turning point in the history of music [5; 9]. And MCTs themselves have become one of the main tools for

transmitting and preserving musical folklore and all the musical and historical experience accumulated by mankind (see, for example, in [1]).

The emergence of new musical instruments, including keyboard synthesizers, is due to two main reasons. The first of them is the desire of musicians to expand their expressive possibilities and enrich the palette of their musical creativity. The second reason is related to the historical improvement of musical instruments, which in their design tends to rely on modern achievements of science and technology in the field of sound creation. In this context, "synthesis" is understood as the creation of a whole using combinations of separate elements of its components. Synthesized sound is created by a musician from the main components of sound using a digital instrument with artificial intelligence (AI) - a musical synthesizer, a specialized hardware and software complex, or a virtual instrument. Its result can be an imitation of acoustic timbre, as well as the generation of fundamentally new, previously non-existent, original sound objects. It is important to emphasize that what is common to all music based on synthesis is the fair statement that sound "by itself" is not music. Music arises only in the process of interaction of these sounds with the musician, who builds them into a composition.

Existing research confirms the significant influence of social and cultural factors on music performance. Listeners' views and reactions to a musical performance depend not only on the external characteristics of the performance, but also on internal characteristics such as their level of training, personal history, cultural background, and more. According to the study [21], each musical performance depends on meaningful interpretation and feedback provided by the listener. Thus, listener-centered performance analysis is determined by the social and cultural aspects of perception that encourage performers to create appropriate pieces of music in their compositions (Lerch et al., 2019). According to the study [23], the syntactic structure of various musical genres and styles differs in different musical cultures. This structure is studied in the process of cultural impact, which makes it possible to identify distinctive features between listeners from different cultures. For this reason, the extent to which the music of

any two cultures will differ from each other. Differences in the context of rhythm and pitch will determine how a representative of one culture will perceive music from another culture (Pierce, 2018). This means that cultural differences in musical characteristics such as pitch, rhythm, and tempo between, for example, Eastern and Western cultures influence differences in the art of performing on modern musical instruments and in the principles and technologies of creating musical compositions. Similar thoughts are also expressed by a number of Russian scientists, whose fundamental scientific research is aimed at highlighting issues related to interdisciplinary and transdisciplinary approaches to the study of musical and creative phenomena (discussed in detail in works summarizing diverse, multifaceted and long-term research, which involved specialists from various fields of knowledge – musicians, mathematicians, acoustics, IT specialists and psychologists – see, for example, in [6; 11-12]. These issues are also partially reflected in the works [3-4; 13-16; 24].

Significant research in this area has been conducted for many years by the staff and teachers of the Research and Methods Laboratory *Music Computer Technologies* of the Herzen State Pedagogical University of Russia. However, there still seems to be insufficient research on playing new electronic and digital musical instruments. For example, in [5; 8-9] it is noted that, despite the research of musicologists and the practical results of innovative teachers who summarize their many years of research and scientific and practical experience, the problems associated with the development of electronic musical instruments and their role and influence on modern cultural processes in society and The formation of a high-tech information educational environment is insufficient. This is especially true for mastering the art of performing on electronic and digital musical instruments. Playing electronic and digital instruments requires a performer to combine knowledge in the field of cultural traditions of performing skills in relation to individual acoustic instruments, as well as a creative approach to developing, adjusting and managing new timbres, the ability to create them in *preparation for the performance* of a piece of music, or even *directly during a performance* in a particular concert hall. This

may be due to the fact that the acoustic capabilities and features of each specific concert hall have unique spatial and acoustic characteristics unique to it.

Traditional musical cultures also contribute to the understanding that a traditional acoustic musical instrument is a specific physical object that can only be used to create certain sounds and only the timbre that is inherent in this particular musical instrument. However, musical cultures are becoming innovative in the context of electronic versions of traditional instruments and, as a result, encourages the creation of new musical compositions, new musical forms, and a new sound. Also, existing musical cultures are becoming innovative in the context of electronic versions of traditional instruments, which subsequently leads to the development of modified musical instruments with several functions that allow reproducing many unique sounds [9].

A study conducted by Lavengood [18] argues that Western genres, known as the "80s sound" and characterized by a shift in the cultural attitudes of the creative elite, continue to be attractive due to musical timbre-related cultures that have been popularized by electronic pianos such as the digital music synthesizer. In addition, this is reflected in the preference to create music that would be fresh, ambitious and reflect the various features of modern culture. The result is a fusion of genres. In addition, thanks to the development of television and music channels such as MTV, which broadcast music videos and live performances by artists, such music also penetrates into various, most remote areas and localities. The recognition and spread of a more creative musical culture has been further enhanced by the development of music and computer technology, which has begun to be widely used in computer recording studios (Lavengood, 2019). This demonstrates the importance of culture in determining the prospects for performing on new musical instruments, including electronic and digital musical synthesizers, and for creating music. Thus, it is obvious that social and cultural factors play a significant role in influencing music and the art of performing, which is of particular importance for the development of musical creativity in general.

Of great importance for our research are the works related to the consideration of such issues as planning qualitative research:

- development and decision-making for novice researchers (see, for example, [25]),
- involving students in creative music making using musical instruments in an online classroom with extended access [22],
- exploring the possibilities of social media for learning to play musical instruments [20],
- differences in timing and strategies of instrumental practice among students studying at various national conservatories in different musical specialties [19].

II. THE EVOLUTION OF MUSICAL SOUND. SYNTHESIS

Thanks to the development of MCT hardware and software, it becomes possible to simulate various stages of the evolution of musical sound systems, as well as the very concept of "musical sound". Modern digital musical instruments (Figure 1) based on the developing MCT, and especially the keyboard synthesizer (see Figure 2) as the most frequently used component in the work of composers and performers, confidently occupy the media space, expanding and enriching the spheres of a musician's creative activity due to the variety of built-in functions, a variety of sound colors, the possibility of sound synthesis and the creation of their own original timbres.



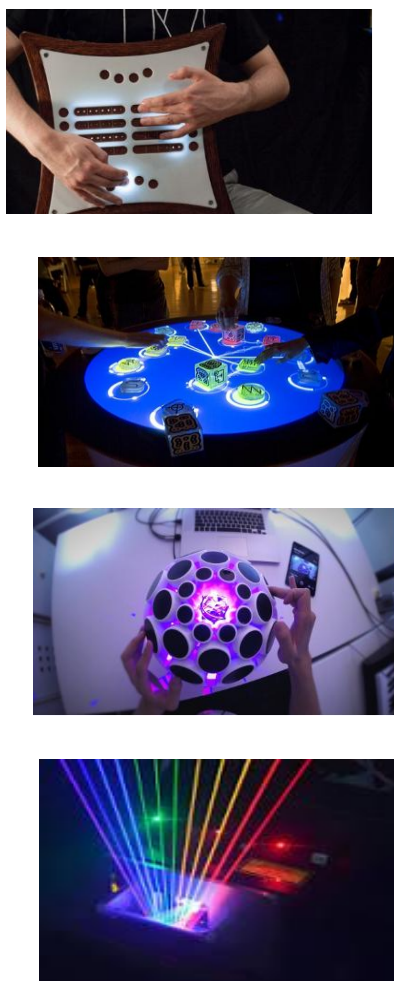


Figure 1. Digital musical instruments: Omnichord, Moodswinge, Mune, Reaktable Miltitouch, Alpha Sphere, Smiletogo



Figure 2. Master classes with keyboard synthesizer teachers

A key element of a modern digital musical instrument is a microprocessor that provides sound synthesis [3-5]. The integration of AI algorithms is becoming a distinctive feature of these musical instruments from their predecessors, opening up new facets of work on musical composition [7-9]:

1. Flexibility of composition and arrangement. Editing of musical material at any stage - from creation to preparation of performing interpretations.

2. Programmability and configuration. Change the parameters of the sound and timbre of the instrument through a system of settings to solve specific artistic tasks.

3. The universality of synthesis. Modeling the sound of individual acoustic instruments and entire



symphony orchestras, as well as the generation of fundamentally new sound images.

4. Sequencer and library function. The ability to pre-create material, record it, save it, and use musical fragments in real time during performance.

Among digital musical keyboard instruments, digital pianos are particularly popular, which can be considered a "transitional stage" instrument (see Figure 3). They combine the tactile and acoustic properties of an acoustic piano with the functionality of a digital keyboard synthesizer, making it easier to transition into a digital environment.



Figure 3. Digital piano

The most important consequence of the development of these technologies is the shortening of the path to creative comprehension of music. Thanks to the use of AI elements, the emphasis shifts from the technical embodiment to the artistic realization of the creative idea of the composition. The main task becomes the realization of the creative idea, the composer's idea, the transmission of the emotional, sound and artistic-figurative content of the work, as well as the selection of various options for its interpretation due to the expanded expressive capabilities of a digital musical instrument.

By imposing additional requirements on a musician compared to acoustic instruments (knowledge of music theory, harmony, and analysis of musical form are complemented by knowledge of the basics of composition and improvisation, sound engineering, and knowledge of music informatics), a digital music synthesizer makes it possible to control the functions of the MCT programs embedded in the instrument using AI. When working with a digital keyboard synthesizer, the musician acts simultaneously as a performer and

composer, while performing the functions of a sound engineer and a user (see for more information about the functionality of the new electronic and digital musical and creative instruments, see [8-9]). This is the basis of creative activity on digital musical synthesizers: creating an original author's composition or arrangement, which involves adding author's elements to the musical material, changing texture, shape, selection, processing or creating your own timbres, etc.

III. INTEGRATION OF DIGITAL TOOLS INTO THE EDUCATIONAL PROCESS. DIGITAL MUSICAL INSTRUMENTS AS AN ELEMENT OF A MUSIC TEACHER'S IEE

The unique technical capabilities of the digital keyboard synthesizer, which distinguish it from acoustic instruments, open up significant didactic potential for children's musical education. According to the researchers, digital musical instruments make it possible to solve an important pedagogical task - the mass involvement of students in musical creative work [9; 20]. The integration of digital tools into the educational process necessitates new pedagogical approaches, technologies, and forms of learning organization. In the context of the expansion of the информационной образовательной среды (hereinafter referred to as IEE), this imposes new requirements on the professional competencies of a musician teacher related to the use of digital keyboard instruments in teaching music to children.

Modern researchers (E.O. Ivanova and I.M. Osmolovskaya) identify the following key characteristics of IOS related to the educational process:

- personal commitment – the environment has an active subjective principle, in which it is the personality that sets the vector of its development and gives it integrity;
- multimedia – representation of information in various ways (visual, auditory, kinesthetic);
- multidimensional is the consideration of objects and phenomena from different points of view, in a variety of their connections and relationships, which contributes to a deeper assimilation of the material and requires the information competence of the student [17].

Thus, the analysis of the didactic potential of IEE shows that learning in such an environment acquires a new quality through the use of tools that expand educational opportunities, ensure diverse professional interaction and learning continuity. Digital musical instruments are becoming one of the elements and principles of the professional activity of a music teacher, which makes it necessary both to master the functionality of computerized instruments and to methodically introduce them into the musical and pedagogical process [14]. The use of digital technologies, expanding the IEE of a music teacher, determines the level and quality of his/her professional activity in the environment itself. Therefore, for the formation of competencies, it is necessary to build the training of a music teacher in the conditions of IEE.

Researchers (see, for example, the works devoted to research on various aspects of the problems of cognitive musicology and the psychology of the musical and creative process [2; 10; 13; 26-27]) propose using a psychodidactic approach, which includes the principles of three scientific disciplines, as the basis for the design of IEE:

- Technologies form the infrastructure that ensures the systematization of working methods, analysis and resource search.
- Psychology reveals the patterns of information and communication behavior of a subject in IEE, as well as the features of his cognitive development.
- Pedagogy defines the methodology of organizing the educational process, creating conditions for the formation of personality, knowledge, and competencies in the digital environment.

IV. THE STRUCTURAL AND FUNCTIONAL MODEL OF THE IEE OF A MUSIC TEACHER

The successful implementation of training in IEE requires the comprehensive development of the competencies of a musician teacher in the field of digital musical instruments and MCT, taking into account the principles of an interdisciplinary approach (see more details in the articles [5; 8; 10]).

Taking into account our long-term experience in teaching a number of disciplines in the system of basic and additional education in the process of

training and retraining of musical teachers working in various musical educational institutions in Russia, we have developed the structure of the pedagogical model of the cotemporary musical teacher (see Figure 4).

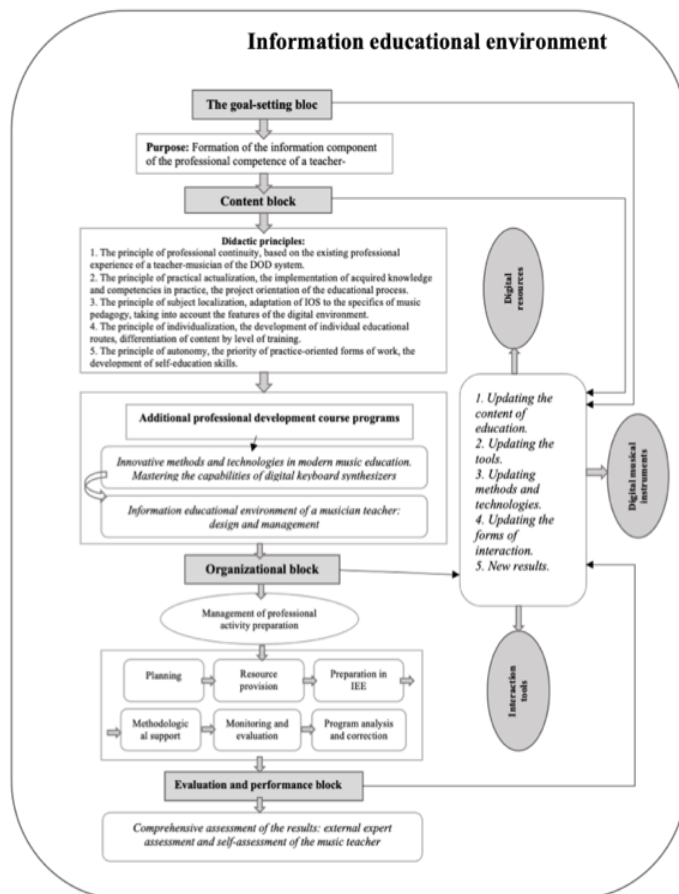


Figure 4. The structure of the pedagogical model of the contemporary musical teacher

Considering the IEE of a music teacher as a model based on the integration of information, communication and management, we can identify the main elements of interaction.:

- information component (interaction with learning content, resources),
- psychological and communicative (interaction of subjects),
- educational and managerial (teaching methods and technologies).

Thus, the structure of the projected IEE for the training of a music teacher is determined by three interrelated components:

Thus, with this approach, these interactions are carried out in such aspects as:

- *information technological* – resources, presentation of material, information;

- *psychological* – communication, interaction, assistance to the subject;
- *educational* – education, preparation.

Therefore, the informational educational environment in which the training of a musician teacher will be carried out will be considered within the framework of the identified basic concepts.:

1. *Resources* (informational educational resources, information, training content).
2. *Communication* (professional community).
3. *Management* (training is managed by the system of additional professional education).

Let's consider the interaction of components in the simulated IEE, which is based on the principles of integrity, complementarity and is revealed through the following relationships (Figure 5).

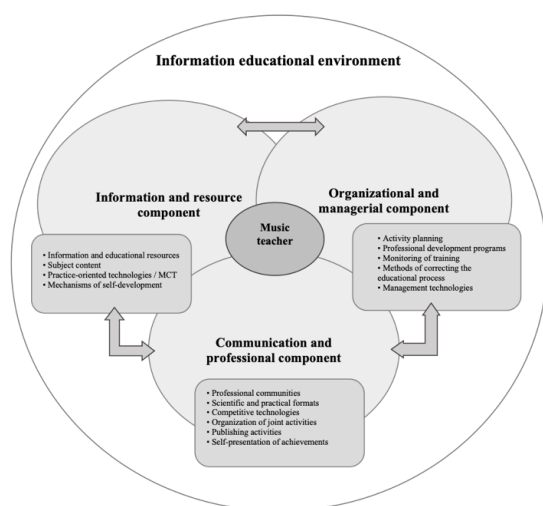


Figure 5. The interrelation of the components of the IEE of the music teacher

In these aspects, educational and informational interactions

1. The relationship "information-resource – communication-professional".

Communication content – information-resource component (educational materials, digital resources) provides a meaningful basis for professional communication. In turn, the communication and professional component creates new methodological content and generates a request for relevant resources identified during discussions and exchange of experience.

The result is a self-developing system in which resources stimulate professional communication,

and its results continuously enrich and update the resource base.

2. The relationship "communication-professional – organizational-managerial".

Communication content – communication-professional component acts as a source of feedback about real needs. Based on the analysis of discussions, difficulties and successful practices, organizationally the management component adjusts the vocational training programs, designs individual educational trajectories, and makes changes to the content of advanced training courses.

The result is that the flexibility and high degree of adaptability of the training system is ensured, as well as its focus on the needs of specific music teachers.

3. The relationship "organizational-managerial – information-resource".

The communication content is an organizational and managerial component that determines strategic priorities for the development of the resource base based on data from monitoring and assessment of competence formation. He forms an order for the development or correction of the content of programs, specific teaching materials, and digital tools.

The result is that the resource base is purposefully developing and adapting to the actual tasks of training, which ensures its high practical significance and relevance.

Thus, the integration of components creates a continuous development cycle according to the "planning – implementation – evaluation – correction" scheme. The application of this approach allows not only to reveal the structure (architecture)

To analyze its impact on the formation of professional competencies, to trace the dynamics of professional growth of a teacher-musician.

This approach is effective because it provides a synthesis of traditional principles of music pedagogy with modern educational technologies.

The productivity of professional training is determined by the effectiveness of the interaction of the components of the designed IEE.

The proposed model implements an integrated approach, creating a flexible and adaptive platform

for the continuous professional development of a music teacher.

1. Information resource component

This component represents the content and technological basis of the IEE and includes:

- professional development course programs,
- IEE complex,
- digital instruments – digital keyboard instruments, MCT.

Functional purpose.

It consists in organizing interaction with the subject matter and digital resources. At this stage, the theoretical and practical development of the content of the subject is carried out, the implementation of cognitive actions related to the analysis and processing of information, work with multimedia, the use of specialized software – MCT [5].

Performance.

Professional competencies are formed through the development of subject content, the practice of using digital technologies, and the creation of their own educational and methodological products. At the same time, key professional skills are being developed, such as working in MCT programs, mastering and adapting multimedia resources, and developing digital competencies. The implementation of these components is of particular importance in children's music and educational institutions.

2. Communication and professional component

This component is a system of methods and tools for organizing professional communication and networking. It provides a multi-level interaction between the teacher and the student, members of the professional community, mentor and experts.

Forms of educational interaction.

Collective forms include participation in professional communities, events (conferences, seminars, master classes, competitions), joint project activities, and discussion of methodological issues.

Individual forms are personalized educational trajectories, independent work with resources, and reflexive practice of professional development.

In this case, the music teacher independently formulates tasks and chooses the content of the training for himself and manages his activities with the support of the course teacher and colleagues.

Functional purpose.

The implementation of this component contributes not only to the development of subject content and the formation of competencies, but also to the development of personal qualities of a teacher-musician, as well as the creation of new educational products.

3. Organizational and managerial component

This component includes a set of elements that ensure the management of the educational process, organizational support, methodological support and coordination of the participants' activities.

Main functions:

- ☐ designing educational programs;
- ☐ resource support;
- ☐ monitoring the quality of education;
- ☐ organization of access to educational resources;
- ☐ providing professional communications;
- ☐ monitoring and evaluation system.

The management structure in the conditions of IEE is implemented on two levels:

1. The course teacher organizes the educational process, provides methodological support, and provides expert assessment.

2. Student self-management includes choosing an educational program, regulating the pace of program development, correcting an individual development plan, and monitoring one's own achievements.

Distinctive features of IEE management.

The use of interactive forms of interaction, the implementation of personalized routes. Thus, effective management of training in IEE ensures the systematic professional growth of a musician teacher, the formation of self-education competencies, and the development of readiness for continuous learning. The management of educational interaction in this context provides a balance between leadership and individual student activities.

We also note the special role played by the process of mastering the capabilities of modern

digital musical instruments and electronic musical synthesizers by music teachers in the system of additional professional education. A modern digital musical instrument is truly an invaluable gift in the hands of a creative teacher, an innovative teacher, who allows the teacher and his students to come into contact with the limitless possibilities of the world of music and pushes the boundaries of classrooms, classrooms, and concert halls (see for more details in [5; 8-10]). The formation of a high-tech creative educational environment in the system of basic and additional professional musical education at its various stages and in educational institutions of different orientation, providing an unprecedented level of accessibility, including the implementation of various facets of the system of inclusive music education (see, for example, in [7]).

V. CONCLUSION

The conducted research allows us to state that the designed IEE is an integral model aimed at the comprehensive development of professional competencies of a music teacher. The main advantage of this model is the possibility of creating an individual learning microenvironment, which ensures the adaptation of the educational process to the individual needs and professional deficits of a particular music teacher.

Thus, the IEE of music teacher training can be characterized as a modern concept of professional

development. The implementation of this model creates conditions for:

- updating professional knowledge;
- formation of practice-oriented competencies in demand in teaching activities;
- integration of digital musical instruments and MCT into the educational process;
- generalizations and dissemination of current pedagogical experience.

The implementation of the proposed model opens up prospects for improving the quality and effectiveness of professional training of music teachers in the context of the emergence of AI and digital transformation of education.

The process of mastering the capabilities of modern digital musical instruments and electronic musical synthesizers by music teachers in the system of additional professional education plays a special role in the formation of a high-tech creative accessible educational environment in the system of basic and additional professional music education at its various stages and levels. A modern digital musical instrument is truly an invaluable gift in the hands of a creative teacher, an innovative teacher who allows the teacher and his students to come into contact with the limitless possibilities of the world of music and pushes the boundaries of the audience, classroom, and the possibilities of concert halls.

REFERENCES

- Aliyeva, I.G., Gorbunova, I.B., & Mezentseva, S.V. (2019). Musical Computer Technologies as an Instrument of Transmission and Preservation of Musical Folklore (by the Example of the Russian Far East). *Music Scholarship*, 1 (34), 140–149. <https://doi.org/10.17674/1997-0854.2019.1.140-149>
- Clayton, M., Jakubowski, K., Eerola, T., Keller, P. E., Camurri, A., Volpe, G., & Alborno, P. (2020). Interpersonal entrainment in music performance: theory, method, and model. *Music Perception: An Interdisciplinary Journal*, 38(2), 136–194. <https://doi.org/10.1525/MP.2020.38.2.136>
- Crawford, R. (2020). Beyond the dots on the page: Harnessing transculturation and music education to address intercultural competence and social inclusion. *International Journal of Music Education*, 38(4), 537–562. <https://doi.org/10.1177/0255761420921585>
- Crooke, A. H., D., Davidson, J., & Fraser, T. (2024). Exploring the real-world applicability of an Intercultural Music Engagement (ICME) framework. *Journal of Intercultural Studies*, 1–21. <https://doi.org/10.1080/07256868.2024.2362747>
- Gorbunova, I.B. (2020). The concept of music computer pedagogical education in Russia. *International Journal of Advanced Science and Technology*, vol. 29, no. S6, pp. 600-615. EDN: AVSRLP
- Gorbunova, I.B. (2020). The integrative model for the semantic space of music and a contemporary musical educational process: the scientific and creative heritage of Mikhail Borisovich Ignatyev. *Laplace em Revista*, vol. 6, no. S, pp. 2-13. DOI: 10.24115/S2446-622020206Especial940p.2-13

- Gorbunova, I., Govorova, A. (2018). Music computer technologies in informatics and music studies at schools for children with deep visual impairments: From the experience *Informatics in Schools. Fundamentals of Computer Science and Software Engineering: 11th International Conference on Informatics in Schools: Situation, Evolution, and Perspectives, ISSEP 2018*. (Vol. 11169 LNCS, pp. 381–389). DOI: 10.1007/978-3-030-02750-6_29
- Gorbunova, I.B., Kameris, A. (2019). Music computer education concept for teachers: Raising the problem. *International Journal of Recent Technology and Engineering*., vol. 8, no. 2 S4, pp. 913-918. DOI: 10.35940/ijrte.B1181.0782S419
- Gorbunova, I.B., Petrova, N.N. Digital musical instrument as a sociocultural phenomenon. *Universidad y Sociedad*. 2020, vol. 12, no. 3, pp. 109-115. EDN: GJRYW
- Gorbunova, I.B., Plotnikov, K.Y. (2020). Music-related educational project for contemporary general music education of school children. *International Journal of Innovation, Creativity and Change*, 12 (2), 451-468. EDN: HSTOTP
- Gorbunova, I. B., and Zalivadny, M. S. (2019). Leonhard Euler's Theory of Music: Its Present-Day Significance and Influence on Certain fields of Musical Thought. *Music Scholarship*, 3 (39), 104–111. DOI: 10.17674/1997-0854.2019.3.104-111
- Gorbunova, Irina B., Zalivadny, Mikhail S., and Tovpich, Irina O. (2020). On the application of models of the semantic space of music in the integrative analysis of musical works and music education with music computer technologies // Sobre la aplicacion de modelos del espacio semantico de la musica en el analisis integrador de obras musicales y educacion musical con tecnologias informaticasmusicales. *Apuntes Universitarios*, 10, 13–23. DOI: [10.17162/au.v10i4.486](https://doi.org/10.17162/au.v10i4.486)
- Granot, R., Spitz, D. H., Cherki, B. R., Loui, P., Timmers, R., Schaefer, R. S., Vuoskoski, J. K., Cárdenas-Soler, R.-N., SoaresQuadros Jr., J. F., Li, S., Lega, C., La Rocca, S., Martínez, I. C., Tanco, M., Marchiano, M., Martínez-Castilla, P., Pérez-Acosta, G., MartínezEzquerro, J. D., Gutiérrez-Blasco, I. M., Jiménez-Dabdoub, L., Coers, M., Treider, J. M., Greenberg, D. M. & Israel, S. (2021). "Help! I need somebody": music as a global resource for obtaining wellbeing goals in times of crisis. *Frontiers in Psychology*, 12, 1–22. <https://doi.org/10.3389/fpsyg.2021.648013>
- Gwinjilia, G. (2023). The concept of transcultural music in a globalized world and the future perspective of music research: on the example of Josef Bardanashvili's Compositional Style. *Journal of Music Theory and Transcultural Music Studies*, 1(1), 113–126. <https://doi.org/10.5281/zenodo.10926722>
- Haven, T. L., Errington, T. M., Gleditsch, K. S., van Grootel, L., Jacobs, A. M., Kern, F. G., Piñeiro, R., Rosenblatt, F., & Mokink, L. B. (2020). Preregistering qualitative research: A Delphi study. *International Journal of Qualitative Methods*, 19, 1–17. <https://doi.org/10.1177/1609406920976417>
- Hu, D., & Zheng, Y. (2024). Research on the innovation of piano music teaching in colleges and universities based on the characteristics of music culture. *Applied Mathematics and Nonlinear Sciences*, 9(1), 1–21. <https://doi.org/10.2478/amns.2023.2.01547>
- Ivanova, E.O., Osmolovskaya, I.M. *Theory of learning in the information society*. Moscow: Publishing House "Prosveshchenie", 2011. 187 p.
- Lavengood, M. (2019). What makes it sound 80s? The Yamaha DX7 electric piano sound. *Journal of Popular Music Studies*, 31(3), 73–94. <https://doi.org/10.1525/jpms.2019.313009>
- Liu, Y. (2023). Differences in instrumental practice time and strategies among Chinese music majors. *Research Studies in Music Education*, 45(1), 127–140. <https://doi.org/10.1177/1321103X211038839>
- Lei, S. Y., Chiu, D. K., Lung, M. M. W., & Chan, C. T. (2021). Exploring the aids of social media for musical instrument education. *International Journal of Music Education*, 39(2), 187–201. <https://doi.org/10.1177/0255761420986217>
- Lerch, A., Arthur, C., Pati, A., & Gururani, S. (2019). Music performance analysis: A survey. *Proceedings of the International Society for Music Information Retrieval Conference (ISMIR)*. [Delft]. <https://doi.org/10.48550/arXiv.1907.00178>

-
- Ng, D. T., Ng, E. H., & Chu, S. K. (2022). Engaging students in creative music making with musical instrument application in an online flipped classroom. *Education and Information Technologies*, 27(1), 45–64. <https://doi.org/10.1007/s10639-021-10568-2>
- Pearce, M.T. (2018). Statistical learning and probabilistic prediction in music cognition: mechanisms of stylistic enculturation. *Annals of the New York Academy of Sciences*, 1423(1), 378–395. <https://doi.org/10.1111/nyas.13654>
- Picaud, M. (2022). Framing performance and fusion: how music venues' materiality and intermediaries shape music scenes. *American Journal of Cultural Sociology*, 10(2), 285–315. <https://doi.org/10.1057/s41290-022-00151-8>
- Tomaszewski, L.E., Zarestky, J., & Gonzalez, E. (2020). Planning qualitative research: Design and decision making for new researchers. *International Journal of Qualitative Methods*, 19, 1–7. <https://doi.org/10.1177/1609406920967174>
- Wald-Fuhrmann, M., Egermann, H., Czepiel, A., O'Neill, K., Weining, C., Meier, D., Tschacher, W., Uhde, F., Toelle, J. & Tröndle, M. (2021). Music listening in classical concerts: Theory, literature review, and research program. *Frontiers in Psychology*, 12, 1–14. <https://doi.org/10.3389/fpsyg.2021.638783>
- Wong, J.Y. (2020). Chinese musical culture in the global context – modernization and internationalization of traditional Chinese music in twenty-first century. *Chinese culture in the 21st century and its global dimensions: Comparative and interdisciplinary perspectives*, 105–122. https://doi.org/10.1007/978-981-15-2743-2_7
-