A Digital Musical Instrument as an Intellectual Element of the Music Teacher’s Information Educational Environment

Irina B. Gorbunova, Klara B. Davletova

***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.**

***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

The 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 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 [7-8].

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 [6-8]. Synthesized sound is constructed by a musician from the basic components of sound using an artificial intelligence (AI) digital 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 [1].

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Irina B. Gorbunova. She is now with the Herzen State Pedagogical University of Russia, St. Petersburg

Klara B. Davletova. She is now with the Herzen State Pedagogical University of Russia, St. Petersburg

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 [2-3].

Figure 1. Digital musical instruments

Fig. 2. Keyboard synthesizer

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 [4-6]). 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 creativity [10-12]. 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 [13].

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 (T.N. Noskova and T.B. Pavlova) propose using a psychodidactic approach, which includes the principles of three scientific disciplines, as the basis for the design of IEE [15-16]:

- Computer science forms the technological infrastructure, providing 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 [17-19]).

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 modern musical teacher (see Figure 4).

Fig. 4. The structure of the pedagogical model of the modern 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).

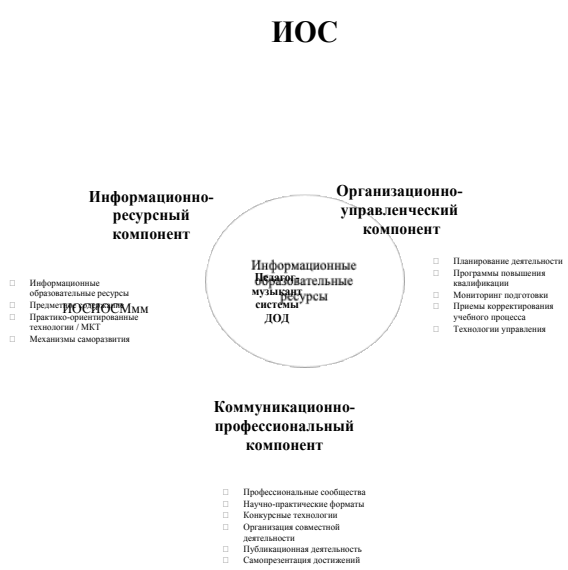

Figure 5. The interrelation of the components of the IEE of the music teacher

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 [19-20].

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 [21-22], work with multimedia, the use of specialized software – MCT [23-25].

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.

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.

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Irina B. Gorbunova was born in Saint Petersburg (Leningrad), Russia.

DipMus, Special Music Higher School of the St. Petersburg State Conservatory named after N.A. Rimsky-Korsakov; BSc in Computer Science: Information Technology, Computer Science and Multimedia, Leningrad State University, Ussurisk State Pedagogical University; MA in Education, the Herzen State Pedagogical University of Russia; PhD in Information Technology and Pedagogical Sciences, the Herzen State Pedagogical University of Russia, St. Petersburg, 1989; Doctor degree: Doctor of Pedagogical Sciences and Information Technology, the Herzen State Pedagogical University of Russia, St. Petersburg, 1999.

Dr., Full Professor, Chief Researcher of the Education and Methods Laboratory *Music Computer Technologies* at the Herzen State Pedagogical University of Russia, St. Petersburg; hold the degree of Honorary Worker of Higher Professional Education of the Russian Federation.

Prof. Dr. Gorbunova is a Chairperson of the annual International Research and Practical Conference *Contemporary Musical Education*: *Creative Work, Research, Technology,* held since 2002; Chairperson of the annual International Research and Practical Conference *Music Computer Technologies in the System of Contemporary Education,* held since 2007; International Research Conference, held since 2017;); Chairperson of the annual International Research Conference *Interdisciplinary East-West Discourse: The 21st Century. Creative Work. Research. Technology. Education*, held since 2020 (Baku, Azerbaijan – St. Petersburg, Russia).

Dr. Gorbunova is a member of the Jury of national and international competitions of musical creative works, including *Electronic Palette* (Saint-Petersburg), *Music and Electronics* (Moscow), *Music of the 21st Century* (Moscow / Saint-Petersburg), International Festivals and Competitions *Musical Electronics and Multimedia* (Moscow / St.-Petersburg), *CLARINE of the 21st Century* (St. Petersburg), *The World of Art without Borders* (Saint-Petersburg, Russia - Szeged, Hungary), *Bridge of Friendship* (Dortmund, Germany), All-Russian Competition of Electroacoustic Music *DEMO* (St. Petersburg, Russia).

Under the guidance of the professor, Dr. Gorbunova developed the first-ever bachelor's degree programs in *Music Computer Technologies* (2004) and *Information Technology in Music and Sound Design* (2023), as well as Master's degree programs in *Music Computer Technologies in Education* (2006) and *Digital Technology in Music and Sound Design* (2022).

Professor Dr. Gorbunova directs a number of doctoral and postdoctoral studies (more than 30) and lectures on music computer technology and information technology in music. She directs research in various fields, including: Theory and history of culture, musical art, information systems and processes, Theory and Methodology of vocational education, mathematical modeling, numerical methods and software systems, Theory and methods of teaching and educational work (in music, computer science, natural sciences). The research results of Prof. Gorbunova has published more than 550 peer-reviewed publications, including more than 50 books and more than 300 articles in various scientific journals.

Her research activities include such directions as:

MCT in professional musical education (as a means to expand creative opportunities);

MCT in general musical education (as one of the means of education);

MCT as a means of rehabilitation of people with disabilities;

MCT as the new direction in preparation of specialists of humanitarian and technological profile;

MCT in the field of digital arts; MCT in information technology, psychoacoustics and musical acoustics; system of training arrangements and the art of performing skills on electronic musical instruments.

Her circle of interests also includes the problems of interrelation of natural and technical sciences and humanities, as well as the possibilities of applying the results of such interrelation for the purposes of music education and upbringing.

She also takes part in working out the specialized software for computer music devices and in application of this software in pedagogical processes.

Her developments and researches also belong to the field of musical pedagogics and musicology, musical informatics, computer modeling of processes of musical creativity, timbre programming, art of performing skills and arrangement on electronic musical instruments, creative work in the field of computer music, mathematical methods in musicology.

Klara B. Davletova was born in Ufa, Bashkortostan, Russia.

2001 - Master of Musical Arts – Ural State Conservatory named after M. P. Musorgsky; PhD student of the Herzen State Pedagogical University of Russia under the supervision of Prof. Dr. Irina B. Gorbunova.

She has more than 100 research publications, among them are monographs, digital educational resources, textbooks and handbooks. Note such as: collections of research articles *Music Computer Technologies.* Vol. 1 - 9: *Electronic Musical Instruments. Theory and Practice of Performing Arts*, authors-compilers I.B. Gorbunova and K.B. Davletova (2016 - 2025); textbooks for music teachers *By Teaching, I am Learning* (by K.B. Davletova and E.A. Mayorova); monograph *Musical Instruments of the Digital Age* (2023 in co-authorship) and many others, dedicated to the topic of “Information Technology in Music" and “The Information Educational Environment of Music Teachers” (she has more than 100 research publications).

Her articles have been published in various scientific journals and editions.