ISBN 978-989-9121-45-4
44th ISTANBUL International Conference on Music, Music therapy and Complementary Medicine (MTCM-24)
Dec. 19-20, 2024 Istanbul (Turkiye)

Musical Informatics in Teaching Students with Profound Visual Impairments in Secondary Specialized Music Institutions

Irina B. Gorbunova[1], Sergey A. Morozov[2], Victor V. Zakharov[3]

[1, 3]Education and Methods Laboratory *Music Computer Technologies* at the Herzen State Pedagogical University of Russia, St. Petersburg

[2]Kursk Music Boarding College for the Blind, Kursk, Russia

Abstract: *Since 2003, the subject "Musical Informatics" has been introduced into the curricula of the secondary vocational (music) specialized educational institution the Kursk Music Boarding College for the Blind, whose activities are related to the musical education of students with profound visual impairments. Musical Informatics in combination with other disciplines contributes to the professional adaptation of young people with visual analyzer pathology, improving their social status and facilitating integration into professional activities. Practice has shown that the introduction of the discipline "Musical Informatics" contributes to a more complete mastery of such subjects as "Computer Arrangement", "Instrumentation", "Concertmaster Class", "Solfeggio", "Harmony" and others. These disciplines are of great interest to students with visual impairments, since the educational process is closely related to computer technology, and this new form of education is especially attractive to students today, makes it possible to form stable orientation skills in a high-tech information educational environment and helps to overcome professional and socially significant difficulties. It is established that the study of the discipline "Musical Informatics", based on the use of music computer technologies, is of the greatest importance for the growth of professional competencies and social adaptation of musical students with profound visual impairments. Based on the use of the discipline "Musical Informatics", a set of academic disciplines has also been developed, which is being introduced into the educational process of professional training of students of musicians with profound visual impairments in a number of educational institutions of the country.*

Keywords: *Music Computer Technologies, Musical Informatics, Inclusive Musical Education, Disabled Students with Visual Impairments.*

1. Introduction

The use of digital technology has permeated the everyday life of students with severe visual impairment [1-4]. Almost all students use digital players, voice recorders, personal computers, laptops, tablet computers, and smartphones for educational purposes. The research findings can be of interest for musicians with profound visual impairments, blind students and their teachers, and for specialists dealing with problems of socialization and social adaptation of people having vision limitations. Connecting stationary and mobile devices to broadband Internet access has become regular and completely meets everyone's needs. When preparing for classes, most students regularly use digitally recorded audio materials, text electronic documents (synopsis, books, articles on the Internet), which are voiced using special voice synthesizers and screen access programs.

It was found that the study of the disciplines "Computer Arrangement" and "Musical Informatics" based on using music computer technologies (MCT) is of the greatest importance for the growth of professional competencies and social adaptation of music students with profound visual impairments. The thematic range and content of these disciplines is very diverse, which allows you to form stable orientation skills in a high-tech information educational environment and helps to overcome professional and socially significant difficulties.

In the late 90s of the 20th century the educational programs of some music faculties of higher and secondary educational institutions of Russia, music schools and schools of arts began to experimentally introduce the disciplines “Musical Informatics” and “Computer Arrangement.” The main emphasis was placed on the study of digital technologies in the field of music and work with digital sound, as well as on the development of the most common music programs. Since 2003, the subject “Musical Informatics” has been introduced into the curricula of many educational institutions in Russia, whose activities are related to musical art and music education.

Let’s take a closer look at the features of teaching the discipline “Musical Informatics” to music students with severe visual impairments in secondary professional and higher educational institutions.

2. Methods and Approaches

The Creative activities with the use of digital musical instruments, being initially an optional subject, subsequently formed the basis of the specialized training “Computer Arrangement” course.

Practice has shown that the introduction of the disciplines of “Musical Informatics” and “Computer Arrangement” contributes to a more complete mastery of such subjects as “Instrumentation and Arrangement,” “Concertmastership Class,” “Solfeggio,” “Harmony” and many others that play an important role in vocational musical training of students with visual impairment in the secondary vocational (music) specialized educational institution the Kursk Music Boarding College for the Blind. These disciplines are of great interest to students with visual impairments, since the educational process is closely connected with computer technology, and this, today relatively new, form of training especially attracts students.

Musical informatics in combination with other disciplines promotes professional rehabilitation of young people with the vision analyzer pathology, increase their social status and, in the future, integration into professional activities.

The purpose of the “Musical Informatics” course is to create the prerequisites for expanding the adaptive capabilities of the visually impaired musician with the help of modern digital technologies and MCT, which contribute to a fuller use of his creative potential.

The objective of the subject is an acquaintance and development of digital sound technologies, gaining experience with digitized and synthesized sound, and musical content in a variety of formats.

This course provides the opportunity to obtain the following skills:

– work in sound editors and sequencer programs with both audio and MIDI data;

– musical notation, preparation of scores and parts for orchestral, choral, ensemble compositions and so on;

– recording live sound and its conversion. In practice, students get acquainted with the main types of professional music software:

– audio editing programs (Adobe Audition, Sound Forge, Wavelab);

– sequencer software (Cubase, Reaper, Sonar, Studio One);

– music notation software programs (Final, Sibelius);

If time permits, you can also include designer programs in this list: both MIDI (Band-in-a-Box) and audio (Dance eJay, Magix Music Maker and the alike).

It is enough to get acquainted with one of the programs in each group, since the operation algorithm and the feature set are almost the same, the difference is in the logical structure of the interface construction.

Audio editing programs are oriented towards flexible work with audio information. This is the most versatile technology that represents sound as it is – in the form of a sound wave. These programs combine the functions of a digital recorder, sound editing station and a set of sound processing devices, recording, playing and assembling musical content. Practically all functions and types of editing in programs of this type are available for people with visual impairments via specialized speech programs. Using them, you can professionally prepare sound content for radio programs and audio books, digitize and restore old recordings, change the sound speed and pitch at a professional level and so on.

Sequencer programs are designed to record music from scratch. They are always multi-track and allow the formation of a work from independent voices of various instruments, combining many of the functions of a virtual studio. Sound can be formed both from software virtual synthesizers and from external sound modules. These programs also work with audio content. Recording and using "live" instruments (voices, strings, winds, etc.) in a score will help enrich the overall sound of an audio project.

One of the most well-adapted virtual sequencers for blind musicians is the Cakewalk Sonar. With the support of JAWS, almost all the program scope is available for use by a blind person.

The result of mastering the course should be the acquisition of practical skills in the field of MCT, as well as developing the student's diverse musical thinking, which is necessary for successful independent professional work as an artist, teacher, accompanist, and arranger.

3. Musical Informatics

Introduction. Contents of the Discipline 'Musical Informatics'. Multimedia Features. Multimedia features of a computer. Requirements for computer resources. Computer as a music station.
The student is obliged: to have an understanding of the modern multimedia capabilities of a computer.

3.1. SECTION I. Digital Musical Instruments and Musical Computer

Topic 1. The first electronic musical instruments and their creators. Electroacoustic music. Electronic tuning fork K. Page; T. Cahill's Telharmonium; I. Efremov's gears and wheels; L. Hammond's organ. Electronic revolution made by T. Edison and Lee de Forest. Inventions by L. Theremin, Martenot. E. Sholpo's grafic sound; E. Murzin's ANS; A. Volodin's Equodyn. RCA of G. Olson and G. Belar.

The student is obliged: to have an idea of the history of development of electric musical instruments, the principles of their operation; to know the main stages of development.

Topic 2. First commercial synthesizers and their development. Analog synthesizers: Aimert, Moog, Oberheim. Digital synthesizers: Yamaha, Korg, Roland, etc. FM synthesis by D. Chowning (Yamaha DX7). Samplers: J. Appleton and Synclavier.

The student is obliged: to have an understanding of the principles of operation and differences between analog and digital synthesizers; to have an understanding of the principles of FM synthesis and sampling.

Topic 3. A new look of the notion "Music of 20th Centure". From Italian futurists to the specific music of P. Schaeffer. Cologne Studio; electroacoustic music of European countries and America; development of the genre in Russia; creativity of modern composers (using and voicing orchestral scores and creating electronic compositions themselves). Pop music (soundtrack and live performance. Television, radio, cinema and theater ("background" music, new approaches to radio drama, music and advertising).

The student is obliged: to have an understanding about the development of "avant-garde" directions of non-traditional music; about the place and possibilities of electroacoustic music; to have an idea about the problems and trends of electroacoustic art in the modern world.

3.2. SECTION II. Speech Support Programs (Screen Readers).

Topic 1. Types of speech support programs, general properties. Specialized and universal screen readers. Windows, window views, zones, markers. Modes: general and reading. The student is obliged: to have an idea

about the types of speech support programs; tools of universal programs; modes of operation of speech support programs.

Topic 2. The JAWS for Windows program. Assign and load the program. Configuration. Managing the Jaws for Windows program: minimizing, activating the desktop, working with Windows; selecting objects and standard operations. Reading mode (Joes cursor); mouse simulation. Applicability of the program, understanding of script functions.

The student must: have an understanding of the capabilities of the Jaws for Windows program and its configuration; be able to use the program Jaws for Windows to work in the Windows environment at the level of a normal user: launch and shut down Windows applications; load and close files, move in and between Windows; select objects and perform standard operations with them; respond to system requests; enter the program menu, Windows, context menus; select and perform actions of menu items; use the Joes cursor.

Topic 3. Working with the Microsoft Word text editor supported by JAWS. Read and create texts in Microsoft Word. Continue studying the alphanumeric block of the keyboard. Editing, standard text operations supported by Jaws for Windows.

The student must: know the program structure. be able to read and create text files in the Microsoft Word text editor supported by Jaws for Windows.

3.3. SECTION III. Fundamentals of Acoustics and Theories of Sound. Analog and Digital Audio

Topic 1. The physical parameters of sound. The sound as the vibrations of the particles of the environment. Periodic (musical) and non-periodic (noise) vibrations. The amplitude, frequency, and phase of sound vibrations. Three main ways to modulate sound vibrations. Harmonic vibrations. Period, wavelength. Measurement of sound strength (volume). Timbre: harmonics (overtones), formant, spectrum of the sound signal. Sound stages: attack, decline, support, fade.

The student must: know what types of sound vibrations exist in nature; what are determined and measured: volume, pitch, how the organs of hearing perceive the direction to the sound source; how can you imagine complex (non-harmonic) vibrations; what sound parameters determine the timbre; what stages make up the sound of a musical instrument.

Topic 2. Sound in space. Sound effects. Reflection and absorption of sound in the room. Changes in the frequency response of the spectrum during sound absorption. Reverb and its main characteristics. Origin and physical essence of sound effects: reverb, chorus; amplitude, frequency and phase modulations; Plate, Flanger, Panner and other variants of sound modulations. Distortion and overdrive.

The student must: have an understanding of the behavior of sound in an open space and in a room, the properties of reflected sound and the applicability of reverberation; the physical nature and influence of amplitude, frequency and phase modulation on the sound; the origin and essence of other sound effects.

Topic 3. Methods of recording and reproduction of sound. Analog methods: the invention of Thomas Edison; recording, tape recording, sound track in movies. Revolution: digital recording. The essence of digital representation of sound. Quality, reproductive performance, price.

The student must: have an understanding of the history of sound recording, the methods and essence of analog sound recording, the principles of digital recording, and the current problems of digital sound recording.

Topic 4. Equipping a modern sound studio. Characteristics of the Toolkit. The main composition of the recording studio: microphones, synthesizers, mixing console, sound processors, tape recorder (analog or digital), audio frequency amplifier, monitor speakers. The main characteristics of the studio equipment: frequency characteristics, signal amplitude standard, signal-to-noise ratio, etc. The role and capabilities of the musical computer in the sound studio.

The student must: have an idea of a modern recording Studio, its components, their purpose, and the possibilities of replacing hardware with a computer; know the basic terms and standards.

3.4. SECTION IV. The Synthesized Sound

Topic 1. The digitization of sound. Sampling. The process of sampling: the sampling ADC (analogue digital converter, or Analog-To-Digital Converter). The accuracy of the digital representation of the sound: resolution and bit depth. Impact on quality. The imposition of spurious signal. RBA standard. Encoding. Struggle to save memory: MP3 format. Sampling to create a "patch": loop, multi-sampling, players, "instrument".

The student must: have an idea about the process of digitizing sound; creating a “patch"; the influence of the main parameters on the quality of digitized sound, distortion; compact audio formats; know what the resolution and bit depth are; Red Book Audio standard.

Topic 2. Methods for the synthesis of sound. PCM synthesizers: summation and subtraction methods; FM modulation. Samplers. Sound formats. Hybrid methods. Method of physical modeling. Virtual synthesizer.

The student must: have an idea of the main methods of sound synthesis, their principles, advantages and disadvantages.

Topic 3. Synthesizers, sound blocks, sound cards. Types of digital synthesizers and their capabilities. Sound blocks. Types of sound cards, the basic device of a universal sound card. Working with the synthesizer: controls; styles and instruments; auto-accompaniment capabilities; tempo, transposition, tuning; macro-processing (registration memory); track recording; setting up MIDI and other functions; effects (DSP).

The student must: have an idea about the types of synthesizers, their capabilities; about sound blocks; about the device of sound cards; about synthesizer settings, track recording and correction; be able to choose styles and instruments, enable auto-accompaniment and use its features; change the tempo.

Topic 4. Digital audio formats. The most common formats for recording to hard disk (.wav, etc.), DVD. Audio file compression: MPEG. Reformat.

The student must: have an understanding of existing audio file formats, their scope, and the possibilities of converting from one format to another.

3.5. SECTION V. MIDI – Digital Interface for Musical Instruments

Topic 1. The concept of MIDI. Switching MIDI devices. Prerequisites for the appearance of MIDI. Different possibilities of MIDI features. MIDI connectors: input, output, pass-through. Connecting MIDI devices.

The student must: have an understanding of the concept of MIDI and its capabilities; know how MIDI devices connect to each other.

Topic 2. MIDI encoding. MIDI events and messages. The numbering of the octaves and keys. The numbering of the controls of the synthesizer. MIDI events, events like Note On (keystroke), Note Off (release), and their parameters. Main controllers and their parameters. Transmitting a MIDI message. Multitrack messages. MIDI channel.

The student must: know the encoding of octaves and keys, the main controllers: volume, panorama, pedals, joystick (wheels); ranges of parameter values; what channels are needed for, their largest number per port (connector).

Topic 3. The principle of operation of the sequencer. MIDI file. Sequencer: time counter and record MIDI messages in RAM. Save to a long-term storage device as a file. MIDI file formats. Playing a MIDI file. The student must: have an idea of how the sequencer works; about MIDI file formats.

Topic 4. Compatibility and MIDI standards. Playing a MIDI file on different sequencers, the need for compatibility. The concept of "font" for a sound set. The main GM standard: distribution of tools by groups, their encoding. Extended standards: GS and XG. Cans. Features of the purpose of a set of percussion instruments.

The student must: have an idea of standardized sound (instrumental) sets, the order of arrangement of groups of instruments; features of extended sets (GS, XG); the choice of Bank; the order of choosing a set of drums.

3.6. SECTION VI. Music Computer Programs

Topic 1. An overview of the programs. Types of music computer programs applications for working with sound and music text: players, music editing and layout programs, sequencers, audio editors, virtual synthesizers, multitrackers, etc.

The student must: have an idea of modern computer programs for working with sound and music text, their purpose, and features.

Topic 2. Players. Types of players and their service. Winamp player, its controls, working with the player when listening to files of different formats.

The student must: have an idea about player programs; be able to work with the Winamp player.

Topic 3. MIDI sequencers. A brief overview of the main developments of MIDI sequencers. Main base: the ideology of DirectX and ASIA. Basic views: counter (tick), size, tempo. Metronome and off-tact. Tracks, destination for tracks: channel, port, bank, patch. Recording, playback. Editing options: quantization, cut, copy, paste, delete. Dynamics, controllers.

The student must: have an understanding of the developments of leading manufacturers of sequencer programs; the main concepts of the sequencer; the purpose of the main parameters; recording editing capabilities; and the use of controllers.

Topic 4. Audio Editors. Purpose and features on the example of the popular audio editor Sound Forge. View of the main window, child window. Selection, place marks, and region. Types of operations with sound using built-in commands: normalization, changing the pitch, duration of sound (tempo), and so on. Built-in tools: generators, configuration tool, etc. Insert programs: Plug-In, their features (effects overlay, auto-tune pitch adjustment, etc.). Record audio files using the Sound Forge program.

The student must: have an idea of modern audio editors and their capabilities; be able to perform simple operations with an audio file as part of a speech support program.

Topic 5. File format conversion programs. Why do I need to change the file format? The most widely used formats. Format conversion programs e.g. Awave; Sound Forge features; MP3. Vienna programs: the creation of a bank of instruments.

The student must: have an understanding of the most popular audio file standards and the possibilities of converting them to another format; work with programs for creating an instrument banks.

Topic 6. Multitrackers. General information about multi-track recording programs and information. Multitracker Samplitude. Track recording. Syncing tracks. Standard operations on selected objects. Real-time audio processing. The volume balance between tracks, the panorama. The preservation of the reduced soundtrack.

The student must: have an idea about the purpose of multi-track recording programs; how to work with them; mixing a phonogram; applying effects; saving a phonogram in a specific format.

4. Types of Creative Work Using Music Computer Technologies Offered to a Student with Visual Impairments

This study discusses questions associated with the creation and development of new techniques of teaching people with visual impairments, rethinking the methods of teaching traditional disciplines in the education system. The development of computer technology, and especially the emergence of screen readers, has led to the creation and development of new forms of teaching music to people with visual impairments, rethinking the teaching methods of both traditional disciplines and the emergence of new subjects related to the introduction of MCTs in the musical educational process.

Today, a lot of technical information exists not only in print, but also as training videos and audio podcasts on the Internet. Therefore, part of the technical content can be offered for independent study, which will give more time for the development of students' creative abilities and their practical implementation in the classroom.

First of all, during the interview, from which the first lesson begins, it is necessary to identify the general level of knowledge: in the field of using a PC in general and MCT in particular. Next is a practical verification of musical data: hearing (melodic, harmonic, timbre, modal, and extra-modal); mastering a musical instrument (first of all, the piano and keyboard digital musical instrument (DMI)); piano keyboard orientation (asking to play a chord sequence, a melodic phrase in different keys and the like). Alternatively, you can have a simple song or instrumental composition to identify playing by ear skills. Testing knowledge in the field of music theory will help to choose the best language for communication in the future depending on the student's competencies. The information received will be the starting point to begin the practical training.

There are several types of creative work offered to the student, revealing his technical knowledge and musical abilities:

– making arrangement (backing track) for the finished original composition;

– instrumentation of a work presented in musical notation;

– remix (cover, remake) of an existing composition;

– making arrangement of music of one's own composition, or written (played, sung) by another author, but not previously adapted.

There are no many main types, but the forms of their implementation are varied.

This is the recording of accompaniment using just one instrument, arranging classical works, and the creation of an orchestra or choral score in the musical notation program, etc. It does not matter whether it is a vocal or instrumental composition, it is important that the content is offered by the student himself or selected based on his musical taste and wishes. This will ensure sustained interest and provide an incentive to work.

5. Conclusions

It should be noted that only a differentiated approach is the most productive way in teaching MCT to students. There can be no common requirements with the exception of the technical component. Everyone has his own musical level of training and creative potential. It is very important to choose a type of activity in which the final result will be presented in the form of a finished music product (there are many examples of how, after several classes or independent attempts to master the technique of computer-aided arrangement, sufficiently trained music students lost any desire to continue working in this direction). Let it be even a piece of music with one or several instruments, or a simple choral arrangement created in a computer graphic-aided musical program. The main thing is that the student will understand that realizing his creative ideas is not as difficult as it might seem from the very beginning.

Mastering MCT together with the development of creative abilities gives not only an incentive to further professional growth, but also involves the acquisition of an additional specialty of the arranger musician, which is in demand today.

The development of MCT contributes to the socialization and integration of visually impaired people into civic society. A set of academic disciplines has been developed based on the use of MCT, which is implemented in the musical and educational process of professional training of music students with deep visual impairments in a number of educational institutions in Russia [5]; [6]. The international community and the state should more actively support and develop technologies that promote the socialization and integration of visually impaired musicians into civic society.

6. References

[1] Kunz A., Miesenberger K., Zeng L., Weber G. "Virtual Navigation Environment for Blind and Low Vision People," in: Miesenberger K., Kouroupetroglou G. (eds) *Computers Helping People with Special Needs. ICCHP 2018*. Lecture Notes in Computer Science, vol 10897. Springer, Cham, 2018.

https://doi.org/10.1007/978-3-319-94274-2

[2] Kouroupetroglou, G. (2018). Welcome to ICCHP 2018! [*Online*]. Available: http://www.icchp.org/welcome-chair-18

[3] Lahav, O., Mioduser, D. "Multisensory virtual environment for supporting blind person's acquisition of spatial cognitive mapping, orientation, and mobility skills," in: *Proc. 4th International Conference on Disability, Virtual Reality and Associated Technology*, 2002, pp. 213–220.

https://doi.org/10.1515/IJDHD.2005.4.3.231

[4] Lazar, J., et al. "What frustrates screen reader users on the web: a study of 100 blind users," *Int. J. Hum.-Comput. Interact*, 22(3), 247–269, 2007.

https://doi.org/10.1080/10447310709336964

[5] Gorbunova, I., Govorova, A. "Music Computer Technologies in Informatics and Music Studies at Schools for Children with Deep Visual Impairments: From the Experience," in: Pozdniakov S., Dagien˙e V. (eds) *Informatics in Schools. Fundamentals of Computer Science and Software Engineering. ISSEP 2018*. Lecture Notes in Computer Science, Springer, vol. 11169, pp. 381–389, 2018.

https://doi.org/10.1007/978-3-030-02750-6_29

[6] Gorbunova, I.B. "Music Computer Technologies in the Perspective of Digital Humanities, Arts, and Researches," *Opcion*, vol. 35, no. S24, pp. 360-375, 2019.

[7] Gorbunova, I. B., Govorova, A. A., Voronov A. M. "Music Computer Technologies in IT Training for Students with Deep Visual Impairment," in *Proc. 12th Int'l Conf. on Informatics in Schools: Situation, Evaluation and Perspectives (ISSEP 2019)*, 2019, pp. 8-12, 2019

[8] Gorbunova, I. B., Zakharov, V. V., Yasinskaya, O. L. "Development of applied software for teaching music to people with deep visual impairments based on music computer technologies," *Revista universidad y sociedad*. vol. 12, no. 3, pp. 77-82, 2020. URL: https://rus.ucf.edu.cu/index.php/rus/article/view/1559.

[9] Gorbunova, I. B., Morozov, S. A. "Computer-aided music technologies in teaching students with visual impairments in secondary and high-level music education institutions in Russia," *Talent Development and Excellence*, vol. 12, no. S3, pp. 918-932, 2020. URL: http://iratde.com/index.php/jtde/article/view/384/337

[10] Gorbunova, I. B., Morozov, S. A. "On Inclusive Musical Education in Russian Universities: Computer Arrangement," in *Proc of the 26th London International Conference on "Literature, Humanities, Education and Social Sciences" (L2HES2-20),* 2020, pp. 19-32.

[11] Gorbunova I. B., Morozov S. A "On Teaching Visually Impaired Students in Russian Educational Institutions of Music," *J. of Contemporary Issues in Business and Government*, vol. 27, no. 1, pp. 3244-3266. 2021. URL: https://www.cibgp.com/article_9599_b59629b490a446a373cfafd3172889ef.pdf.