

On Teaching Visually Impaired Students in Russian Educational Institutions of Music

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Abstract

Purpose of the study: This study discusses questions associated with the creation and development of new techniques of teaching music people with visual impairments, rethinking the methods of teaching traditional disciplines in the education system which is based on introduction of music computer technologies (MCT). The question is raised about the need to develop specialized software for the blind in order to optimize the process of their musical education.

Methodology: In this work, we investigated the content aspects of the methodology of teaching musical disciplines with using MCT for music students with deep visual impairments: the content and methodological support for teaching these disciplines were developed, and methodological approaches for implementing the educational process in the practice of teaching visually impaired music students in secondary and higher educational institutions were determined.

Main findings: It was found that the study of the disciplines "Computer Arrangement" and "Musical Informatics" based on using 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.

Applications of this study: 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.

Novelty/Originality of this study: The development of MCT contributes to the integration of visually impaired musicians into the professional community. A set of academic disciplines

has been developed based on the use of MCT, which is implemented in the process of professional training of music students with deep visual impairments in a number of educational institutions in Russia. The international community and the state should more actively support and develop technologies that promote the socialization and professional adaptation of visually impaired musicians.

Keywords: *Blind, Visually Impaired, Music Computer Technologies, High-Tech Information Educational Environment, Inclusive Musical Education, Social Adaptation.*

1. INTRODUCTION

The development of computer technology, and especially the introduction of screen readers, has led to the creation and development of new forms of learning for people with visual impairments.

Teaching music to visually impaired people in the conditions of forming a network interactive educational environment, rethinking the methods of teaching both traditional musical disciplines and the emergence of new disciplines is associated with the introduction of music computer technologies (MCT) in the music and educational process (Gorbunova, 2002; Gorbunova, 2019; Gorbunova, 2020; Gorbunova&Plotnikov, 2020)

Learning the functions of a modern multimedia computer gives enormous opportunities for students with visual impairment to master the unlimited space of sound and music. The fact that blind students can work with a musical computer (MC) thanks to screen access programs (speech synthesizers) – without a computer mouse, with the monitor turned off and not least, without outside help, is of particular importance. This allows students with profound low vision to acquire new professions that are currently in demand, and also significantly contributes to the expansion of their personal and creative self-realization (Gorbunova&Govorova, 2018b; Gorbunova, I., Govorova&Voronov, 2019).

Inclusive musical education is part of the comprehensive innovative educational system “Music Computer Technologies in Education” developed by the staff of the Education and Methods Laboratory (EML) *Music Computer Technologies* at the Herzen State Pedagogical University of Russia under the supervision of I.B. Gorbunova. This system is successfully applied at all stages of the inclusive educational process, including the level of primary, secondary and higher musical education, as well as at the stage of additional professional education (professional retraining program “Teaching Musical Disciplines with Using Music Computer Technologies”, advanced training program “Music Computer Technologies”, “Contemporary Methods of Teaching Musical Disciplines with Using Music Computer Technologies,” “Methods for Teaching Musical Disciplines Applying Music Computer Technologies,” “Computer Musical Creative Work,” etc.).

The methodology for incorporating MCT as a means of forming the professional competence of students with visual impairment was tested in St. Petersburg at the Herzen State Pedagogical University of Russia, in the Special (Remedial) educational institution Boarding

School No. 33, St. Petersburg (Berger & Yatsentkovskaya, 2019]), at the Center for Social Rehabilitation of the Disabled People and Disabled Children from the Nevsky District (Gorbunova & Voronov, 2015), in music classes for blind and visually impaired children at the State Budgetary Institution of Continuing Education “Children’s Art School at the Okhta Centre for Aesthetic Education” (Gorbunova & Govorova, 2018), as well as in many other educational institutions of the country, including the Kursk Music Boarding College for the Blind (Morozov & Zakharov, 2016]), Nizhny Novgorod College of Music M.A. Balakireva (Klimentova, 2019; Belikov, 2019; Belikova, 2019), at the Pskov Regional College of Arts named after N.A. Rimsky-Korsakov, the Center for Clinical Pedagogy and Differential Education in the Pskov Region and Integration workshops for the Disabled named after V.P. Schmitz (Galkovskaya, 2019) and many others, where teachers who have received special training at refresher courses and professional retraining at the EML *Music Computer Technologies* at the Herzen State Pedagogical University of Russia, work.

2. LITERATURE REVIEW

The World Health Organization reports that more than 1.3 billion people with visual disabilities live in the world (World Health Organization, 2019); among them, about 40 million people are completely blind (Bourne et al., 2017), and more than 820 million people have profound visual impairments (Fricke et al., 2018). In this regard, today one of the most important problems is the search for new opportunities for social rehabilitation of visually impaired people in a high-tech information and educational environment, the analysis of current topics of their communication in the network, the formation of professionally and socially oriented Internet communities (Pronchev et al., 2020).

Currently, digital technologies and MCTs are becoming an indispensable tool for the educational process for various social groups in exposing them to a high-art musical culture, as well as a unique technology for implementing an inclusive pedagogical process, as MCT opens up new creative perspectives for both people with disabilities and educators working in this field. The most significant events devoted to this issue include the annual International Research and Practical Conference *Contemporary Music Education*, held jointly by the EML *Music Computer Technologies* at the Herzen State Pedagogical University of Russia and by the Rimsky-Korsakov St. Petersburg State Conservatory since 2002; annual international scientific and practical conferences held as part of the program *Ensuring Access to the Cultural and Historical Heritage of the Visually Impaired* by the St. Petersburg Committee for Culture, the St. Petersburg State Library for the Blind and Visually Impaired, and the Herzen State Pedagogical University of Russia since 2013. Materials of reports of participants in the following conferences are also of certain interest: St. Petersburg International Conference *Regional Informatics*, organized by the St. Petersburg Society of Informatics, Computer Engineering, Communication and Control Systems, the Ministry of Science and Higher Education of the Russian Federation, the Ministry of Telecom and Mass Communications of the Russian Federation, and the Russian Academy of Education, Department of Nanotechnology and Information Technology of the Russian Academy of

Sciences, St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences; International Conferences *A Child in the Modern World, Internet and Digital Space: Post-Material Values of Youth, The Ecology of Childhood*; International Research and Theoretical Conference *Communicative Strategies of Information Society*; International Scientific Conference *The 10th Anniversary St. Petersburg Sociological Readings. Fourth Industrial Revolution: Realities and Modern Challenges*; 16th International Conference on Literature, Languages, Humanities & Social Sciences (*LLHSS-18*) (Budapest, Hungary); The 11th International Conference on *Informatics in Schools. Fundamentals of Computer Science and Software Engineering.ISSEP 2018* (St. Petersburg, Russia); International Conference on *Multidisciplinary Research & Practice (ICMRP)* (Oxford, UK); 15th International Conference on *Education, Economics, Humanities and Interdisciplinary Studies. EEHIS-18* (Paris, France); 2nd *International Congress of Special Education* (Rome, Italy); 16th International Conference on *Computers Helping People with Special Needs* (Linz, Austria); The 12th International Conference on *Informatics in Schools. Fundamentals of Computer Science and Software Engineering.ISSEP 2019* (Larnaca, Cyprus), etc.

The latest developments in the application of information technology for the blind and people with severe visual impairments are of significant interest. The authors of the work (Cheng et al., 2018), using portable Utilizing RGB-Depth images acquired by a wearable system, offer integrated assisted navigation for people with visual impairments. The proposed approach reliably detects several goals and provides effective assistance to people with low vision.

The work (Cheng et al., 2017) reports on the use of digital media and MCT in educational institutions, in particular in the field of vocational education and training, discusses the idea of a systematic analysis of the digital media and MCT potential for increasing the inclusive capabilities of the educational organization as a whole.

At present, blind and partially sighted people still rely on traditional navigational aids, such as a cane for micro-navigation, which, however, does not help develop orientation on a larger scale or plan routes. To overcome this problem, elements of a virtual environment are introduced (Kunz et al., 2017), which allows experiencing unknown places while remaining in a controlled environment.

When using interactive tactile maps and charts, widely used by people with visual impairments, researchers propose a new approach – augmented reality, which makes it possible to quickly and easily supplement real objects with sound feedback (Brock, 2018). The instructors found the tool easy to use.

It should be noted that the computerization of educational institutions (including musical education), in which people with visual disabilities are taught, is not only aimed at solving common educational problems and the convenience of storing and exchanging information (Manduchi&Kurniawan, 2011; Laviolle&Hachet, 2012; Katz et al., 2012; Hoshino & Motoki, 2018; Engel & Weber, 2017; Ducasse et al., 2018). It also allows finding new forms of professional education and training (Goncharova&Gorbunova, 2020; Gorbunova, 2020a; Gorbunova&Govorova, 2019; Gorbunova&Petrova, 2020; Gorbunova&Petrova, 2020a;

Gorbunova, Zalivadny&Tovpich, 2020). In this regard, we have analyzed the works, which present the results of the research conducted by the authors. Articles, monographs, scientific reports, among which (Araki & Watanabe, 2013; Brock et al., 2015; Brayda et al., 2013; Alieva et al., 2019; Albouys-Perrois et al., 2018; Giraud et al., 2017), became a methodological basis for understanding the possibilities of applying new breakthrough technologies in the field of inclusive education. The works (Rodríguez Vázquez&Mileto, 2017; Teixeira &Moorkens, 2017; Torres-Hostench et al., 2017; Wang et al., 2014; Watanabe & Mizukami, 2018; Weber, 2018; Wei et al., 2014; Wild, 2018; Zeng et al., 2015, Zank et al., 2017) formed our ideas about the main directions of development of new areas of activity in inclusive musical education. The works (Putnam & Tiger, 2015; Motoki, 2015; Moorkens& O'Brien, 2017; Mascetti et al., 2017; DaudénRoquet et al., 2016; Gotzelmann, 2016) allowed us to formulate the main ideas of our research.

The use of digital technology has permeated the everyday life of students with severe visual impairment (Kouroupetroglou, 2018; Gorbunova&Govorova, 2018; Gorbunova&Morozov, 2020; Gorbunova, Zakharov&Yasinskaya, 2020; Gorbunova&Voronov, 2018; Lahav&Mioduser, 2002; Lazar, J., et al., 2007). Almost all students today use digital players, voice recorders, personal computers, laptops, tablet computers, and smartphones for educational purposes. 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.

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.

This category of people is still practically deprived of the opportunity to fully work with flat-printed musical text and its subsequent replication in a point version. Today, there is no specialized software for the blind to work with music braille; and attempts to adapt screen access programs to music editors (in particular Avid Sibelius) have not resulted in a comprehensive reading of visual material. In addition, none of the existing programs for working with musical notation is capable of displaying information on a tactile Braille display or a printer to print in braille.

What is the purpose and essence of the previously mentioned subjects in teaching students with visual impairments musical specialties? How to use various auxiliary software tools created for people with pathology of the visual analyzer, related to the activities of a musician who works with modern software tools? Such specialized rehab programs are those which are

highly demanded by a musician working with digital technologies and developed by foreign colleagues, and requiring additional functions related to translation. Is it possible to apply specialized software, for example, Web-based Computer-Aided Translation (CAT) (Rodríguez Vázquez et al., 2018) and EasyTrans (Al-Bassam et al., 2016), which is widely used by blind translators?

These and many other questions concern teachers and researchers today, whose activities are related to teaching students with severe visual impairments.

Let us dwell in more detail on the peculiarities of teaching the disciplines “Musical Informatics” and “Computer Arrangement” to musician students with severe visual impairment in secondary vocational and higher educational institutions.

3. METHODS AND APPROACHES

The key shortage for a blind person – the lack of information – is satisfied with digital technologies, in particular, computers, smartphones and so on, thanks to speech support programs developed for the most popular platforms – Windows, Mac OS, and Android. Modern operating systems have a number of their own built-in applications for visually impaired and blind people (screen magnifiers, screen speakers), but these facilities do not allow work with complex programs where the interface is based on graphic objects (buttons, amplitude and spectrum analyzers in sound editors, location tags, etc.).

Today, there are two of the most functional screen access applications – JAWS for Windows and NVDA.

JAWS (Job Access with Speech) for Windows Screen Reading Software is the world’s most popular screen reader running on a Windows PC. It provides access to system, office applications and other necessary software, including Internet browsers. Information from the screen is read out loud thanks to the speech synthesizer, through the computer’s audio card, providing voice access to a wide variety of content. JAWS also displays information on the braille-relief display panel, includes a large set of keyboard commands that allow you to reproduce actions that are usually performed only with the mouse. These commands also perform other useful functions designed to increase speed and efficiency. The package utilities provide the ability to fine-tune for the most comfortable work with almost any application.

NVDA (NonVisual Desktop Access) is a free, open-source program for MS Windows, which allows blind and visually impaired persons to work on a computer without visual control, displaying all the necessary information using speech or a braille display. NVDA is a mature product for screen readers and is always at the forefront of the high-end technology in the field of accessibility. Since NVDA is an open source project, each user, with sufficient knowledge, will be able to contribute to the development of the program or make it more convenient for himself.

The joint Sibelius project (cross-platform music score editor for MS Windows, Mac OS and RISC OS from Sibelius Software (Avid Technology) provides on-screen access with speech accompaniment for working with complex musical notes, starting with the specially released version 7.5.1 with the support of the NVDA program. This is, first of all, the input, editing

and reading of visual musical and graphic material – something that was primarily lacking for both students and teachers of theoretical disciplines.

The use of MCT in the education of the visually impaired students has already turned from promising innovative projects to reality. The opportunities for the inclusion of the blind in inclusive music education are expanding. Previously it was possible to test knowledge and skills only verbally (first of all, these are theoretical disciplines: music theory, harmony, polyphony, and solfeggio); now it became real to work with music and computer graphics programs.

With the help of MCT, blind composers received a full-fledged instrument in order to independently type musical notation and prepare it for further publication. This greatly accelerated the implementation of the creative ideas of the authors, since earlier musical notation had to be written first in Braille point tactile writing system, and only then it was dictated or given to a specially trained copyist of Braille notes. And there are very few such experts not only in Russia, but also in the world.

A real opportunity to educate the visually impaired in new, previously inaccessible areas in professional musical activity emerged. But in practice, MCT is fully implemented for this category of people in Russia only by one secondary specialized educational institution – the Kursk Music Boarding College for the Blind (Federal State Professional Educational Institution "The Kursk Musical College and Boarding School for the Blind" of the Ministry of Labor and Social Protection of the Russian Federation), and, partially, by a number of higher educational institutions, including the *EMLMusic Computer Technologies* at the Herzen State Pedagogical University of Russia. All multi-annual activities of these educational institutions are aimed not only at educating a fully-fledged specialist in the chosen profession, but also at his integration into modern society. In secondary and higher musical educational institutions (both special, that is, those that carry out educational activities with students with limited health abilities, and ordinary ones), there are very few specialists who know the specifics of working with blind students in this area.

4. RESULTS

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 abilitation 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 like).

CONTENT OF THE DISCIPLINE "MUSICAL INFORMATICS"

Introduction. Multimedia Features.

Multimedia features of a computer. Requirements for computer resources. Computer as a music station.

SECTION I. Electronic Musical Instruments and Musical Computer.

Topic 1. . The first electronic musical instruments and their creators. Electro-acoustic music.

Topic 2. First commercial synthesizers and their development.

Topic 3. A new look of the notion “Music of 20th Century”.

SECTION II. Speech Support Programs (Screen Readers).

Topic 1. Types of speech support programs, general properties.

Topic 2. The JAWS for Windows program.

Topic 3. Working with the Microsoft Word Text Editor supported by JAWS.

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

Topic 1. The physical parameters of sound.

Topic 2. Sound in space. Sound effects.

Topic 3. Methods of recording and reproduction of sound.

Topic 4. Equipping a modern sound studio. Characteristics of the Toolkit.

SECTION IV. The Synthesized Sound.

Topic 1. The digitization of sound. Sampling.

Topic 2. Methods for the synthesis of sound.

Topic 3. Synthesizers, sound blocks, sound cards.

Topic 4. Digital audio formats.

SECTION V. MIDI – Digital Interface for Musical Instruments.

Topic 1. The concept of MIDI. Switching MIDI devices.

Topic 2. MIDI encoding. MIDI events and messages.

Topic 3. The principle of operation of the sequencer. MIDI file.

Topic 4. Compatibility and MIDI standards.

SECTION VI. Music Computer Programs.

Topic 1. An overview of the programs.

Topic 2. Players.

Topic 3. MIDI sequencers.

Topic 4. Audio Editors.

Topic 5. File format conversion programs.

Topic 6. Multitrackers.

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 “*Computer Arrangement*” course is based on the knowledge and skills acquired by students as a result of studying “*Musical Informatics*” and it is its natural continuation or addition (if classes coincide chronologically in the curriculum).

The aim of the course is to master new opportunities that have arisen thanks to computer technology for the arrangement of a vision-disabled musician in the modern world; create prerequisites for full creative cooperation in society.

The objectives of the course are the mastery by vision-impaired musicians of arrangement techniques using MCT, specialized software and hardware (mixers, microphones, sound

processing devices, professional software, etc.) by studying and mastering them with the subsequent creation of a final creative project.

The result of mastering the course should be the acquisition of practical skills both in the field of MCT and in the field of arrangement, 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.

THE CONTENT OF THE DISCIPLINE "COMPUTER ARRANGEMENT"

Introduction.

SECTION I. Working in Windows with the Support of the Speech Support Program Jaws for Windows.

Topic 1. Basic techniques for working in Windows.

Topic 2. Resource management of the sound card.

SECTION II. Working in the Sequencer.

Topic 1. View of the main program window.

Topic 2. Tracks window.

Topic 3. Port i/o program.

Topic 4. Standard operations for editing a MIDI file.

Topic 5. Event List.

SECTION III. Working on the Soundtrack.

Option A. Recording an arrangement of a popular play (song).

Option B. Arrangement of the musical score.

Option D. Creating an arrangement of your own work.

Topic 1. Analysis of the form, instruments, and style.

Topic 2. General rules of arrangement.

Topic 3. Features recording percussion instruments.

Topic 4. The creation of arrangements in the software of the sequencer.

Topic 5. The use of controllers.

Topic 6. The final version of the MIDI file.

Topic 7. Working with audio files in the Cakewalk Sonar program.

Topic 8. Sound effects and their application.

Control requirements.

The current control of knowledge and skills is carried out at each lesson in the form of checking independent work, as well as an oral survey on the material passed and identifying skills directly in the classroom.

The final control is carried out in the form of an audition and an open test – a creative project of students.

The time period for assessing the implementation of MCT in the educational process of the Kursk Musical Boarding College for the Blind was determined by the following criteria:

1995-1998 – there were no subjects related to MCT in the educational process;

1998-2002 – "Computer Arrangement" was taught as an optional feature in the 5. – 8. semesters (on average, 20-30% of the students of the 3th and 4th years);

2002-2008 – "Musical Informatics" entered the Federal State Educational Standard of Secondary Vocational Education (was studied by the students in the 4. and 5. semesters),

"Computer Arrangement" was taught for as an option of the students of the 3th and 4th years in the 5. – 8. semesters (studied by 60-70% of the students);

2008-2014 – "Musical Informatics" was studied by the students in the 4. – 5. semesters, "Computer Arrangement" was an optional subject and was studied by all students of 3th and 4th years in the 5. – 8. semesters;

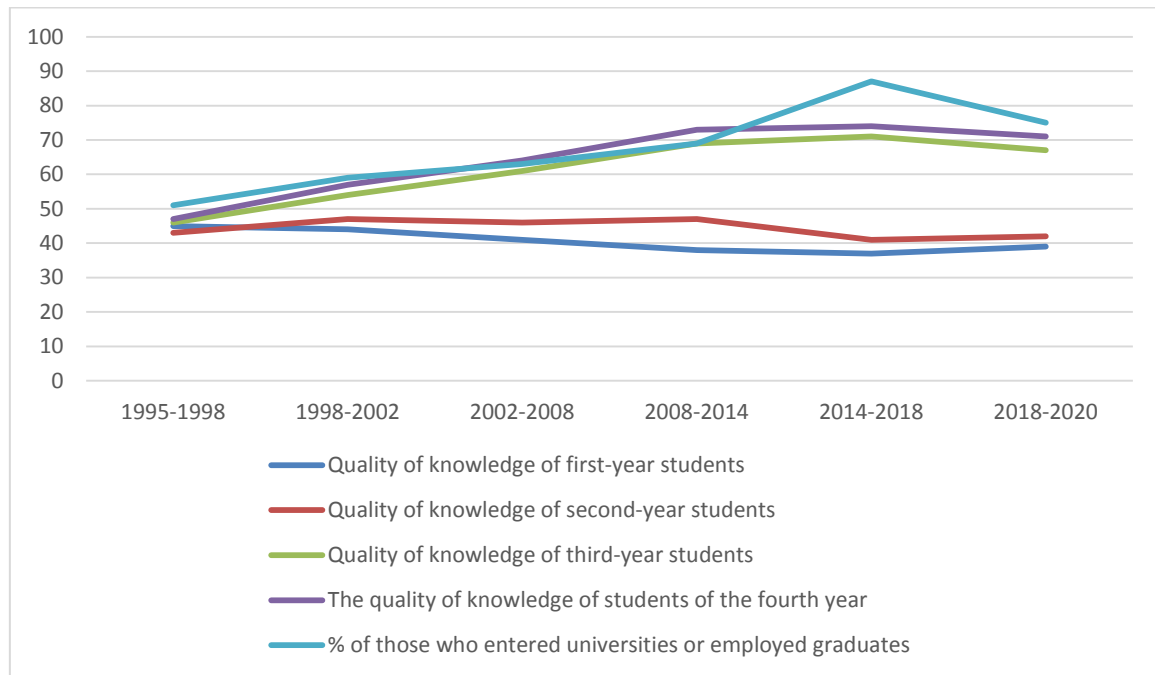
2014-2018 – "Musical informatics" according to the changes of the Federal State Educational Standard of Secondary Vocational Education became to be studied in the 7. – 8. semesters), "Computer Arrangement" continued to be an optional subject and was studied by all the students of the 3th and 4th years in the 5. – 8. semesters;

2018-2020 – "Music Informatics" in the Federal State Educational Standard of Secondary Vocational Education (studied in the 7. – 8. semesters). "Computer Arrangement" is studied by the students of the Vocal Department in the 5. – 8. semesters, and by the students of the Instrumental Playing and Choral-Conducting Department in the 6. and 8. semesters.

The results obtained are presented in Table 1.

Table 1: Influence of Subjects Related to MCT on the Development of Professional Musical Disciplines ("Elementary Music Theory," "Solfeggio," "Harmony")

	1995-1998	1998-2002	2002-2008	2008-2014	2014-2018	2018-2020
Percentage ratio of the students studying music Informatics from the total number of students	0%	0%	100%	100%	100%	100%
Percentage ratio of the students studying computer arrangement from the total number of students	0%	27%	68%	100%	100%	Vocal Department – 100% (5-8 semesters), the rest – 100% (but 6 and 8 semesters)
Quality of knowledge of first-year students	45%	44%	41%	38%	37%	39%
Quality of knowledge of second-year students	43%	47%	46%	47%	41%	42%
Quality of knowledge of third-year students	46%	54%	61%	69%	71%	67%
The quality of knowledge of students of the fourth year	47%	57%	64%	73%	74%	71%
% of those who entered universities or employed graduates	51%	59%	63%	69%	87%	75%



As we can see, the introduction of subjects related to MCT directly affects the quality of knowledge in musical disciplines of the theoretical cycle. The decrease in the number of hours in the 2018/19 and 2019/20 academic years also affected the overall quality of academic performance. And the transfer of the subject "Musical Informatics" from 4. and 5. semesters to 7. and 8. semesters has not given the better for the 2nd and 3d year students' quality of knowledge.

5. DISCUSSION

The use of digital technology has permeated the everyday life of students with severe visual impairment (Kouroupetroglou, 2018; Gorbunova&Govorova, 2018; Gorbunova&Morozov, 2020; Gorbunova, Zakharov&Yasinskaya, 2020; Gorbunova&Voronov, 2018; Lahav&Mioduser, 2002; Lazar, J., et al., 2007). Almost all students today use digital players, voice recorders, personal computers, laptops, tablet computers, and smartphones for educational purposes. 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.

This category of people is still practically deprived of the opportunity to fully work with flat-printed musical text and its subsequent replication in a point version. Today, there is no specialized software for the blind to work with music braille; and attempts to adapt screen access programs to music editors (in particular Avid Sibelius) have not resulted in a comprehensive reading of visual material. In addition, none of the existing programs for working with musical notation is capable of displaying information on a tactile Braille display or a printer to print in braille.

What is the purpose and essence of the previously mentioned subjects in teaching students with visual impairments musical specialties? How to use various auxiliary software tools created for people with pathology of the visual analyzer, related to the activities of a musician who works with modern software tools? Such specialized rehab programs are those which are highly demanded by a musician working with digital technologies and developed by foreign colleagues, and requiring additional functions related to translation. Is it possible to apply specialized software, for example, Web-based Computer-Aided Translation (CAT) (Rodríguez Vázquez et al., 2018) and EasyTrans (Al-Bassam et al., 2016), which is widely used by blind translators?

These and many other questions concern teachers and researchers today, whose activities are related to teaching students with severe visual impairments.

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 electronic musical instrument (EMI)); 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.

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 Kursk Music Boarding College for the Blind is an only education establishment in Russia, which today fully implements these disciplines, having in its arsenal the most modern technical means, professionally trained teaching staff, specially equipped classrooms with the possibility of independent studies for students. This is, in fact, a ready-made base for research, monitoring and testing of innovative MCT.

Graduates of a boarding college quite often choose the Herzen State Pedagogical University of Russia for further training and achieve brilliant results. So, over the past 2 years, a student at the Institute of Information Technologies and Technological Education of the Herzen State Pedagogical University of Russia Viktor Zakharov became the laureate of the prize of the Council of rectors of universities of St. Petersburg Talent to Overcome named after L.M. Shipitsyna (Russia); a student of the Faculty of Social Sciences Vladimir Kazankin received a diploma of the winner of the competition in the system of higher professional education Student of the Year 2016 in the nomination "Best in Organizing the Activities of the Volunteer Movement".

The practical experience gained by college teachers while working with the blind for more than 60 years of the institution history is passed on from generation to generation and is unique. The Kursk Music Boarding College for the Blind closely cooperates with the Kursk Institute for the Development of Education, being an experimental platform for students and teachers of musical educational institutions, as well as defectology departments at universities. The college is actively collaborating with the EML *Music Computer Technologies* at the Herzen State Pedagogical University of Russia, take part in research and practical conferences, educational webinars, online conferences, workshops, etc.

The EML *Music Computer Technologies* is implementing training according to the professional retraining program "Teaching Music Disciplines with Using Music Computer Technologies" is being implemented, one of the modules of which is "Methods of Teaching Music Disciplines with Using MCT" It involves an in-depth study of the topic related to organizing inclusive musical education.

Within the framework of the annual International Research and Practical Conference *Contemporary Musical Education*, the section *Inclusive Music Education* began its work in 2015, in which scientists and teachers from various professional and special institutions of Russia take part.

Since 2017, the staff of EML *Music Computer Technologies* has been publishing a series of collections *Music Computer Technologies*, which reflects educational and methodological developments, research materials and presents the results of advanced educational experience in various fields of using MCT in modern education. In 2019, the collection of the series,

Music Computer Technologies. Inclusive Musical Education (Issue 6) was published. A number of articles in this collection (Klimentova, 2019; Belikov, 2019; Belikova, 2019; Berger & Yatsentkovskaya, 2019) describe methodological approaches and pedagogical materials for using digital technologies and MCT as tools for implementing the educational process for various social groups in connection with a highly artistic musical culture, and for implementing an inclusive pedagogical process with using MCT; new creative prospects are revealed both for people with disabilities and for teachers working in this field (*Music Computer Technologies*, 2020).

Decades of experience of work with various age categories of people with visual impairments (music students of secondary and higher educational institutions, teachers working with students with visual impairments, as well as composers and arrangers studying in the system of additional professional education and having profound visual impairment) have identified an urgent need to develop specialized software for the blind.

The development of hardware and software systems related to music and computer graphics for blind musicians of various ages and at different levels of training is the most promising and most important area in the field of tactile interpreting means for the practical implementation of technologies that help optimize the learning process for people with low vision. Application of these tools will significantly expand the possibility of including the blind in inclusive music education. If earlier it was possible to test knowledge and skills only verbally (first of all, these are theoretical disciplines: music theory, harmony, polyphony, and solfeggio), now it became possible to work with music and computer graphics programs.

An integrated approach is required to develop such software (Gorbunova, Zakharov, and Yasinskaya, 2020). On the one hand, these are program specialists, on the other hand, people who are interested in implementing this project, who know the specifics of the system and the logic of the Braille music, and are able to pose technical tasks for the project implementation. Currently, the concept of developing specialized software for the blind is being actively discussed. This software is necessary not only in the training of professional musicians, but also for children with visual impairments for mastering a musical linear system and the Braille music.

To ensure comfortable work with musical content, it is recommended to “parallelize” the process of dubbing using the NVDA program and directly the musical content itself in the Sibelius program. The NVDA speech synthesizer should be directed to the built-in sound card, and the sound from Sibelius to the card that support ASIO (this is the most preferable option in order to avoid delays in the response of keystrokes when working with the MIDI keyboard and virtual synthesizers and samplers), since Sibelius is quite data-greedy.

6. CONCLUSIONS

Certain conclusions can be drawn due to our own pedagogical experience in teaching the disciplines of “Musical Informatics” and “Computer Arrangement” to music students with visual impairments.

Mastering the functions of a modern multimedia computer gives enormous opportunities for students with visual impairment to acquire the unlimited space of sound and music. The fact that blind students can work with a MC thanks to screen access programs (speech

synthesizers) – without a computer mouse, with the monitor turned off and equally important, without outside help, is of particular significance. This allows students with profound low vision to acquire new in-demand professions, and also greatly contributes to the expansion of their personal and creative self-realization.

Practice has revealed that the introduction of musical informatics in the educational process together with a computer arrangement provides a more complete practical mastery of MCT and is the most optimal solution for their study. This is facilitated, first of all, by individual lessons, in which the student and the teacher solve exactly those problems the students are most interested in, which contributes to a more effective learning. For this, the curriculum of secondary and of a number of higher professional musical educational institutions includes such disciplines as “Mathematics and Informatics,” “Musical Informatics,” “Music Sound Engineering,” “Computer Arrangement,” which form the basis for the acquisition of high professional knowledge by students with low vision, constitute a valuable component for their social adaptation, are a significant addition to the implementation of social promotion.

In addition, it is necessary to use a differentiated approach as one of the most important ways to optimize the learning process for students with profound visual impairments in the above-mentioned subjects and other disciplines that require mastery of MCT.

Despite the fact that information technology and MCT are necessary, without any doubts, in training music students, in most cases, the situation is such that by far not every educational institution manages to fully include these subjects into the educational process. The main reasons are a lack of qualified specialists and an imperfect material and technical base.

It is still quite difficult to reveal and fill up all aspects of teaching new disciplines related to MCT to blind musicians, a lot is still being formed.

Here is a list of some new activities for future graduates with low vision, who can work with modern MCT:

- ✓ making adaptation, instrumentation and original compositions;
- ✓ “live” sound record;
- ✓ professional typing of musical text;
- ✓ old records restoration;
- ✓ making digital phonograms;
- ✓ sound synthesis;
- ✓ sound engineering work.

Decades of experience of work with completely different age categories of people with low vision have identified an urgent need to develop specialized software for the blind not only in this country, but also all over the world. *The authors of the article are fully prepared to cooperate with stakeholders and developers in conducting further research in the above-mentioned areas in the field of typhlopedagogy and in the practical implementation of technologies that help optimize the learning process for people with visual impairments.*

In conclusion, it should be noted that learning the functions of modern MC gives huge opportunities for students with low vision to master the unlimited space of the sound and musical world. The fact that blind students can work with a MC thanks to screen access programs (speech synthesizers) – without a computer mouse, with the monitor turned off and equally important, without outside help, is of particular significance. This allows students

with profound low vision to acquire new in-demand professions, and also greatly contributes to the expansion of their personal and creative self-realization.

Limitations and Study Forward

The authors proceeded from some assumptions when conducting this research. Firstly, as noted in the *Methods and approaches* section, the authors used the hypothesis about the existence of a stable and significant statistical relation between the user activities in the field of using MCT in the education of the visually impaired students and the expanding the opportunities for the inclusion of the blind in inclusive musical education. A real opportunity to educate the visually impaired in new, previously inaccessible areas in professional musical activity emerged. For instance, blind composers received a full-fledged instrument in order to independently type musical notation and prepare it for further publication. This greatly accelerated the implementation of the creative ideas of the authors, since earlier musical notation had to be written first in Braille point tactile writing system, and only then it was dictated or given to a specially trained copyist of Braille notes. And there are very few such experts not only in Russia, but also in the world.

Further, on the basis of the study and analysis of the experience of pedagogical activity, the authors of the article are planning to work at adapting sheet music editors and developing an environment of non-visual access for musicians with visual impairments. As an example, we can cite the authors' works related to this problem (Morozov&Zakharov, 2016; Gorbunova&Govorova, 2018; Gorbunova et al., 2020).

Possible lines for continuing this research may also be comparative studies of the features of studying MCT and related subjects of the music cycle in the process of teaching visually impaired students in Russian and foreign music colleges and universities.

Co-authors Contribution:

The roles were distributed within the research group as follows:

Dr. Irina B. Gorbunova, determined the objective of the research, stated the research tasks, discussed the research results, selected the research toolkit, obtained the empirical data, discussed the research results, and penned the methodology section. She also wrote the introduction, literature review, and worded the conclusions.

Sergey A. Morozov discussed the research results, processed and analyzed the empirical data, discussed the research results, and wrote the empirical section.

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