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# DEVELOPMENT

## OF APPLIED SOFTWARE FOR TEACHING MUSIC TO PEOPLE WITH DEEP VISUAL IMPAIRMENTS BASED ON MUSIC COMPUTER TECHNOLOGIES

## DESARROLLO DE SOFTWARE APLICADO PARA ENSEÑAR MÚSICA A PERSONAS CON PROFUNDIDADES VISUALES PROFUNDAS BASADAS EN TECNOLOGÍAS DE COMPUTADORAS MUSICALES

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ABSTRACT

The development of computer technology in the late 20 early 21 centuries has significantly expanded the ways of obtaining information. A high-tech educational information environment requires a search for new approaches and fundamentally new educational systems in the digital age schools. Innovative musical pedagogy at the present stage is associated with the use of music computer technology (MCT) - a modern and effective means of improving the quality of teaching musical art at all levels of the educational process. MCT are a unique technology for implementing an inclusive pedagogical process in teaching BVI (blind and visually impaired) people. The article discusses the features of the development of applied software for teaching music to severely BVI people based on MCT and the main directions of its use.

Keywords: Inclusive music education, visually impaired, music computer technologies, music editor, specialized software.

RESUMEN

El desarrollo de la tecnología informática a fines del siglo XX y principios del siglo XXI ha ampliado significativamente las formas de obtener información. Un entorno de información educativa de alta tecnología requiere la búsqueda de nuevos enfoques y sistemas educativos fundamentalmente nuevos en las escuelas de la era digital. La pedagogía musical innovadora en la etapa actual está asociada con el uso de la tecnología de computadoras musical (TCM), un medio moderno y eficaz para mejorar la calidad de la enseñanza del arte musical en todos los niveles del proceso educativo. Los TCM son una tecnología única para implementar un proceso pedagógico inclusivo en la enseñanza de personas con discapacidad visual (PDV). El artículo discute las características del desarrollo de software aplicado para enseñar música a personas con BVI severas basadas en TCM y las instrucciones principales de su uso.

Palabras clave: Educación musical inclusiva, discapacidades visuales, tecnologías informáticas musicales, editor musical, software especializado.

## INTRODUCTION

For severely BVI (blind and visually impaired) musicians, the use of a musical computer (MC) is of particular importance (Gorbunova, 2019). First, MC is for them a means of making contacts with the "outside world", but at the same time, it helps in realizing their creative potential and adaptation in the modern social environment. MCT opens wide opportunities for BVI musicians to study more effectively the educational material, diverse in content and ways of presentation, contributing to the achievement of positive learning outcomes in a shorter time (Gorbunova & Govorova, 2018b; Gorbunova, Govorova & Voronov, 2019). However, the mastery of MCT by BVI musicians has a number of characteristic features that are most pronounced in the initial period of education (Gorbunova & Voronov, 2018; Gorbunova & Govorova, 2018a).

First of all, modern computer technologies (speech synthesizers, Braille displays), as well as using hotkeys, BVI people can master many MCT software pieces. Nevertheless, the specifics of teaching MCT to deeply BVI people is that the professional development of MCT software implies that BVI students have the basic skills of a PC user. Getting skills to work with a "talking" computer is a laborious, lengthy process that requires special education not only from students, but also from their teachers. This is due to the widespread use of MCT by severely BVI people, mainly in the field of secondary and higher musical education, while MCT is currently actively used in the early stages of education, including in inclusive education (when working with children with hearing impairments musculo-skeletal system).

One of the types of computers - a laptop - BVI people, like no other, is actively used, literally justifying the translation of its name: a laptop for them has become not just a notebook, but also a library, voice recorder, and organizer. The computer has become an even greater assistant for BVI *musicians*: with the advent of screen access software, BVI people got the possibility to create, process, record, and edit music independently.

Today, digital technologies and MCT are becoming an indispensable tool of the educational process for various social groups in connection with a highly artistic musical culture, as well as a unique technology for the implementation of an inclusive pedagogical process, as the use of MCT opens up new creative perspectives for both people with health limitations and for educators working in this field. The most significant events dedicated to this issue include the following: annual International Scientific and Practical Conference "Contemporary Music Education", held jointly by the Education and Methods Laboratory "Music Computer Technologies" of the Herzen State Pedagogical University of Russia and 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 Committee for Culture of St. Petersburg, the St. Petersburg State Library for the Blind and Visually Impaired People, and the Herzen State Pedagogical University since 2013.

Materials of reports of participants in the following conferences are also of some interest: St. Petersburg International Conference "Regional Informatics", organized by the St. Petersburg Society of Informatics, Computer Engineering, Communication and Management Systems, the Ministry of Science and Higher Education of the Russian Federation, the Ministry of Communications and Mass Communications of the Russian Federation, the Russian Academy of Education, the Department of Nanotechnology and Information Technology of the Russian Academy Sciences, St. Petersburg Institute of Informatics and Automation, Russian Academy of Sciences; International conference "A child in the modern world" - "Internet and digital space: post-material values of youth", "Ecology of childhood", etc.; international scientific and theoretical conference "Communicative strategies of the information society"; International Scientific Conference "X 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).

The latest developments in the application of information technology for the BVI people are of particular interest. For example, the authors of Cheng, Wan & Lin (2018), using portable Utilizing RGB-Depth images acquired by a wearable system, offer integrated assisted navigation for BVI people. The proposed approach reliably detects

several goals and provides effective assistance to BVI people. The work (Weber, 2018) reports on the use of digital media and ICT in educational institutions, in particular in vocational education and training, discusses the idea of a systematic analysis of the potential of digital media and ICT to increase the inclusive potential of the educational organization as a whole.

Today, BVI people still rely on traditional navigational aids, such as a cane for micronavigation, which, however, does not help to develop orientation on a larger scale or plan routes. To overcome this problem, elements of a virtual environment are introduced Kunz, et al. (2018), which allows for experiencing unknown places while remaining in a controlled environment. When using interactive tactile maps and diagrams, widely used by BVI people, the authors of Brock (2018), propose a new approach - augmented reality, which makes it easy and quick to supplement real objects with sound feedback. The teachers found the tool easy to use.

It should be noted that the computerization of educational institutions (including music), in which BVI people study, is not only aimed at solving common educational problems and the convenience of storing and exchanging information, it also allows finding new forms of professional education. In this regard, the authors have analyzed the work, which presents the results of the research conducted by the authors. Articles, monographs, scientific reports, among which (Albouys-Perrois, et al., 2018), formed a methodological and methodological basis for understanding the possibilities of applying new breakthrough technologies in the field of inclusive education, formed our ideas about the main directions of development of new areas of activity in the field of inclusive musical educational process.

## MATERIALS AND METHODS

The most important deficit for a BVI person is the lack of information is filled with the help of digital technologies, in particular, computers, smartphones and so on thanks to speech support programs that are developed for the most popular platforms - Windows, Mac OS and Android. It should be noted that modern operating systems have a number of own built-in applications for BVI people (screen magnifiers, screen speakers), but work with complex software where the interface is based on graphic objects (buttons, amplitude and spectrum analyzers in sound editors, location labels etc.) is difficult with these means. Today, there are two of the most functional screen access software - JAWS for Windows and NVDA.

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

NVDA (NonVisual Desktop Access) is a free, open-source program for MS Windows that allows BVI people for working on a computer without visual control, displaying all the necessary information using speech or Braille display. NVDA is a mature product for screen readers and is always on the cutting edge of the most advanced 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.

The joint Sibelius project (cross-platform music score editor for MS Windows, Mac OS, and RISC OS from Sibelius Software (Avid Technology)), starting with the specially released version 7.5.1 and supporting NVDA, provides on-screen access with speech accompaniment for working with complex musical notes. This is, primarily, the input, editing, and reading of visual musical and graphic material - something that was primarily lacking for both students and teachers of theoretical disciplines.

Using MCT in teaching to BVI people turned from promising innovative project to the reality today. The opportunities for the inclusion of BVI people in inclusive music education are expanding. Where previously it was possible to test knowledge and skills only verbally (first, these are theoretical disciplines: theory of music, harmony, polyphony, solfeggio), there is now the possibility to work with music-computer graphics software.

With MCT, BVI composers received a full-fledged instrument to type independently musical notes and prepare them for further publication. This greatly accelerated the implementation of the creative ideas of the authors, as musical texts had to be written first in a point-and-point manner using the Braille system, and only then dictated material or given to a specially trained copyist of Braille notes. There are very few such specialists not only in Russia, but also in the world.

There was a real opportunity to educate BVI people in new, previously inaccessible areas in professional

musical activity. But in practice, only one secondary specialized educational institution - the Kursk Music College and Boarding School for BVI Students (Gorbunova & Morozova, 2019) fully implements MCT for such people. There are other higher educational institutions partially implementing such type of MCT, among which is the learning and teaching laboratory "Music computer technologies" of the Herzen Russian State Pedagogical University of Russia. All the many years of activity of these educational institutions is aimed not only at educating a full-fledged specialist in the chosen profession, but also at its integration into modern society. In secondary and higher musical educational institutions (special, that is, those that carry out educational activities with students with health limitations, and ordinary students), there are very few specialists who know the specifics of working with BVI students in this area.

## RESULTS AND DISCUSSION

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 software can be attributed to a musician who is widely in demand in the activities of a musician working with digital technologies performed by foreign colleagues and requiring additional functions related to translation. If it is possible to use more widely specialized software, such as Web-based Computer-Aided Translation (CAT) (Rodríguez Vázquez, Fitzpatrick & O'Brien, 2018) and EasyTrans, which is widely used by BVI translators?

These and many other questions concern teachers and researchers today, whose activities are related to the teaching to severely BVI students. When teaching severely BVI children to musical disciplines in children's music and art schools, as well as student musicians in higher and secondary professional musical educational institutions in Russia and abroad, the authors encountered a shortage of Braille musical notes. This fact helped the authors to look at this problem wider and deeper, since, as it turned out, the problem is not in the musical notes themselves or in books with musical notes, but in the interaction of the teacher and student, the exchange of information between the teacher and the BVI student, or vice versa - the BVI teacher and the ordinary student.

The most important thing is to convey information so that this information is correctly interpreted. At this stage, many difficulties arise with different conventions: a BVI student requires a teacher with specific knowledge, and a BVI teacher needs to explain certain symbols and styles of various signs to the sighted student, to be able to ask new material, a new play.

In the process of overcoming these difficulties, the idea was born of creating application software that would help to solve these difficulties and overcome the barrier to the transfer of educational information, create such an instrument, accessible to sighted and BVI people at the same time, which does not cause difficulties in working with it for both groups.

Such software has special requirements: full access from the keyboard, both in the score set and in managing all the functions of this software piece; the full output of information through a speech synthesizer and Braille display; listing on solid media; the adequacy of the information displayed.

This software piece should have the following properties and meet the following parameters:

1. The software should be a music editor, with the help of which an unhindered set of notes or the editing of ready-made scores is possible.
2. An important condition is the ability to enter notes and other necessary characters, as well as other manipulations and commands from the keyboard. Since a BVI person cannot see the mouse cursor, such a person performs the usual tasks for a sighted person using standard keyboard shortcuts (hotkeys). In order for a BVI person to use this software piece fully, its hotkeys should not coincide with the hotkeys of the operating system and other software, which is in use simultaneously.
3. The software piece should be "readable" using a speech synthesizer through screen access software, such as NVDA or JAWS. Screen access software is a special software for BVI people, which performs the following functions: displays information from a computer monitor by means of sound accompaniment (speech synthesizer) or tactile output to the Braille line. Often people encounter such a situation when a software is developed without considering the features of work in conjunction with a screen access software. In the future, the developers try to adapt the interface of the already developed software for the needs of BVI people at the request of the BVI community. The authors' idea is that they initially consider all the features of the screen access software.
4. Adequate and accessible visualization of the interface. Quite often, special software for BVI people are developed without a proper graphical interface. Therefore, for example, there is a situation where the software piece for BVI people meets all the specifics of the work of BVI people, but at the same time on the computer monitor there can be either a blank screen

without images or an outline image, which is inconvenient for users, who can see. In the development of the authors' music editor, the authors aim to make this software accessible to absolutely everyone, both visually and with full audio output.

5. The ability to import and export music text to files of popular extensions. Many note editors save note text in files with their unique extensions. Accordingly, there are many musical scores written within these extensions. Alternatively, another situation: the user either does not want to learn the new editor, or wants to use the editor the user is familiar with. One of the tasks of our development is the fact that the authors' software allows for importing files with various extensions into own environment. The authors achieve an easier interaction between the sighted and the BVI musician by this property of the software.
6. Ability to convert scanned musical scores to accessible formats. One of the known drawbacks of screen access software is the need to convert graphic images (graphic information is not readable or requires a certain recognition system). Currently, there is no adequate music text converter with access for BVI users. This proposal results from that many scanned musical scores are distributed on the Internet, but, as mentioned above about the lack of a screen access software, BVI people do not have access to these materials.

## CONCLUSIONS

Application software for MCT-based teaching music to deeply BVI people should have the following properties and comply with the parameters that will allow this application to be used in various fields of activity of BVI musicians:

When teaching music to BVI students of Children's Art and Music Schools, this software will expand the available material. This software can be used in the process of teaching such disciplines as solfeggio, harmony, music theory, musical literature, analysis of musical works, teaching a special instrument, etc. The teacher can give the prepared musical notes to a BVI student, and at the same time, the teacher may not know Braille. Moreover, a very important, from the authors' point of view, the universal property of such software: a BVI teacher has the opportunity to teach a sighted student by giving material through such software, which will contribute to the development and implementation of inclusive education.

Today the number of BVI musicians is increasing. This is due to two main factors: firstly, BVI children, have a keen ear that "takes on" a partial completion of obtaining information about the outside world, and secondly, the development of information technology (IT) opens up unique prospects for BVI people in providing and receiving music information in almost full. Using specially developed technologies, BVI people can access all kinds and methods of transmitting information about music - all this gives a BVI person the opportunity to receive the profession of a modern musician that matches their interests and abilities. In this regard, our software piece will be useful and in demand by many people, because it, for example, makes it possible for a trained deeply BVI musician to write a work on their own and to share their work without outside help.

Thanks to the existence of such a tool as a music editor with the possibility of non-visual access, a BVI musician has the opportunity to become a full-fledged member of a creative group, to enter the stage, since in the process he can freely and easily type musical notes to exchange musical and other material.

When such an instrument appears, BVI musicians open up wide horizons: free exchange of musical notes, free transfer of material to the sighted musician, the possibility of complete and unhindered cooperation between the musicians. In the future, the developed software will become a multitasking tool for BVI musicians in working with musical text, which will open more horizons for musical creativity and will allow a BVI musician to work as a team on a par with sighted people without experiencing difficulties in reading and editing musical material. The software, developed based on the latest achievements in MCT, can become one of the essential elements of inclusive music education in various directions of its implementation.

## BIBLIOGRAPHIC REFERENCES

Albouys-Perrois, J., Laviole, J., Briant, C., & Brock, A. (2018). Towards a multisensory augmented reality map for blind and low vision people: a participatory design approach. (Paper). ***International Conference CHI 2018***.

Brock, A. M. (2018). Augmented Reality for People with Visual Impairments: Designing and Creating Audio-Tactile Content from Existing Objects. In Miesenberger, K., Kouroupetroglou, G. Computers Helping People with Special Needs. (Paper). ***ICCHP 2018. Lecture Notes in Computer Science, 10897***.

Cheng, R., Wang, K., & Lin, S. (2018). Intersection Navigation for People with Visual Impairment. In Miesenberger, K., Kouroupetroglou, G. Computers Helping People with Special Needs. ICCHP 2018. ***Lecture Notes in Computer Science***, ***10897***.

Gorbunova, I. B. (2019). Music Computer Technologies in the Perspective of Digital Humanities, Arts, and Researches. ***Opcion***, ***35***(S24), 360-375.

Gorbunova, I. B., & Morozova, S.A. (2019). Music and computer technology in the training of students with visual impairments in secondary and higher professional music educational institutions in Russia. *World of Science, Culture, Education*, *5*(78), 308-316.

Gorbunova, I. B., Govorova, A.A., &Voronov, A.M. (2019). Music Computer Technologies in IT Training for Students with Deep Visual Impairment. (Paper). *12th International conference on informatics in schools Situation, evaluation and perspectives proceedings*.

Gorbunova, I.B., & Voronov, A.M. (2018). Music Computer Technologies in Computer Science and Music Studies at Schools for Children with Deep Visual Impairment. (Paper). *16th International Conference on Literature, Languages, Humanities & Social Sciences (LLHSS-18). Budapest, Hungary. Int'l Conference Proceedings*.

Gorbunova, I. B., & Govorova, A. A. (2018a). Music Computer Technologies as a Means of Teaching the Musical Art for Visually Impaired People. (Paper). *International Conference on Literature, Languages, Humanities & Social Sciences (LLHSS-18). Budapest, Hungary.*

Gorbunova, I. B., & Govorova, A. A. (2018b). Music Computer Technologies in Informatics and Music Studies at Schools for Children with Deep Visual Impairments: From the Experience. In, S., Pozdniakov, V. Dagiena, *Informatics in Schools. Fundamentals of Computer Science and Software Engineering. ISSEP 2018. Lecture Notes in Computer Science.* Springer.

Kunz, A., Miesenberger, K., Zeng, L., & Weber, G. (2018). Virtual Navigation Environment for Blind and Low Vision People. In K., Miesenberger, G., Kouroupetroglou, Computers Helping People with Special Needs. *ICCHP 2018. Lecture Notes in Computer Science, 10897*.

Rodríguez Vázquez, S., Fitzpatrick, D., & O'Brien, S. (2018). Is Web-Based Computer-Aided Translation (CAT) Software Usable for Blind Translators? In Miesenberger, K., Kouroupetroglou, G. Computers Helping People with Special Needs. *ICCHP 2018. Lecture Notes in Computer Science, 10896*.

Weber, H. (2018). Increasing Inclusive Capacity of Vocational Education and Training (VET) Organizations with Digital Media and ICT. In, K., Miesenberger, G., Kouroupetroglou, Computers Helping People with Special Needs. ICCHP 2018. *Lecture Notes in Computer Science, 10896*.