Music Computer Technologies in Informatics and Music Studies at Schools for Children with Deep Visual Impairments: From the Experience

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Abstract. Music computer technologies (MCT) open up wide opportunities for blind students to more effectively study the diverse content and methods of presentation of educational material in Informatics, contributing to the achievement of positive learning outcomes in a shorter time. This is especially important for children who study in children's music schools. Mastering of MCT by children with profound visual impairment has a number of characteristic features, which are most clearly manifested in the initial period of studying Informatics. With the help of contemporary computer technologies (speech synthesizers, Braille displays, etc.), as well as due to the possibility of using "hot keys" blind students quickly master many MCT-programs.

The main objectives of the lessons on musical informatics are: to study the basic concepts related to the receipt and use of information, both in school and in everyday life; to obtain skills in working with a computer and some peripherals. In the program considered by the authors of the article it is supposed to study the basic concepts and acquire the skills included in the existing programs in informatics, taking into account the fact that all tasks in informatics are based on materials related to music.

The program is designed in such a way that it is possible to perform the proposed tasks not only with the help of a computer keyboard and "hotkeys", but also with the help of MIDI-keyboard. This is achieved by the connection between the actual music and informatics.

The authors also propose to consider the application software – a tool that would be accessible to the sighted and blind and would not cause difficulties in working with him/her both in some and in others: the exchange of information between the teacher and the blind student or vice versa - the blind teacher and the ordinary/seeing pupil.

Keywords: Inclusive education · Informatics · Music computer technologies
Visual impairment pupil

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1 Introduction

The development of computer technology in the late 20s – early 21st century has significantly expanded the ways of obtaining information. High-tech information educational environment requires the search for new approaches and fundamentally new systems of education in the School of the Digital Age. "The ICT revolution brings along an increased potential for inclusion and participation, but also risks for exclusion and thus the responsibility for implementing eAccessibility. It provokes a growing number of challenging research questions. Old boundaries of concepts dissolve, new approaches and fresh thinking are formed: not only in technical terms, but also in social, economic, pedagogic and other terms" – G. Kouroupetroglou, General Chair of the 16th International Conference on Computers Helping People with Special Needs ICCHP-2018 (July 11–13, 2018, Linz, Austria) said [9].

Innovative pedagogy of music and informatics at the present stage is associated with the use of music computer technologies (MCT), it is a contemporary and effective means of improving the quality of teaching the art of music and informatics at all levels of the educational process [5].

MCT is a unique technology for the implementation of inclusive pedagogical process in teaching children with disabilities.

Possibilities of MCT for inclusion and participation in the information society strive for better Assistive Technology "for support, enhancement and restoration of resources for people with disabilities and compensating limitations of standardized Human Computer Interaction (HCI)". These opportunities still gains "more importance due to the ongoing ICT revolution (Internet/ Web of Things/ Ubiquitous computing/ Cloud based services)" [9].

It should be noted that the consequent application of MCT in inclusive pedagogy still remains little known among the contemporary pedagogical approaches.

Nevertheless, there are some remarkable premises for forming and developing the methods constituting this approach. These premises have been discussed by the authors of the article with colleagues in Hungary, including Prof., Dr. N. Maczelka, Pianist, Head of the Arts Institute and the Department of Music Education Faculty, Prof., Dr. T. Csendes, Head of Department of Computational Optimization University of Szeged, Prof., Dr. M. Benedict, Department of Theoretical Physics, some colleagues from the Eszterhazy Karoly University (Eger) and Eötvös Loránd University (ELTE), Budapest, - as well as with Dr. I. G. Alieva, Baku Musical Academy named after U. Hajibaili, Azerbaijan.

All of them have marked that MCT are able to make a significant contribution to the improvement of the life of pupil with disabilities.

2 MCT as New Creative Educational Medium

The authors were guided by the general principles that had been developed at the Educational and Methodical Laboratory 'Music Computer Technologies', Herzen State Pedagogical University of Russia (Saint Petersburg). Sphere of interests of its members includes the problems of interrelation of natural and technical sciences and humanities,

as well as the possibilities of applying the results of such interrelation for the purposes of music education and upbringing. Scientific group of the Laboratory also take part in working out the specialized software for computer music devices and in application of this software in pedagogical processes.

Research activities of the members of Laboratory including such directions as:

- MCT in professional musical education (as a means to expand creative opportunities),
- MCT in general musical education (as one of the means of education),
- MCT as a means of rehabilitation of people with disabilities,
- MCT as the new direction in preparation of specialists of humanitarian and technological profile,
- MCT in the field of digital arts,
- MCT in information technology, psychoacoustics and musical acoustics.

Developments and researches in the field of musical pedagogics and musicology, music computer science (musical informatics), computer modeling of processes of musical creativity, timbre programming, art of performing skill and arrangement on electronic musical instruments, creative work in the field of computer music, mathematical methods in musicology, etc. – all these directions in its totality allow to work up the methodological principles and pedagogical approaches to the use of MCT in inclusive education (as part of eInclusion) for children with profound visual impairment. (See: [4, 5, 10] a.o.)

3 From the Experience

3.1 Psychological and Pedagogical Features of Teaching MCT for the Visually-Impaired

The process of teaching the MCT to people with profound visual impairments is related to the following main points. First of all, the computer facilitates a blind person's access to information of all kinds, but at the same time people with LHO on vision have a complex set of mental reactions that the teacher needs to keep in mind when giving classes.

The specificity of the training of blind MCT is also in the fact that this contingent of students is heterogeneous in the type of visual pathologies available, in the form of visual impairments, etc. at the same time, each group of people with LHO in vision, combined on the basis of the severity of visual pathology, is characterized by the presence of certain mental features that must be taken into account in the organization of the educational process. A significant role in the development of the blind basic computer skills play their visualization. A comprehensive study of this problem is being carried out by Y. Krivodonova (Ural State Pedagogical University, Ekaterinburg, Russia) and A. Voronov (Educational and Methodical Laboratory 'Music Computer Technologies', Herzen State Pedagogical University of Russia, Saint Petersburg). According to contemporary scientists, vision provides a person with about 90% of information. The image analysis allows us to study the spatial structures of the object,

and the distribution of optical densities and colors reflects the most important information about the properties of both real and virtual objects of the world. Thus, we can say that visualization is of great importance in the process of development of the blind people, because it is thanks to the ability of a person to create a certain imaginary picture in the study of a computer program he has an adequate idea of their own actions; this "forms <…> the image of themselves as a figure, able to understand certain things, in certain computer programs" [11, p. 255].

Visualization plays a particularly important role in the development of the blind; it is objectively more difficult to study the basic, MCT-programs. It should be noted that each person who has an LHO on vision, regardless of the time of the onset of damage to the visual analyzer and the degree of its severity, the visualization is purely individual. This phenomenon is caused by a complex of various factors and largely depends on the strategy of family education, on the method of formation of a blind child or an adult who has lost his sight, "the ability to dream – visualize, to attract the desired images of certain objects to his/her imagination" [10, p. 256]. It should be emphasized that the development of MCT people with LHO on vision ability of a particular person to visualize often becomes a powerful mechanism that allows him/her to master a particular music program.

Thus, to achieve the best results in teaching people with LHO on vision, the teacher of the MCT should take into account the above features. The teacher, first of all, should form the ability of blind students to correlate the real image that appears in the process of mastering certain knowledge with the imaginary one. In this case, close attention should be paid to the individual characteristics of each individual student. For example, it should be borne in mind that the visualization of people with congenital blindness has an important distinctive feature: the image that arises from them in the study of a particular material is initially created on the basis of tactile sensation, and then can be endowed with visual elements. The teacher should be given material based on the method of visualization of a particular student. In particular, if a person with born blindness is given material based only on visual information, he/she will not be able to understand a lot, and if the same information is given out taking into account the peculiarities of his/her perception, the result will be noticeable immediately.

In addition, it is necessary to pay attention to the fact that in recent years, people with visual impairments are increasingly found in so-called "comorbidities", that is, along with deep visual impairment, there are concomitant diseases, often associated with the defeat of the central nervous system. These diseases are mainly responsible for difficulties in assimilating the information offered, which greatly complicates the successful implementation of the learning process. In this regard, the same information should be presented by the ICT-teacher in different ways, taking into account the whole complex of psychophysical characteristics of a particular person. At the same time, for people with concomitant diseases, the work should be dosed, so as not to harm their health. It is noted that such people are not recommended to work permanently in the headphones, listening to the voice synthesizer programs JAWS (Job Access With Speech) or NVDA (NonVisual Desktop Access), because sounding headphones and voice synthesizer cause the rehabilitant increased feelings of fatigue.

We also note that all of the above psychological and pedagogical features of MCT training for students of specialized music schools and music classes for children with

profound visual impairment determine the need for an individual approach, taking into account the state of health and psychological characteristics of a particular person, which is the basic principle of working with blind people of any age.

3.2 The Use of MCT in Teaching Informatics for Children with Deep Visual Impairment

For musicians with profound visual impairment, the use of a musical computer (MC) is of a particular importance [10]. First of all, the MC is for them a means of contact with the "outside world", however, it helps in the realization of their creative potential and adaptation in the modern social environment. MCT opens up a lot of opportunities for blind musicians to more effectively study a variety of content and methods of presentation of educational material, contributing to the achievement of positive learning outcomes in a shorter period of time [7]. However, the development of MCT by musicians with profound visual impairment has a number of characteristic features that are most clearly manifested in the initial period of training [3, 4].

First of all, it should be noted that with the help of contemporary computer technologies (speech synthesizers, Braille displays), as well as the possibility of using "hot" keys, blind people can master many MCT programs. Nevertheless, the specifics of teaching the ICT to people with profound visual impairment, is that the professional development of the ICT programs involves the presence of blind students' basic skills of a PC user. Getting skills to work with a "talking" computer is a time-consuming process that requires special training not only from students but also from their teachers. This is due to the widespread use of MCT by people with profound visual impairment, mainly in the field of secondary and higher music education, while at present, MCT is actively used at the early stages of education, including inclusive education (when working with children with hearing impairment, muscle-skeleton disorder).

One of the types of computers – a laptop – blind, like no other, is actively used, justifying in the literal sense the translation of its name: the laptop for them was not just a notebook, as well as a library, recorder and organizer. And for blind musicians, the computer has become even more of an assistant: with the advent of screen access programs, people with visual impairment were able to create, process, record and edit music on their own.

In training, we faced a shortage of Braille notes. And this fact helped us to look at the problem more broadly and deeply. After all, the problem is not in the notes or books themselves with these notes, but in the interaction of the teacher and the student. Exchange of information between a teacher and a blind student, or vice versa – a blind teacher and an ordinary student. The most important thing is to convey the information so that this information is correctly (adequate) interpreted. At this stage, there are many difficulties with different conventions: for the blind student, a teacher with specific knowledge is needed, and the blind teacher needs to explain to the sighted student certain symbols and styles of various signs, to be able to set new material, a new play.

3.3 The Use of Special Software in Teaching Informatics and Music for Schoolchildren with Visual Impairments

In the process of overcoming these difficulties, the idea was born to create an application software with which to solve these difficulties and overcome the barrier in the transmission of training information. To create a tool that would be accessible to the sighted and blind, and would not cause difficulties in working with it, both in some and in others. (In particular, we examine the concepts constituting the bases of education technologies that has earlier been used in inconsistent and contradictory ways.)

Of course, this software will be presented with certain requirements: full access from the keyboard, both in the set of the score, and in the management of all functions of this application; full information output through the speech synthesizer and Braille display; printout on solid media; the adequacy of the information displayed on the display.

This program should have the following properties and meet the following parameters:

1. The program should represent music notation editor with which possible to have a seamless set of notes or revision of the scores.
2. An important condition is the ability to enter notes and other necessary characters, as well as other manipulations and commands from the keyboard. Due to the fact that the blind person can't see the mouse, he/she performs the usual for the sighted person standard tasks using keyboard shortcuts (hot keys). In order for a blind person to fully use this program, the hot keys of this program should not coincide with the hot keys of the operating system, and simultaneously running programs.
3. The program must be "readable" using a speech synthesizer through screen access programs such as NVDA or JAWS. A screen access program is a special program for blind or visually impaired people, which performs the following functions: displays information from the computer monitor by means of sound (speech synthesizer) or tactile output to the Braille line. Often we are faced with a situation where the program is developed without taking into account the features of the interaction with the program screen access. In the future, at the request of the blind community, they try to adapt the interface of the already developed program for the needs of people with visual impairment. Our idea is that we initially take into account all the features of the screen access programs.
4. Adequate visualization of the interface. Quite often, special programs for the blind are developed without the correct graphical interface. For example, there is a situation when the program for the blind meets all the specifics of the work of people with visual impairment, but the computer monitor can be either a blank screen without images or a contour image, which is an inconvenience for the seeing users. In the development of our music editor, we aim to make *this software* available for everyone, both visually and with a full sound output.
5. Ability to import and export a music text to files of popular extensions. There are many music editors that save a music text in files with their extensions. Accordingly, there are many scores written in these extensions. Or another situation: the user either does not want to learn a new editor, or wants to use the familiar editor.

One of the tasks of our development is the fact that our software allows you to import files with various extensions into your environment. With *this software* property we want to achieve easier interaction between the sighted and the blind musician.

6. Ability to convert scanned scores to available formats. One of the known disadvantages of the screen access programs is the need to convert graphic images (graphic information is not readable or requires a certain recognition system). To date, there is no adequate Converter of a music text with access for blind users. This proposal is also due to the fact that there are a lot of scanned scores on the Internet, but, as due to the lack of screen access program mentioned above, blind people do not have access to these materials.

It should be that teaching materials on teaching informatics include: a set of materials for the teacher; a set of computer tasks for the pupil; a set of tasks in workbooks; a set of tasks for active logical and creative games using musical material.

4 Conclusions and Future Work

It is possible to solve the problems of information education for schoolchildren with deep visual impairments using specific software.

This application can be used in various fields of activity of blind musicians:

1. When teaching music to blind students of children's musical schools and children's schools of arts, this application will expand the available material. This program can be used in the process of teaching such disciplines as solfeggio, harmony, music theory, music literature, analysis of musical works, a special instrument, etc. The teacher can give a pre-prepared music text to the blind student, while he/she does not own Braille. And most importantly, from our point of view, the universal property of this program – the blind teacher has the opportunity to teach a sighted student, giving material through this program, which will contribute to the development and implementation of inclusive education.
2. Today there is a fact that the number of blind musicians is increasing. This circumstance is due to two main factors: firstly, children deprived of vision, by definition, possess acute hearing, which "takes over" partial replenishment of information about the outside world, and, secondly, the development of Information Technology (IT), in general, and MCT, in particular, open up unique prospects for people with visual impairment to provide and obtain musical information in almost full [1, 2, 6]. With the use of specially developed technologies, blind people are able to access all kinds and ways of transmitting information about music; all this gives blind people the opportunity to get a profession of a contemporary musician, corresponding to their interests and abilities. In this regard, our application will be useful and in demand for many, because it, for example, gives the opportunity to a trained musician to write a work and to share his/her work without anybody's assistance.
3. Thanks to the appearance of such an instrument as a music editor, the blind musician has the opportunity to become a full member of the creative group, to join

on stage, because in the process of work he/she can freely type music texts to exchange music and other materials.

We also propose to consider the application software – a tool that would be accessible to the sighted and blind and would not cause difficulties in working with him/her both in some and in others: the exchange of information between the teacher and the blind student or vice versa – the blind teacher and the ordinary/seeing student.

With the appearance of such an instrument, blind musicians have wide horizons: free exchange of a music text, free transfer of the material to the sighted musician, the possibility of full and unhindered cooperation between musicians [8].

This application software is now being worked up.

The results of the methodological principles and pedagogical approaches concerning the use of MCT in informatics and music studies at schools for children with deep visual impairments, worked out by the authors of the article, were presented at the Russian-Hungarian Education Forum, February 17, 2017 (Hungarian Cultural, Scientific and Information Centre, Moscow), at the annual International Research and Practical Conference 'Contemporary Musical Education' (2015, 2016, 2017, Saint Petersburg, Russia), and at the 16th International Conference on Computers Helping People with Special Needs, July 11–13, 2018 (Linz, Austria). The participants of the conferences have estimated these results as having good perspectives.

In the future, the developed software will become a multitasking tool for blind musicians in working with a music text, which will open up more horizons for musical creativity and allow the blind musician to work in a team with sighted people on an equal basis, without experiencing difficulties in reading and editing musical material. The application, developed on the basis of the latest achievements in the field of MCT, may become one of the essential elements of inclusive music education in the future [5] in various directions of its implementation.

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