UNIVERSAL LEARNING DESIGN

ULD@ICCHP | LINZ 13–15 JULY 2016

A technological proposal to support music education shared between blind and sighted students

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Keywords: Assistive technology, Education of blind, Braille Music
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ABSTRACT

This paper discusses aspects of the integration of blind and sighted children in inclusive music classrooms and launches new ideas so that the use of computers would enable the creation of a more favorable environment for teaching Braille music. It proposes the creation of a specific computer tool, designed under Universal Design principles, that allows the application of an adequate pedagogical approach for basic music teaching assuring that the process of inclusion must be placed in the foreground.

1 Inclusion of Visually Disabled Students in Brazil: New Challenges for Music Teaching

In Brazil since 1988 musical education is mandatory by law in all schools. The purpose of this legislation is not to foster the preparation of future musicians, but to develop creativity, sensitivity and integration of students. As a result, it is expected that children with and without disabilities be motivated to share learning in basic music education classes. However, complex pedagogical problems arise when trying to teach simple concepts involving writing and reading music (JELLISON, 2008).

In the context of inclusive education, if teachers of ordinary classrooms could dominate musical writing in Braille, or could work in pairs with another teacher, specialized in this kind of writing, there would be no major problems in the simultaneous use of writing in ordinary scores and in Braille, except for some additional transcription work - which can be greatly simplified through specific computer programs. However, if only Braille writing was used, the blind student could not share his development in the discipline with colleagues, because what he writes tactually, almost any fellow seer could read (BORGES, 2009). On the other hand, these computer tools that have provoked a decrease in the ability of the blind read Braille (NBCNEWS, 2009) also don't work well for the specifics of musical writing.

The root of the problem is that the theoretical and practical content of music teaching is always the same, just the way of writing is different. So, how to share the essence of the musical record, regardless of the form of writing? How to allow that what the writing of seers could be instantly read by the blind and vice versa? How to make computer technology, which allows high degree of automation of musical writing, could be combined with the maturity of the data transmission process and the many possibilities for information sharing, to create new opportunities for music education?

As a background stage of these questions is the configuration of the current communication systems changing the logics of distance, inclusion and exclusion, introducing new dimensions to these logics (spatial, temporal and social) and enabling new communication flows overlapped with existing structures (CASTELLS, 1999). Information and communication technologies should therefore be enhancing the skills of everybody, being able to recognize the particular dynamics of them, understanding and supporting how they globally relate and ensuring that in amplification processes of access and use, the logic of singularity is not compromised. The technologies for Information and communication can therefore play a key role in the integration of groups and individuals that are traditionally segregated and leverage a richer relationship and a deeper mutual understanding between different individuals, communities and cultures.

2 Conceptual research framework.

The research on which this article is embedded crosses the problems of Communication and Information Sciences (CIS) with the Educational Sciences (ES). It is obvious that focusing shared learning refers to the study of the educational phenomenon, but it is worth noting that in its root there is also an info-communicational phenomenon that cannot be avoided. The success of the teaching-learning process is necessarily, for an informational work quality and high communication effectiveness. It also passes by careful examination of the mediating role of educational agents, the use and enhanced digital platforms and the ability to engage students in two complementary dynamics: the digital inclusion and of proper information literacy.

It is not up scrutinizing here the deep epistemological relationship between the CIS and the ES, because the idea is to draw a positive contribution to the development of closer relations between sighted and blind, students and teachers. The implementation a digital tool or platform that enables the dialogue between them, with the elimination the exclusive use of the Braille code only for those who cannot communicate through the characters of natural languages, is a relevant objective that produces a wide-reaching impact which is still difficult to evaluate. There is no doubt that there is a clear goal that urges to reach in the most effective and possible way.

For this purpose, an effort for basic conceptual clarification is necessary to help us to integrate the thematic scope of this article in the scientific field of Information and Communication. This effort is greatly facilitated by using the main concepts explained in (PASSARELLI, 2014), which propose operative definitions to mark and help in the exploration of all kinds of questions posed inside and at the borders of this interdisciplinary field.

The concept of information is of course the first that is highlighted with this formulation:

"... structured set of mental and emotional coded representations (signs and symbols) and modeled with/by social interaction, which can be registered in support any material (paper, film, magnetic media, CDRom, etc.) and therefore communicated asynchronously and multi-form" (p. 85).

By this definition it is clear that Braille can be a taught and learned by a group of people who need it to express their mental and emotional representations (of any kind and in any situation and context) tending to process that is both communicational and educational.

The second concept to reveal may be the communication that is distinct and complementary, *"while the information is the content of the communication order"* (p. 102). Clearly,

communication is established as an exercise of cooperation, negotiation, joint direction construction, which implies respect and attention to the caller.

"think communication in the era of information triumph and technical means to emphasize the complexity of the nature of the communication process with its triple dimension of questioning the relationship of otherness and receptor." (p. 103)

To complete the triad of key concepts we cite the concept of information systems:

"An information system is a totality formed by the dynamic interaction of its parts, or has a permanent structure with a stream of states in time. It consists of different types of recorded (or not) information external to the subject, no matter in what media (material or technological) according to a structure (agency producer / receiver) that extends its action in the timeline. (p. 116)

This is a "space" technological complex that, in essence, continues to consist of hardware and software, but which converge various technologies and services in order to make it an instrument of info-communicational mediation. Music theory, music compilation, man-machine communication, voice synthesis, hardware control, and many others subjects interact through command and control techniques and algorithms that try to mimic some aspects of human behavior of a educational mediator, theme which could be mapped on the interests of a new field of research: Affective Computing (PICKARD, 2000). However, this interesting approach for our research is not being explored at this moment.

Much of this text talks about aspects of technological mediation and distance education, concepts explained in many references, e.g. (KOEHLER, 2005). In particular, technological mediation imposes itself as an indispensable concept because it covers both the roles of a communicator and an educator. The mediating function is not neutral, but it is natural and critical, with implications for the info-communication process. If the media is linked to this deeply human and social function, the momentum triggered by the binomial teaching-learning / teacher-student loses intelligibility out of questions embodied in mediation.All these concepts don't exhaust the theory necessary for understanding the present research. We affirm the importance of studying other concepts, less relevant to the context of this text, but of transcendental importance if a wider study is on perspective. We emphasize here the subjects related to memory, emergent literacy, cognition / knowledge, document and interaction / interactivity.

3 Music production and teaching for the blind, mediated by technology.

As cited in (HERSH, 2008) the main products for the international market that support writing and reading music for the blind are GOODFEEL, Tocatta and Braille Music Editor (BME). These products operate philosophically the same way: they take a digital file representing a conventional music pentagram and automatically generate a digital file with some representation that allows printing.

The input file is encoded in a proprietary format or in MusicXML – which may have been produced in a musical editor (such as Sibelius, Finale or PrintMusic) or created with a music scanning program, like SharpEye Music Reader, Musitek SmartScore or PhotoScore Neuratron. Some programs (like GOODFEEL and BME) even allow a blind person interact with the generated file with "Braille representation", reproducing it in a MIDI musical instrument or in a simulated synthesizer on the computer. Feedback from musical elements is

done through a speech synthesizer associated with a screen reader, being the Jaws program the product for which there is a greater number of specialized scripts that support this reading.

As we can see, none of the products are really focused on two-way interaction. In other words, the destination is always Braille. There is no emphasis on exploring the possibilities that the semantic compatibility between the representation in ink and Braille have. The emphasis is always that a seer (or even the blind) will produce texts for the blind, and the blind will interact with Braille.

This functional unidirectionality is a huge obstacle for teaching in inclusive classes. In other words, the blind person can get information that others produce, but what it produce does is not gotten by colleagues. The huge potential of learning sharing, the musical manifestations generated from it, so as discoveries and intuited ideas, nothing is explored, because the technology was not built to deal with them.

The emphasis of these products is not music education, but production of texts in Braille to be used by blind musicians. In other words, support for education is clearly precarious. This does not mean that teachers would not use these technologies at school with their blind students, but this almost always takes place using segregated education strategies, and in particular, individualized instruction.

The adoption of logics and practices of implementation and the use of digital technologies by students with special needs should therefore be developed in a coordinated manner in an interdisciplinary logic (NIELSEN, 1999). It is also essential to ensure specialized training for both music teachers in the area of inclusive technologies and for ICT specialists in music. This may generate motivation and flexibility, added to the work of the different agents involved, with the distributed and distance communication to be considered as an important modality that could ensure this specialized training (EADSNE, 2013; UNESCO, 2013).

We understand as essential, therefore, to observe the importance of making digital technological resources accessible to blind people to facilitate them to learn Braille Music and to interact with sighted musicians, reinforcing the sharing practices between these two groups. This will be done by the resource given by the real-time access to a digital platform of music scores that allows communication of blind and sighted students, music teachers and musicians in scenarios such as music schools and universities.

4 The Musibraille system, its limitations and advantages.

In Brazil, one of the main technologies for Braille Music transcription is the Musibraille software, created by us, which can be considered as part of actions promoted to revitalize the use of Braille music in our country (BORGES & TOME, 2012). Thanks to this effort, several hundred people have been trained in this form of writing. The system has spread in all Brazilian states, with the financial support from the private sector and government projects. The Musibraille is free software, distributed freely over the Internet.

Musibraille is also focused in interactive writing of music scores in Braille. Data entry can be done using the computer keyboard, typing on a 6-key keyboard simulator (Perkins mode) or through transcription of files represented in the MusicXML format. The information in Braille is translated in real time to a conventional musical score, which helps the seer transcriber to verify the correction of typing.

The program displays an audible feedback with the translation of Braille music symbols into synthesized speech or musical tones as they are typed, and also allows playing the music

during its creation. It contains an interactive Braille music dictionary and also includes a small screen reader tuned to its operating interface, which relieves the installation of external screen readers or specialized scripts. A small virtual library on the Internet, with simple songs for beginners, completes a basic set of tools for the student.

Recently some tools have been created to educational purpose only, as shown in (BORGES & TOMÉ, 2014). Other tools have been introduced into the program to allow very simple input data through using icons clickable by the mouse, very useful for sighted users. However these facilities did not change Musibraille's main objective: easily editing with excellent feedback of Braille Music.

Despite these limitations, Musibraille is really a technological item of huge importance to the development of new products and especially to this proposal. We explain why: it was created within a university project, nonprofit, using methodologies of open and reusable code, and more, *under our technical guidance*. In other words, we have complete knowledge about its code, being able parts of its code it to modify it and even to create new products, so that if its interface is not suitable for teaching purposes we know that it is fully possible to reuse their algorithms and implementations to leverage and simplify programming of a new software architecture, with fully targeted focus for inclusive music education, with a cost and time infinitely smaller than would be required in a design usual situation.

This proposal would be impossible to produce with our small budget, working almost with students, without the availability and technical knowledge, made publicly available by the Musibraille project.

5 Proposal for a new architecture for music education with operating sharing.

The premise that makes this project possible is the fact that the representations used in Braille Music and conventional musical notation (musical score) refers to semantically equivalent entities, so that the bidirectional, automated and real-time translation is possible. Thus, what is stored is, in essentially, a musical data structure, whose sound representation, visual presentation, tactile sensations, etc., could be produced and selected on demand and interactively, and whose most appropriate feedback should be freely chosen by user.

The execution interface, should be bimodal: the conventional and Braille writings have the same operational importance, and the act of writing, reading, listening and print is interchangeable and supported by specific selection and configuration interfaces. In particular, five outputs are available (as they are also available in Musibraille): conventional graphical form, Braille output on screen, output on a Braille Display, score printing with ink and Braille printing.

Data entry has also to be multimodal, with entries taken from the keyboard, touch screen, Braille display and Midi interface, at least. It is expected to include, in the future, the translation of sound capture (from singing, for example), but it should, at least at first, restricted to no polyphonic input. The system also provides the translation for files represented in MusicXML (within the limit of using an agenda at a time) by using a variation of the Musibraille XML compiler. The important is that it allows obtaining material from the internet, as well as supporting a broader sharing of information.

The key point of the program is its real-time communication. In other words, what is produced or selected in an instance of the program is immediately transmitted to the other instances of the program that are located on the same Local Area Network, as having being

previously interconnected. Thus, the interaction on the musical information can be established and, given that the internal representation of musical information is the same, sharing can occur independently of the input mode or output chosen. It allows, for example, writing with a mouse in some computer, and immediately read in the Braille Display in other machine (automatically or on demand).

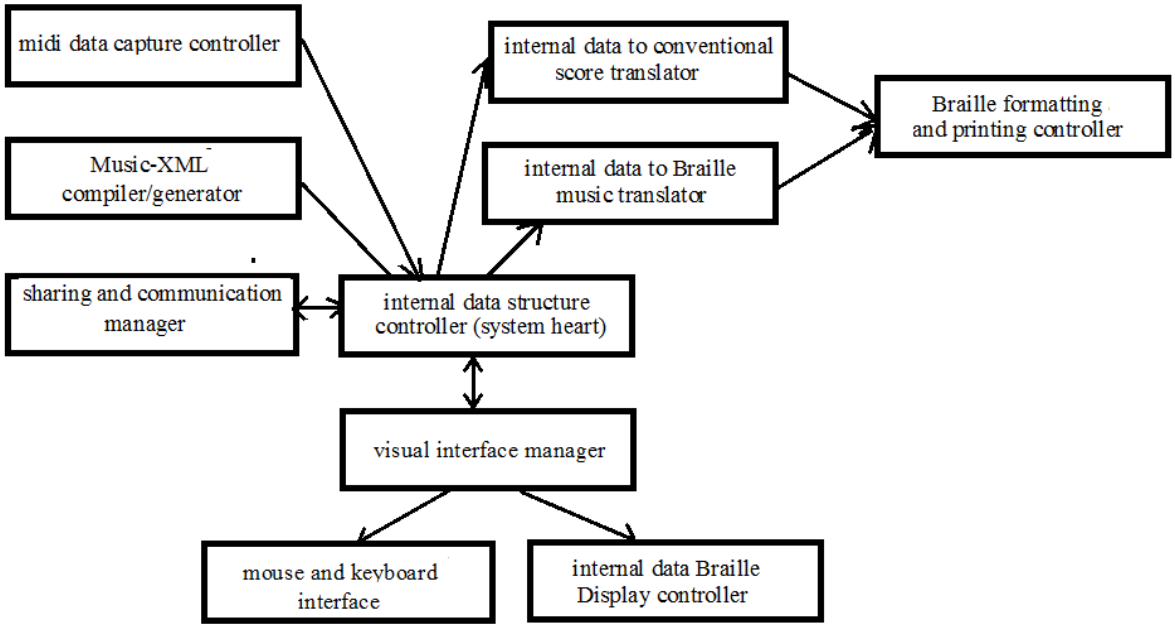

Figure 1 - Architectural sketch

Figure 1 shows the main structure that are being planned to implement. We must note that this product is not designed to be a music publisher but as a basic teaching tool, with well defined pedagogical and architectural limits. This is an important design decision, otherwise the architecture would be much more complicated, going far beyound our project possibilities.

6. Prototype implementation and evaluation.

A prototype for functional evaluation, provisionally called PianoVox is currently under construction and validation with a small group of volunteers. The first discussions with them have shown clearly that PianoVox should not grow to become a transcription tool: it is a tool to make easier the shared study of Braille Music. In particular a significant programming investment has being done to provide simple but effective intercommunication between instances of the program, allowing synchronized executions in different devices in real time.

It was necessary to limit the prototype to be used in non-mobile environments, to avoid further implementation difficulties and uncertainties of the design. The music items that are supported are a small subset of the Music Universe, enough to fulfill the needs of the most common tasks of a basic music course.

Our emphasis at the moment is to clearly define what should be essential or accessory in the final program, assuring that the interface will be kept very simple and intuitive, and always remembering that its purpose is mainly educational. It is expected that the program will be fast in its responses, even in modest equipment (in Brazil the majority of school computers is not new), so a teacher can use the simple machines that exist in real schools. The program should be intuitive and trivial to understand and operate. The most important of all: the

system has to assume equal operational importance to blind and sighted users, giving to both the opportunity to create and interact with the same efficiency and productivity.

Among the dubious points to the project, is the emphasis on supporting certain expensive technology items. The emphasis on using Braille printers and Braille displays are now points of disagreement with teachers who know that they will hardly have access to these technologies in third world countries. In practice the student will work mainly with the sound interface, and Braille printing will not be available locally. However, in our opinion, the program should provide a sophisticated setting as the ideal, knowing that should behave effectively in a more modest environment, likely to be the model used in most schools in Brazil.

7. Conclusion: on the coverage and importance of this project.

The models of education of people with disabilities have been accompanied by the progressive use of digital technologies to support communication processes, collaboration, participation and social and professional inclusion of these subjects. In consequence, it's essential to promote further study and experience in this area. In this context, it is observed as especially urgent to ensure the availability of adequate resources and materials and to create networks and distributed structures to support communication, collaboration and training of the many actors involved.

The open and inclusive space of communication we want to promote with these new tools is neither an exclusive design of the blind community, nor refers only to the teaching of music: it aims to simultaneously and complementarily deepen areas of theory and practice from both blind and sighted people's cultures, pointing new directions for a deeper understanding of the role of digital technologies in music and in inclusive education.

This project is also important because one of the boldest goals of this development is to support the development of a future project involving the introduction of Braille Music in Portuguese-speaking countries in Africa and in Portuguese-speaking countries, the main PhD research of one of the authors (Dolores). In this context, we propose to investigate how the distributed access may favor this audience, considering the multitude of people from these countries who use and is benefitted by the Internet, particularly blind people, enhancing their interaction with everyone.

Indeed, distributed communities are generating collective knowledge, and the online availability of Braille Music techniques constitute an example of relief in this field, as they may provide inclusive educational potential for a full and unrestricted music education. Blind people become beneficiaries and responsible to promote their own inclusive and participatory progress.

Dolores Tomé is a doctoral student granted by MEC/CAPES-Brazil.

This research is partially funded with resources from CNPq project 458633/2013-5.

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