Technology at the service of music education

Tecnología al servicio de la educación musical

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Abstract:

Technology is part of our everyday lives, whether we like it or not. Learning to live with it is not just a requirement but is also necessary if we are to avoid succumbing to a new form of illiteracy: technological illiteracy. As teachers we must contribute through continuous training to the computer literacy that contemporary society demands of us in the day-to-day performance of our activities. In the following pages, we present and analyse some of the tools available for use in music education, applying criteria of quality, stability, and, above all, freedom of use.

Keywords: ICT, musical education, music software, new technologies, free software, education.

Resumen:

Las tecnologías, queramos o no, forman parte de nuestra vida cotidiana. Aprender a convivir con ellas no solo es una obligación, sino una necesidad para no caer en un nuevo analfabetismo: el tecnológico. Los docentes debemos contribuir con nuestra formación permanente a la alfabetización digital que la sociedad actual impone en el desarrollo diario de nuestras actividades. En las siguientes páginas presentaremos y analizaremos algunas de las herramientas disponibles para su utilización en la educación musical, desde criterios de calidad, estabilidad y, sobre todo, libertad en su utilización.

Palabras clave: TIC, educación musical, *software* musical, *software* libre, nuevas tecnologías, formación.

1. Introduction

When discussing the use of Information and Communication Technologies (ICT) in music education, in broad terms, the first issue is how to define them. What resources are we discussing when we discuss these technologies?

At certain points in the history of education, coloured chalk, photocopiers, whiteboards, tape and CD players, televisions, video, etc. might have been seen as «new technologies». However, the most important medium in current society is undoubtedly the computer, allowing

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collaborative use of computer applications specific to the field of music and sharing work on the internet.

Therefore, new technologies in music education are currently defined as those using internet-connected computers as the focus of the various on-line and off-line possibilities they offer: playing audio and video, presentations, simulations, and searching for information.

While not all specific music technology might be integrated into ICT resources, we now face a degree of globalisation that, in our opinion, makes this separation difficult and unnecessary. Resources such as microphones and speakers are currently part of the hardware of the great majority of computer resources, and the internet provides online tools and software resources that make it possible to create activities and musical resources with applications that previously had to be installed on the computers as well as sharing their own resources on websites, blogs, etc.

Consequently, it is difficult to establish clear distinctions between the different technological elements that feature in music education experiences with ICT. On similar lines to Marqués (2011, pp. 17-35), in this article we include in the term ICT all musical technologies associated with computing, both hardware and software, as well as a wide range of technologies that enable the transformation of information, in particular the use of computers and computer programs to create, modify, store, administer, protect, and recover this information.

The presence of ICTs in music education, as in education in general, is initially dependent on two basic aspects: equipping schools and classrooms, and the teaching staff's training in and use of them.

This piece presents the tools teachers might use in the compulsory education centres which have basic ICT provision. Knowledge and in-depth use of them should be part of the digital training and skills of teachers specialising in music.

2. ICT resources in music

The emergence of and standardisation on MIDI technology and its language in the 1980s was a technological revolution in music. The development of it meant that we can now all use its potential in particular in our personal computers. It is just a few decades (1985) since Atari[1] launched the Commodore Amiga, a computer-games console that included Notator, a MIDI interface and software for music sequencing and score editing. Since then, technological development has made it possible for individuals to have their own small home recording studio at a cost that would once have been unimaginable, thus making it accessible to much of the population.

This development has meant that we can have sound sequencers-editors and sufficient technology to make recordings and mixes at our disposal, as well as technological resources for simulating performances by instrumental groups that previously were only possible live and in recording studios.

Numerous technological resources are available for musical activities, and new ones appear every day. We will, therefore, attempt to classify them, making an initial distinction between online, or Web 2.0, resources and off-line ones, in other words resources that can be used without an internet connection. Within this classification, a secondary classification will consider whether the resources are proprietary, and so the corresponding licences must be obtained to use them, or whether they are resources from the free software or open source movement, which can be shared and used freely.

Any attempt to list all of the available software related to music and its possible use in education would be extremely prolix, and so we will basically focus our attention on free-software resources available. The reasoning behind limiting the sample to resources from the free software field is, on the one hand, the need for resources in education that can be used without a significant investment by schools and students, and, on the other hand, the need for lessons on values and respect for other people's work: «intellectual property».

Authors like Adell and Bernabé (2007, p. 185) identify the following educational reasons for using free software in education, taken from the ideas of Richard Stallman:

> *Free software can be copied and redistributed at cost price.* Educational authorities can provide all of their educational centres with software at a very low price and use the resources saved in other necessary areas in education: more computers, teacher training, etc.
>
> *Education in values.* Schools should promote the use of free software for the same reason they promote recycling: because it benefits us all.
>
> *Free software encourages students to learn how computers and software itself work.* Future programmers start programming in their adolescence. By allowing access to the source code, free software helps enormously with their learning.
>
> *The mission of schools is to teach people to be cooperative, supportive, and critical citizens.* These are the foundations of society. In computing, cooperation means, among other things, sharing, being able to make copies for all of their classmates or taking home the software used in class. And with proprietary software all of this is unlawful.

Finally, teaching students to use free software and participate in the community of software users/developers is a practical lesson in civics. It teaches students that the ideal is the model of public service and solidarity, not the profit-at-any-cost model of some corporations. All levels can and should use free software.

Among the tools we find for carrying out musical activities in education, we will pay particular attention to sequencers. Sequencers, whether audio or MIDI, offer broad possibilities for manipulating and creating music that are available to everyone, especially music teachers. These tools make it possible to generate musical ideas and turn them into sound with great versatility. Writing a musical

idea, motif or phrase, whether invented or transcribed from a piece by a composer, and instantly being able to listen to it with different timbres, tempos, and intensities is something that is only possible with the use of technology. This is an example of meaningful learning from individual or collective experimentation.

MIDI sequencers allow us to play anything from a simple melody to a symphony with all of its instruments, to write a song to sing in class, to be able to change its tonality with a few mouse clicks to adjust it to the tessitura of the class as a group, to prepare an accompaniment that acts as a harmonic support to singing, as well as an endless list of possibilities that we can discover with creativity and experience, all of this with limited resources.

Technology has also reduced costs to the extent that we can now have audio sequencers to record our musical activities inside and outside class and carry out postproduction work on the recording that was previously solely in the hands of the recording studios. YouTube is a clear example of how many musicians and artists have publicised their work through their home recordings with this type of tool, achieving professional recognition as artists and on many occasions finding a career opportunity in the world of music.

Sequencers are tools that make it possible to organise sound information, either MIDI or audio, on independent tracks, thus allowing manipulation of the information from each of them independently until the desired result is attained, finally achieving a master audio track in stereo like any CD recording.

Having defined the limits of this analysis, we will now divide the tools we will consider into two categories: on-line resources and off-line resources.

2.1. Off-line music resources

This section considers music software resources that must be installed on the computer to be used. From the free code applications, we can find on the internet, the most important and stable are: Audacity[2], Ardour[3], Denemo[4], Musescore[5], Hydrogen[6], LMMS[7] (Linux Multi Media Studio), GNU Solfege[8], and Phonascus[9].

The Audacity and Ardour sequencers make it possible to create and manipulate audio files. These applications make it possible to record live musical activities for subsequent mixing in postproduction while also allowing the mixing and manipulation of ready-created audio files in WAV or MP3 formats.

The opportunity to manipulate the audio of a previously-created song or to sequence a new one by tracks with these tools makes it possible to record a song where each instrument is recorded individually with its panning in the stereo signal, create songs and structures based on loops, manipulate the frequencies of the sounds of the instruments (as long as they are sequenced on individual tracks), alter the tempo and the dynamics, or equalise each track to obtain the best result in the final mix.

FIGURE 1. Example of the Audacity desktop.

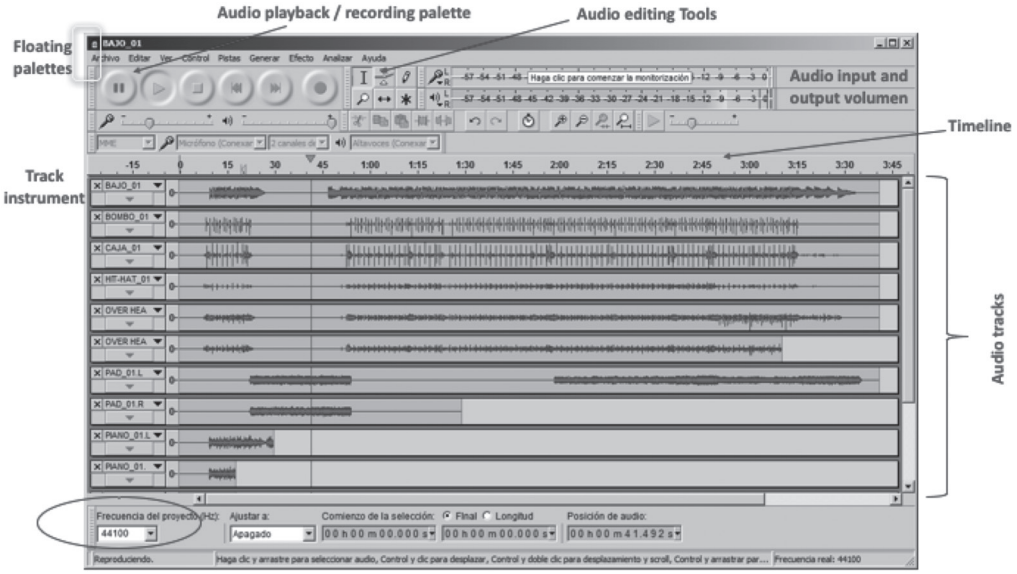


Figure 1 shows a generic example of the Audacity desktop: each instrument has a track for manipulating it, in some cases even recordings of the same instrument differentiated by its position in the stereo signal, right (R) or left (L); various graphics palettes are available for working with the recorded audio information; and there are floating palettes that can be placed anywhere on the desktop as the user prefers. Similarly, we can see the total duration of the audio for our recording on the timeline. We can zoom in on this gradually to see on-screen in more detail the part of the audio on which we want to work. At the bottom, we can see the quality of the audio with which we are working, 44,100 Hz. This is the sampling frequency established for the recording quality of a commercial CD.

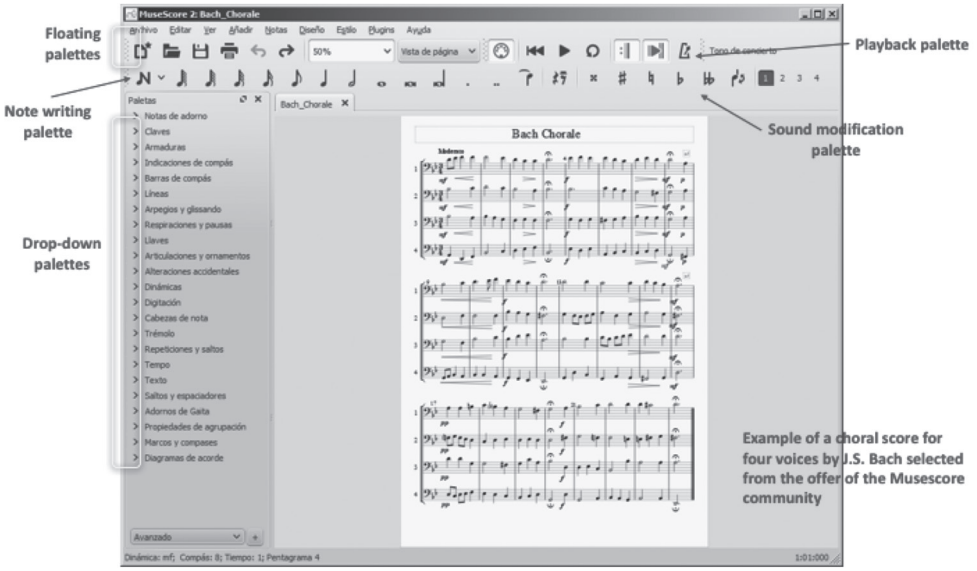
Audacity and Ardour are two applications which, despite being free software, have professional features for creating, editing, and publishing quality audio, albeit with some limitations compared to professional software. The most significant ones, at present, are that they cannot record more than one track at the same time and that effects to the recordings cannot be applied in real time and simultaneously to all of the tracks.

Denemo and Musescore are two MIDI sequencers with a blank sheet of staff paper as a desktop. These two applications amply cover the requirements for publishing and editing printed music. Within the professional sphere there are numerous applications for creating and then printing scores such as Final, Sibelius, Logic, and Cubase, but these have a

significant licensing cost. With these free applications, we can not only create quality scores but also ensure that the computer can perform them with the criteria we choose at each moment, as well as having the option of performing the same score with different instrumental groupings, according to the needs of the classroom experiences.

Musescore is very intuitive — much more so than Denemo — and gives excellent results in very little time, as with a little dedication the great potential in comparison to the paid programs of the same name of this application for preparing scores of any type can be uncovered.

FIGURE 2. Musescore desktop.



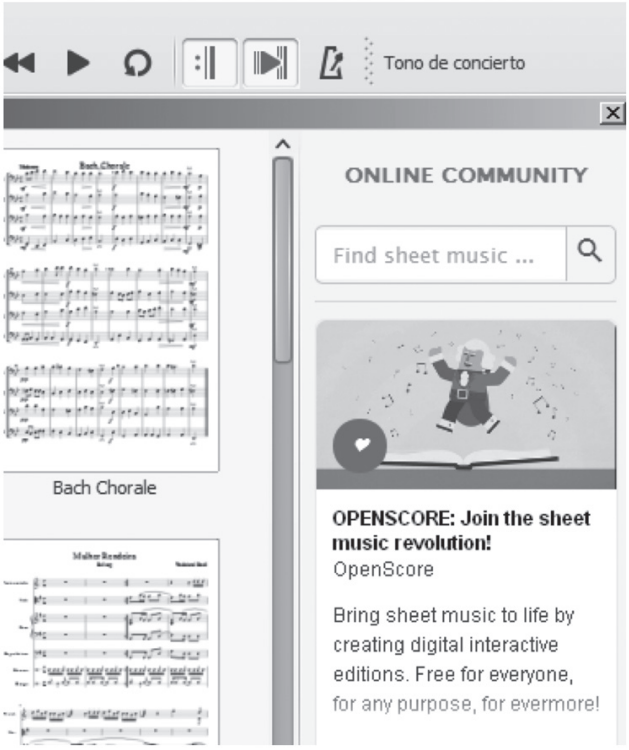
The example in Figure 2 clearly shows how almost all of the options necessary for making a score are visible and available in different palettes with just a few clicks.

Musescore also has a social network where users can share their work. Finding that someone has already written the score that you need for your class can save time in planning.

Musescore has recently launched an initiative called OpenScore with the aim of digitising the greatest possible number of musical copyright free works through Musescore.

Another feature this tool is developing is the possibility of playing PDF files and turning them into scores. This feature still needs more development, but it offers good results when the performance uses PDF files prepared by a sequencer.

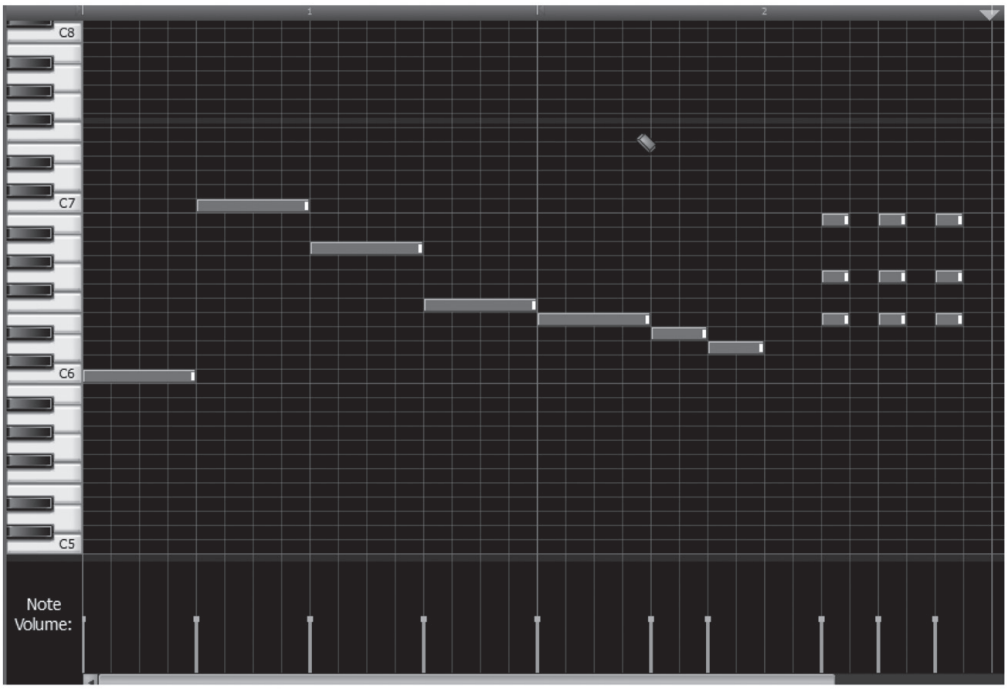
FIGURE 3. Musescore online community.



Musescore's features are very good compared with those of the proprietary version. If we had to criticise something, it would be the possibility of communicating with other sound sources and doing so simultaneously with all them. At present, linking the application to other peripherals, essentially sound modules, has been done using the JACK[10] supplementary sound connection tool. This involves installing and configuring another program, something that is not always easy.

Hydrogen and LMMS are two applications that enable sequencing in MIDI language. By using them, we can experience the creation of sequences under different graphic parameters than the ones discussed above. In this case, instead of writing notes and rests on a staff, the music is created and organised by marking the sounds graphically on a pattern editor according to the rhythm and pitch we want to create. The duration of the sounds is defined by the horizontal extension of the image and its tuning by its location on the vertical axis. This was how, until the option of writing on a score appeared, music was written on sequencers, allowing many people to access musical practice and composition with limited musical-theoretical knowledge.

FIGURE 4. LMMS 1.1.3 music writing window.



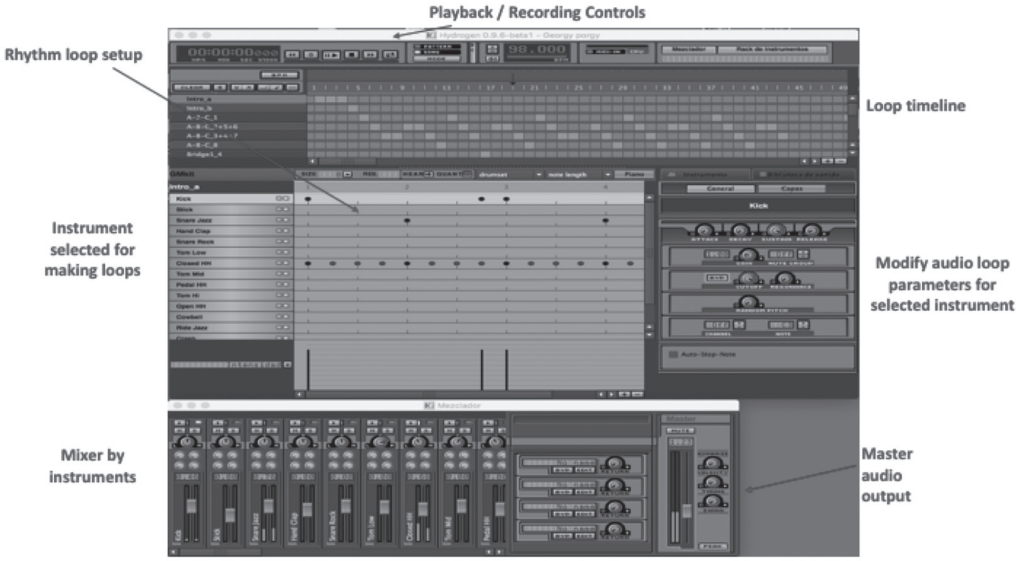
Hydrogen is essentially an application for creating and composing percussion rhythms by combining the different sounds of a drum set or other percussion instruments such as claves to accompany our creation, for example, a rap. LMMS offers many more options: as well as the possibility of creating combinations of rhythms and including sounds from tuned instruments, it makes it possible to delve into the area of the qualities of the sound, allowing us to modify the wave patterns of the original sounds, and reworking new sounds and timbres based on the original sound chosen. This is undoubtedly an application that can help us to develop the imagination and creativity of our students, but its use has a steeper learning curve than Hydrogen and so it requires prior experience with this type of tools. This is something to consider when using it with the students.

In Figure 5 the Hydrogen desktop shows a timeline at the top where we can set and order the different rhythm loops so that they sound at the desired moment in the sequence. Above the timeline are the resources for playing the created piece, and below the timeline there is a space for the rhythmic design of each loop.

As this image shows, the different beats or percussion instruments available for preparing the accompaniment

are shown on the left. In the centre, the beats in a loop are shown where the user can graphically place the intervention by each instrument, forming different polyrhythms on the timeline to represent the pulses that make up each loop. On the right, it shows the possibility of adjusting different audio parameters of the sound sample for the instrument used.

FIGURE 5. Hydrogen desktop.

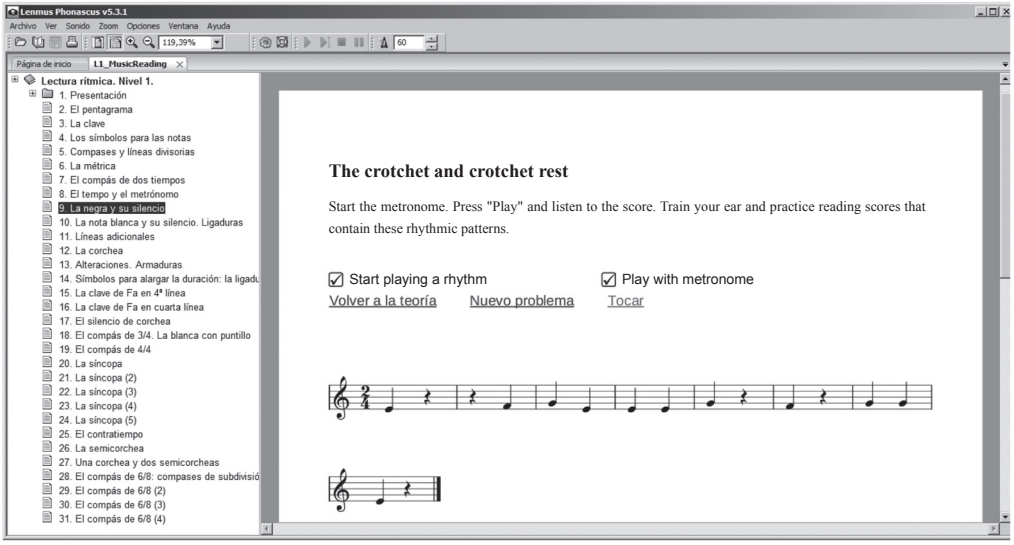


In another floating window, there is a virtual mixing desk for controlling the final mix of the rhythm created.

Finally, programs for training and learning musical language include GNU Solfege and Lenmus Phonascus. These two applications allow students to work independently and progressively on theory, rhythm, and musical ear, and depending on the exercises they receive immediate correction of the musical training proposals provided.

Lenmus Phonascus has a section for general exercises, two levels for rhythm reading, and a section dedicated to theory and harmony. As shown in Figure 6, the application displays the lessons for each instruction section and within each section it offers different training exercises. This may seem like a very basic application for musical training and education, but looking around it and using it is a pleasant surprise thanks to its potential application as a teaching resource with students of all levels and its possibilities for autonomous learning.

FIGURE 6. Lenmus lessons window.



2.2. Online music resources

As the previous section has shown, there are enough tools to be able to approach students' learning and our learning as teachers using ICT music resources in class. However, the internet's rapid movement towards the so-called Web 2.0[11] has made it possible to access similar tools in the «cloud»[12]. Obviously in this case, the vital requirement is to be able to have a stable and permanent internet connection.

Among the online resources with a philosophy akin to free software there are applications that allow the use of resources similar to installed software. In this case they are applications that first appeared as free-use developments whose evolution and improvements mean that the developers offer various subscription levels, while keeping an open and free offer of a large part of the application. These resources include: Noteflight[13], Soundation[14], Audiotools[15], Incredibox[16], and Music Theory Web[17].

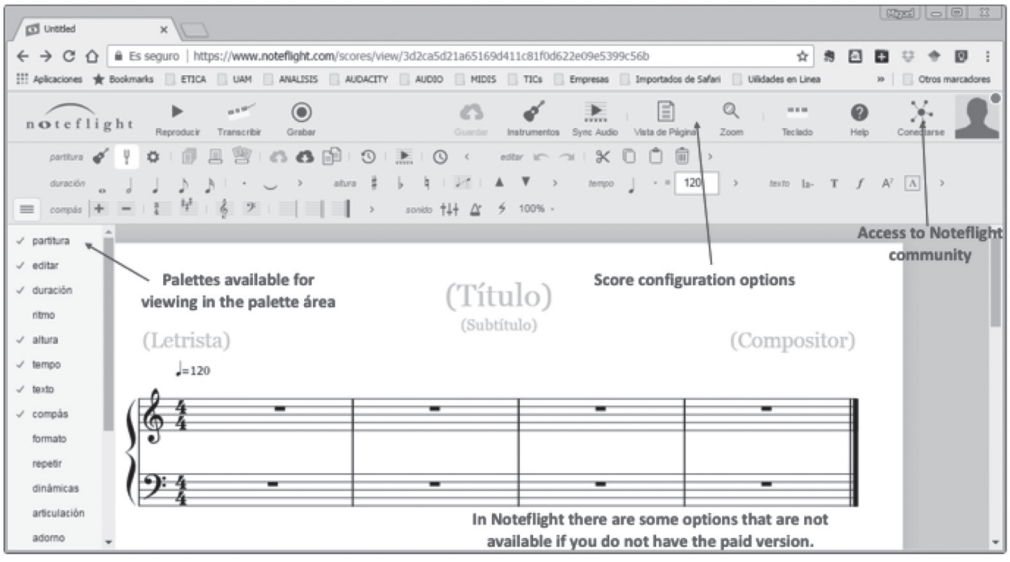
Noteflight is the free version of the Crescendo online sequencer. Although its features are limited compared with the paid version, it is a score editor that extensively covers the basic requirements for editing with various instruments and percussion.

As is normal in music editing programs, its control through contextual graphic palettes, as shown in Figure 7, makes it very easy and intuitive to use from the first moment. Despite being a reduced version, it allows MIDI and XML format files to be imported. This enables users to access the musical score that is saved in this format quickly.

Like Musescore, it has a community of users who share their works online and where we can upload and share our own works. Furthermore, they generate html codes to be able to show the scores on educational websites or blogs.

Noteflight is free and obviously has certain limitations that can only be overcome by subscribing to the paid version. These include the number of scores that can be generated and saved online.

FIGURE 7. Noteflight desktop.



Soundation and Audiotools are online audio sequencers. Soundation has a limited free-use option in which all of the sounds from the free library, virtual instruments, and audio effects can be used for composing, saving, and publishing; the only restriction is that if audio is recorded directly using the application or is imported, the completed project cannot be saved without the paid version.

Soundation is an application that allows the creation of songs through musical sequences using loops[18] in MIDI or pre-recorded audio formats. In the free version, melodies can be created with virtual instruments and effects added to them. Having completed the composition, it can be saved in the application format and exported in audio format (WAV) to be shared or used in other audio applications.

FIGURE 8. Soundation desktop.

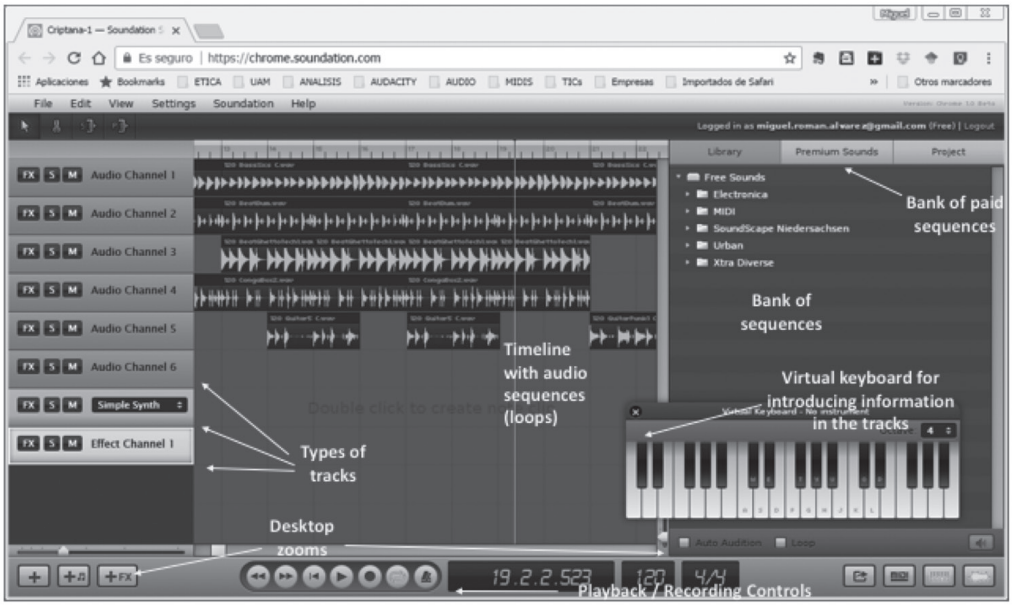


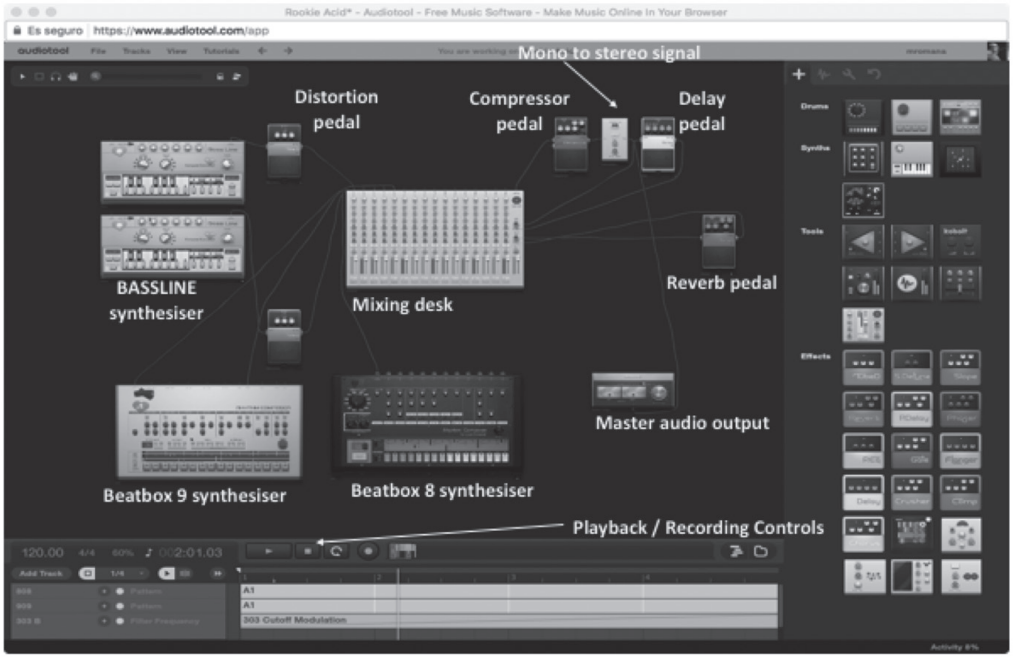
Figure 8 shows how by placing the resources that the program provides in its sound bank onto the different tracks we can create a song using loops, add effects, and even add sequences created directly through external or virtual MIDI instruments.

Audiotools, for its part, is a very powerful tool which is slightly more complex to use depending on the user's level of experience in the use of digital and virtual instruments.

This application features a flexible desktop where users can place and connect a series of modules: instruments for generating sounds and manipulating their timbre, mixer modules for channelling the sound and mix of all of the instruments, and modules for sound equalisation and generating effects.

The playback and recording tracks are located at the bottom of the desktop. The modules and connections controlling and channelling the tracks played by the different modules are positioned in the middle, and on the right of the desktop there are various types of module that can be used in the mix to create new instruments. As shown in Figure 9, there are modules dedicated to percussion sounds, synthesiser modules for creating different timbres, and a large quantity of effects modules.

FIGURE 9. Audiotools desktop.



The image shows a small virtual digital sound studio with which we can experience the manipulation and creation of all sorts of timbres and sound levels, but it is necessary to know about or find out about audio concepts in general and digital audio in particular to use it.

Incredibox is an online tool that makes it possible to creatively make multiple accompaniments emulating the method of beatboxes by combining the sound loops available to it. It has a very interactive interface where several effects can be combined simultaneously with the group of virtual musicians in the accompaniment. The result can be exported to an audio file for use outside Incredibox.

Using this tool, students can develop their creativity and create a melodic-rhythmic mix with the audio fragments that the tool provides in its different styles, with a minimum of 10 loops per sequence and an approximate maximum duration of around three minutes. Users can also choose to export the audio loops for each musician separately and combine them with more elaborate postproduction work in an audio sequencer such as Audacity.

Finally, in the field of musical training, «Teoría.com» is a website for learning and practising musical language online. This website allows continuous assessment of the work done by the student throughout the year, but for this function the centre must subscribe to the website. However, the exercises that the webpage offers can be used for free, making it possible to

practice individually; furthermore, the application corrects the exercises in real time, although it does not save the student's development over time. This is undoubtedly a good option for learning and practising the basic concepts of musical language.

To summarise this section, we can set out the need to train teachers in the use of free musical tools as part of their basic initial training. This will encourage collaborative work between teachers, between students, and between teachers and students, given that they will all be able to use the same tools without restrictions and with a minimal economic cost while respecting the lawfulness of the intellectual property and copyright, so often called into question by software piracy.

3. Reflection and proposal

Having identified the proposals for the inclusion of ICT in music education from the perspective of free software, the university sector and relevant authorities must implement basic, quality, and specific technology training for music education in compulsory education. This training will be for all future teachers in the fields of early childhood education, primary education, and compulsory secondary education.

As is noted in Román's thesis (2014), the first step would undoubtedly be to develop the necessary skills in all teachers regarding the expert knowledge and handling of, as a minimum, one audio sequencer and one MIDI sequencer. This basic training proposal would initially take shape using two free applications: Audacity and Musescore.

Expert handling of both applications would, consequently, provide knowledge of musical processes applicable to other similar software without the need to study it specifically, as well as a broad range of possibilities for creative use in everyday teaching mediated through ICT.

Paying greater attention to the training possibilities of free software and supporting this movement by using it will be of great help for the field of music education.

Notes

1 Atari was a pioneering company in arcade games, home videogames, consoles, and personal microcomputers. Its dominance in these areas maintained Atari as the major force in the computer and entertainment industry from the start to the middle of the 1980s.

2 Audacity: *http://www.audacityteam.org/*

3 Ardour: *https://ardour.org/*

4 Denemo: *http://www.denemo.org/*

5 Musescore: *https://musescore.org/es*

6 Hydrogen: *http://hydrogen-music.org/hcms/*

7 LMMS: *https://lmms.io/*

8 GNU Solfege: *https://www.gnu.org/software/solfege/solfege.html*

9 Phonascus: *http://www.lenmus.org/es/phonascus/intro*

10 Jack: *http://jackaudio.org/*

11 As observed by O'Reilly, a supporter and advocate of the free software movement, Web 2.0 is the internet as a platform including all connected devices, and Web 2.0 applications are ones that provide most of the intrinsic advantages of this platform: supplying software as a continuously updated service that improves as more people use it, consuming and mixing data from multiple sources, including individual users, at the same time as its own data and services in a way that permits remixing by others, creating network effects through an architecture of participation, and goes beyond the page metaphor of Web 1.0.

[12] This term refers to the storage of data and programs that no longer need to be installed or stored on the computer to be able to access them.

[13] Noteflight: *https://www.noteflight.com/login*

[14] Soundation: *https://soundation.com/accounts*

[15] Audiotool: *https://www.audiotool.com/*

[16] Incredibox: *http://www.incredibox.com/*

[17] Music Theory Web: *http://teoria.com/es/*

[18] Loops are audio fragments of one or several beats that can be linked and mixed successively to form longer musical sequences or songs.

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Table of Contents

Sumario

Music education
Educación musical

Guest editor: Ángela Morales
Editora invitada: Ángela Morales

Studies
Estudios

2. Book reviews

Table of contents of year LXXV

This is the English version of the research articles and book reviews published originally in the Spanish printed version of issue 268 of the **revista española de pedagogía.** The full Spanish version of this issue can also be found on the journal's website http://revistadepedagogia.org.

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