Music Education In The Digital Age: Challenges Associated With Sound Homogenization In Music Aimed At Adolescents

Abstract

Adolescent music preferences revolve around so-called popular music, specifically that which is highly manipulated by audio and music production technologies and aimed at the mass market. These processes can result in music genres that lean towards sound homogenization, a phenomenon that could gradually restrict adolescents' access to the acoustic richness of other music styles that have emerged throughout history. The objective of this work was to analyse the music genres favoured by a sample of Spanish adolescents (n=464), based on their acoustic qualities (timbre, rhythm and dynamics). The results of the automatic analysis indicated a great deal of overlap in terms of sound, which corroborated the homogeneous character of the genres. This calls for an approach to secondary music education that helps preserve musical richness and stylistic variety in the classroom.

Keywords: music, adolescence, music education, acoustic, musical preferences

Music Education In The Digital Age: Challenges Associated With Sound Homogenization In Music Aimed At Adolescents

The digital era confronts us with many challenges derived from the technological drift that is currently expanding in our lives. Education and more specifically, musical education does not escape to this trend that we must know in depth in order to understand its value. However we also must dare to mark its limits to preserve the value of the cultural and artistic diversity that nursed us until today. As we will see throughout the present work, musical education is facing a difficult challenge due to the homogenisation produced by technology.

Authors such as Hargreaves and North (1997), May (1985), Mills (2000), Tanner et al. (2008) and AUTHOR (2020a) have established that the genres favoured by adolescents can be categorized as popular music. Specifically tracks made up of recordings and aimed at the mass market. These characteristics will be explored in greater detail at a later stage.

With this in mind, the educational policies of Spain and other countries have exhibited a fairly widespread trend towards the inclusion of popular music in the curricula of compulsory secondary education (henceforth, CSE) (Isbell, 2007; Väkevä, 2006; Wang & Humphreys, 2009). This trend is underpinned by factors that go beyond a desire to bring content into line with adolescents' music consumption habits (Powell et al., 2019). Teaching such music genres has many benefits in terms of motivating today's young people to learn (Flores, 2007; Springer, 2016). However, other studies have warned of the potential problems associated with addressing these genres through a non-rigorous approach that fails to take audio and technological aspects into account (Abramo, 2011; Georgii-Hemming & Westvall, 2010; Green, 2006; Koizumi, 2002; Mantie, 2013; Woody, 2007). Having in-depth knowledge of the characteristics of popular music is therefore key to offering a meaningful learning experience, and thus constructing quality education. It is important to be in a position to answer the following questions: What are the traits of these music genres? What artistic value do they hold for tomorrow's society? How can their musical and acoustic characteristics be exploited in CSE classes?

To answer some of these questions, it is first necessary to characterize the styles that adolescents listen to most. This is no straightforward task. Especially, given the speed at which popular music genres and the fashions and trends of the music industry are changing (Mauch et al., 2015), and the fact that, despite the growing trend towards globalization, such genres differ from one sociocultural context to the next (Achterberg et al., 2011).

In light of these observations, the music styles favoured by adolescents belong to a specific category of popular music, which is defined by the following common characteristics: they are designed for mass distribution, they are easy to consume –both economically and cognitively, due to the cultural knowledge they require– and they have been created through *mass technologies*; that is, artistic production systems that involve studio recording, duplication and mass distribution (Pouivet, 2010). The resulting "phonographic works", which are unique and made up of recordings, therefore differ from other music styles based on musical performance and writing, since they are the result of creative processes that are specific to music recording[1] (Burgess, 2013). They are not limited to capturing a live musical performance as faithfully as possible, but rather construct an individual sound ideal that is reliant on recording techniques and processes (Eisenberg, 2005).

Even though these observations are already known, it is important to highlight them. Because they advocate that the analysis and study of the music of preference within the teenagers should not be limited by its compositional and interpretive dimensions; rather, the technological dimension is crucial to understanding and addressing them effectively in CSE curricula.

Sound manipulation processes can be determining factors in an individual's music experience, since our music consumption habits have been shaped by the recording industry for decades (AUTHOR, 2020b), through the figure of the music *producer*. This agent, who plays the role of intermediary between musician and audience, adapts musical ideas to consumer habits (Hennion, 1989). To achieve this,

[1] Despite the fact that production processes are used in the majority of today's music recordings, including genres such as jazz, rock and classical, the settings and application procedures are specific and different for each style and genre. This research has focused exclusively on the models applied to the music styles most listened to by adolescents.

producers make use of the technological resources of recording studios, thereby transforming the way music is made and listened to (Milner, 2010).

For example, the use of techniques such as compression, which reduce the dynamic range of performances to generate a heightened sense of sound pressure in listeners (Deruty & Tardieu, 2014). This practice has been applied to a variety of music styles and genres, especially during the so-called "loudness war"[2], in the radio and recording industries. Over time listeners have become used to a hypercompressed sound, which is essential these days and perfectly suited to playing music in noisy environments (Devine, 2013) and on mobile devices (Ronan et al., 2014). Due to the change in adolescents' music consumption habits, hypercompression has become a standard with its own characteristics. Another example is provided by DAWs –Digital Audio Workstation–, which created new aesthetic trends, associated with the home studio sound (Harper, 2014) and promoted the use of "humanization" tools such as the shuffle, which generates rhythmic irregularities to make mechanical, electronic or digital performances sound more "human". Conversely, there are rhythmic correction tools, such as Beat Detective, and melodic correction tools, such as Auto-Tune, which are widely used in music aimed at adolescents (Danielsen, 2017).

In recent decades, these and other sound manipulation techniques have been used to generate musical aesthetics defined by mainstream sounds and controlled by major record labels (Théberge, 2001; Juan de Dios & Roquer, 2020). In short, the "age of representation", in which the musical experience focused on live performances, has been abandoned and given way to the "age of repetition", in which music is defined by recordings (Attali, 1985). These days, what leads adolescents to identify and favour certain music genres also lies in the standardized audio manipulation techniques[3] typical of record production (AUTHOR, 2020b). The repeated use of particular protocols of sound manipulation has habituated the youth to new sounds that they have gradually internalised as quality standards. Knowing how the adolescents musical preferences are

[2] Radio studios and the recording industry developed compression techniques that generated a general sense of acoustic power, without exceeding the decibel limit that applied to stations and recorded music formats. This apparent sensation of intensity acted as a magnet for the stations that applied it and the recordings that incorporated it, and was used to increase audience numbers and stand out from the competition.

[3] It is important to note that music production techniques are constantly changing. Thus, "standardized audio manipulation techniques" are not an entrenched concept, but rather trends that endure in a standardized fashion for a certain period of time, but that end up transforming over time.

constructed is therefore considered essential in order to provide them with meaningful learning within the framework of formal education. Especially when we take into account that all of this has resulted in a certain amount of music homogenization, since the recording industry has set the standards for how mainstream music should sound (Peterson & Berger, 1996). It is true that the golden age of the major labels, which used to have total influence over the "sound" of music, has diminished for many music genres and styles in the last 20 years; independent releases via music streaming platforms such as Spotify and SoundCloud and the explosion of social media platforms such as TikTok often lie beyond the historical influence of the major labels. But most of the music favoured by adolescents continues to be produced and distributed by mainstream record companies, which is why this research examines the relevance of their influence on the musical behaviour of adolescents.

Thus, this work aims to shed light on the potential consequences of the sound homogenization process in the genres most listened to by adolescents. The influence that record labels exert over the sounds trending in the media shape young people's music interests and habits, so we run the risk of losing sight of the sound diversity presented by other music styles. To that end, this phenomenon should be taken into account when planning music curricula. The role of the teacher is crucial when it comes to addressing such genres in the curriculum and the need to combine them with a broader, more varied repertoire. The music trends observed in Spain are not unique; the possibilities and limitations of music education in this country can be extrapolated to international music education research.

Objectives

The aim of this work was to analyse the acoustic characteristics of music preferences among Spanish adolescents, to identify the homogeneous characteristics created through music production techniques and to develop an educational approach designed to preserve the richness and stylistic variety of music.

To achieve this, several specific objectives were set:

- To identify the music preferences of the adolescents in our sample;
- To identify the audio characteristics shared by these genres, in terms of acoustic qualities (timbre, rhythm and dynamics);

- To develop, based on the results, an approach to CSE music education designed to guarantee more diversity in terms of sounds and styles.

Methodology

This study used a non-experimental exploratory ex post facto design.

Sample

The participants who made up the sample for this research were adolescents attending secondary schools in Barcelona metropolitan area (Spain). Given that it was an exploratory study, a decision was made to carry out intentional rather than probability sampling (Morse, 1994), in order to obtain a representative sample of the population under study and thus correct possible population variability biases (Ávila Baray, 2006). To ensure that the sample was representative of today's Catalan metropolitan society, the sample was selected from a number of different secondary schools and with different socio-economic and cultural characteristics (Corbetta, 2003).

Thus, the sample consisted of 464 adolescents (249 girls and 215 boys), with a mean age of 13.27 years (SD = 1.342). The participants came from six secondary schools in Barcelona metropolitan area. The sample was divided as follows:

- 119 students (25.6%) from two schools with a high socioeconomic status and a highly homogeneous sociocultural profile;
- 214 students (46.1%) from two schools with a medium socioeconomic status and a more heterogeneous sociocultural profile;
- 131 students (28.3%) from two schools with a low socioeconomic status and broad sociocultural diversity.

All those surveyed participated on a voluntary basis and signed an informed consent form. All their data were processed using identification codes to preserve the anonymity and confidentiality of the results, in accordance with the conditions of the Belmont Report and the Code of Good Research Practices (2010).

Tool: Automatic Analysis and Calculation of Descriptors

Automatic analysis, based on tools such as Sonic Annotator, Python and R, consists of the systematic extraction of acoustic parameters calculated based on the audio of each piece of music, which makes it possible to identify shared audio characteristics (Kassler, 1966; Lincoln, 1967). In this work, the analysis focused on the audio characteristics that affect timbre-related, rhythmic, metric and dynamic aspects.

To optimize the automatic analysis, the files that made up the sample's audio collection were trimmed. To achieve this, 30-second clips, located around the second third of each song (where, as a general rule, the climax lies in mass-market music) were analysed. Audio clips lasting 10, 30 or 60 seconds, extracted from the middle part of a song, are sufficient to characterize the type of music in question (AUTHOR, 2009). This method made it possible to reduce the size of the data set and the computational cost without reducing variability and representativeness. Finally, we compiled a total of 645 audio clips from the participants' favourite songs, determined from six open questions in which they were asked their three favourite songs and their respective authors. To guaranty the representativeness of the results, we have worked with audio files in compressed AAC format (256 kbps), which is one of the most used by online music platforms such as Apple Music or Spotify. For that, the sound engineers responsible for the recordings carried out specific mastering processes.

The songs were divided into four categories according to the number of times they were cited by the participants: songs with only 1 vote, songs with 2 to 5 votes, songs with 6 to 10 votes, and songs with more than 10 votes. This system helped ensure that the number of songs in each category was balanced and consistent.

Next, an analysis was carried out based on the automatic calculation of audio descriptors currently used in the field of music information retrieval. The aim of this analysis was to visualize musical aspects related to timbre, intensity and rhythm. Specifically, for each of the musical aspects mentioned, the following descriptors were used, respectively (Fingerhur & Donin, 2006):

- Spectral centroid (SC): A measure related to the brightness of a sound based on its harmonics (Scheirer, 1998). The higher the spectral centroid, the brighter the sound of the song and, by contrast, the lower it is, the less bright it will be.
- Inter-onset interval (IOI): A measure related to the interval between the beats of the audio clip analysed (Allen & Dannenberg, 1990). IOI is used to analyse the time that elapses between each onset (the beginning of a note in an audio signal).
- Loudness (L): A measure related to sound intensity and its perception by the ear to determine the dynamic complexity of the audio clip analysed (Stevens, 1962; Pampalk, 2001). It is used to calculate the extent to which intensity fluctuates

throughout a song and its dynamic range, thereby indicating the use of dynamics processors such as compressors, limiters and expanders.

Once the descriptors had been calculated segmentally for each audio clip, the means and standard deviations of each were obtained. This made it possible to create a compact, representative overview of each song and carry out a subsequent statistical analysis. Figure 1 shows a diagram for calculating descriptors.

(figure 1) by here

Results and Discussion

Regarding musical preferences, the data obtained show that the genres preferred by the participants were: pop (M = 3.46; SD = 1.311), reggaeton (M = 3.44; SD = 1.618), hip hop or rap (M = 3.31; SD = 1.432), trap (M = 2.86; SD = 1.618) and electronic music (M = 2.85; SD = 1.455).

With respect to the automatic analysis of the audio files that represented the respondents' favourite songs, the resulting data for each of the three descriptors are presented below.

Spectral Centroid

This descriptor refers to the "brightness" or timbre of an audio clip, determined as the center of mass of the spectrum or the balancing point between high and low frequencies. It should not be confused with the pitch of a sound. The spectral centroid is used to quantify information related to the instruments and equalization used in the mixing and mastering process carried out during the production of these songs.

Figure 2 shows the arithmetic means of the spectral centroid of each sequence, calculated frame by frame, and grouped according to the four categories. It shows how both the medians (Q_2) (represented by the thick line in each box) and the data between the 25th (Q_1) and 75th (Q_3) percentiles (lower and upper extremes of each box), remained in the same area, approximately between 2200 and 3200 Hz. These values indicate a medium frequency spectrum, which was prominent in all categories.

It also shows how the minimum and maximum values recorded (lower and upper limits of the dashed lines) form a funnel shape that changes from a wider opening (the songs with the least votes) to a narrower opening (songs with the most votes). This gradual decrease between the maximum and minimum percentiles was due primarily to the lower number of audio clips in each of the categories, since the fewer the songs, the lower the variability. However, the mean values and the interquartile range (IQR) of the four groups were similar. This led us to confirm that the groups were similar in terms of timbre and that the funnel shape described above therefore resulted from the lower timbral variability of the most popular songs. Finally, the data expressed with small circles were considered atypical values (outliers), and were not taken into account when interpreting the figure.

(figure 2) by here

These results indicate that the songs favoured by the adolescents in our sample were subjected to very similar audio processing in terms of the equipment used, equalization of the mix and mastering, with a tendency towards lower variability in the most popular songs, and a balancing point between high and low frequencies of around 2700 Hz. This homogenization phenomenon is consistent with the opinions of music producers who warn of the danger of sound and style homogenization in the genres listened to most by adolescents. For example, in research based on interviews with five active music producers specializing in popular music and responsible for producing music for the major labels, they pointed out that the time adolescents spend listening to each song has decreased. Therefore, the style needs to be instantly recognizable and, consequently, the sound models applied to recordings need to be very rigid and explicit, which leaves little room for variety (AUTHOR, 2020b). In addition, it should be noted that, according to studies by Tomatis (1991), these frequencies lie in the same range as the “frequency territories” that favour the phonetic comprehension of many languages, including English and Spanish. Therefore, given that these are the two main languages used in the songs analysed, it is apparent that the sound processing techniques used to produce these songs help listeners understand the lyrics. Similarly, this frequency range matches the range highlighted by certain microphones designed for recording voices, such as the Shure SM58 Dynamic Vocal Microphone, which boosts at 2.4 kHz.

Likewise, the standard deviations remained in the same area, approximately between 800 Hz and 1300 Hz, with a slight increase in IQR in the category “6 to 7 votes”, which reached 1400 Hz. As with the mean, the minimum and maximum values recorded change progressively from a wider opening, in the songs with least votes, to a narrower opening, in the songs with most votes. These results strengthen those obtained in the analysis based on the arithmetic mean of the SC, where the songs favoured by the adolescents were subjected to very similar audio processing techniques during the production process, thereby homogenizing the soundscape that generally accompanies them.

Inter-Onset Interval (IOI)

The IOI is used to quantify information relating to the rhythm of a song, thus making it possible to predict its tempo (if the mean values are analysed) or the regularity with which the sounds are articulated (by making reference to the standard deviation). Thus, the possible rhythmic differences or similarities between the most popular songs can be determined, and this can be used to identify the use of quantization and/or programming in said music.

(figure 3) by here

Figure 3 shows the arithmetic means of the inter-onset interval, calculated frame by frame, and grouped according to the four categories. It shows how, in all categories, the medians and data between the 25th and 75th percentiles indicate a very similar mean time between onsets, of between 0.15 and 0.20 seconds. Likewise, the standard deviation indicate that both the medians and the data between the 25th and 75th percentiles lay between 0.05 and 0.1 seconds, extremely low values when considered in terms of a human musical performance. Therefore, it makes sense to assume that, for virtually all songs in the sample, the musical performances were rhythmically corrected (quantized), digitally programmed or cyclically sampled and reproduced during the production process. This rhythmic homogeneity facilitates playback, for example in dance sessions where several songs have to be linked together, a growing trend in popular music hits between 1955 and 2015 (Roessner, 2017).

However, the third group (songs that obtained between 6 and 10 votes) presented greater rhythm and variability, a finding at odds with the timbral analysis. Figure 3 shows how the arithmetic mean and standard deviation were higher in the third group of songs (which obtained between 6 and 10 votes), which was not the case with the timbral analysis. This phenomenon could be related to the fact that a certain amount of rhythmic freedom is allowed in mass-market music for adolescents. This variability can be explained by the presence of different musical genres (pop, hip hop, trap, etc.) and distinct sections with rhythmic changes within the same song (introductions, rapped parts, etc.).

Although some rhythmic diversity was observed, the values relating to rhythmic variations do not detract from the fact that these genres are highly mechanized since, in most cases, they are built on a programmed or quantized rhythmic base.

Loudness

Figure 4 shows how, in the audio collection, both the medians and the data between the 25th and 75th percentiles remained in the same area, around 10 dB, with a very narrow IQR and a medium intensity level that was very similar across all categories in the sample. Likewise, the minimum and maximum values recorded formed a funnel shape, from the songs with the least votes (highest number and variety of audio clips), towards the songs with the most votes, a phenomenon already described above.

(figure 4) by here

With respect to the standard deviation of loudness, Figure 4 shows how most lay approximately between 1 and 1.5 dB, extremely low values for the human ear, with a maximum IQR of 0.5 dB. Similarly, the fact that it narrowed towards the songs with most votes indicates a preference for less variety and greater dynamic homogeneity. Thus, the songs we analysed were subjected to very similar dynamic processing techniques during the production process, which could be interpreted as a marked use of compression in mass-market music for adolescents. In this case, compression of a song's dynamic range could prevent sections with lower sound pressure levels being masked by the listening environment (Stobbart, 2017). This repeated use of hyper-compression is characteristic of popular music production (Taylor & Martens, 2014).

This dynamic homogenization, for Vickers (2010), may be a consequence of the listening habits of adolescents, given that they often listen in noisy environments where levels need to be standardized to avoid having to constantly adjust mobile devices (when running or travelling on public transport, for example). It is also important to note the wide range of platforms used by adolescents to listen to music, such as Spotify and Apple Music, which are usually played on headphones that need this type of sound to optimize the listening experience. In fact, Widen et al. (2018) commented that this trend towards reducing the dynamic range of mass-market music has led to the dangerous habit among adolescents of listening to music that is constantly at the limit of the hearing pain threshold.

In summary, the results of the automatic analysis of the audio clips showed a widespread, rigid sound profile, despite the different genres represented. Therefore, it is clear that mass-market music genres intended for adolescents share certain standardized production techniques that are applied globally, regardless of the music style. The characteristics of this unifying sound model relate to the timbral homogeneity, rhythmic mechanization and dynamic range compression applied during mixing and mastering processes in music production. These sound models will exert a major influence over the sounds and aesthetics of new music genres designed for adolescents.

Conclusions

First and foremost, this work confirms the trend observed in other research, that the music favoured by adolescents continues to be popular music; specifically mass-market music made up of recordings and including genres such as pop, reggaeton, hip hop, trap and electronic music.

Moreover, the results led us to conclude that these music genres are all subjected to standardized audio processing techniques. The testimonies of music producers in the work of AUTHOR (2020b), confirmed the repeated use of sound manipulation patterns during the recording of these genres. Likewise, according to Théberge (2001), the growing incursion of technology in music creation has contributed to the homogenization of certain genres, in a market dominated by the mainstream recording industry, where the primary goal is mass sales (Peterson & Berger, 1996; Williamson & Cloonan, 2007; Burnett, 2008). All this accounts for the results of the automatic analysis, which indicated that all songs analysed shared three virtually identical characteristics:

- A timbral homogeneity resulting from the mixing and mastering process of songs and whose very aim is probably to avoid rejection by listeners who are not familiar with non-mainstream sounds. In other words, the more standardized the music, the greater its market reach.

- A process of rhythmic mechanization, which facilitates recording (Tanaka et al., 2005), multi-track editing and synchronization of rhythm processors or synthesizers (Danielsen, 2017).
- A process of dynamic range compression that favours the playback of songs in accordance with the music consumption habits of adolescents, such as listening to music in noisy environments and using mobile devices (Williams, Geringer & Brittin, 2019).

Technological advances have had a significant impact on music consumption (Perona et al., 2014), to such an extent that they now play a decisive role in music production and creation (Katz, 2010). This functional adaptation of certain music genres to the listening habits of the public is also supported by various studies (Jones, 2002). We can state that the musical experience has been transformed in parallel with advances in sound technologies; to that end, it is essential to overhaul music curricula in line with this technological and cultural trend and thus avoid creating a gap between the musical reality and formal education of today's young people. Thus, there is a need to review the methodology used to address the most popular music genres among adolescents in the CSE curriculum. Because the patterns of analysis, listening and interpretation applied to these genres normally do not differ from those applied to other music styles and are therefore not tailored to the specific characteristics of these styles, which are the result of the modern recording technologies and techniques applied (Wise et al., 2011). To that end, technology offers educators a way of expanding the music genres and practices addressed in their curricula (Hein, 2017). However, it should be noted, as stated by Savage (2010), that the use of digital technology is generally used to reinforce traditional content, and its potential is thus squandered; this is aggravated by the lack of resources in many educational centres (Crawford, 2009). In addition, a number of studies have reported that they do not reflect the social recognition that exists in relation to the use of technology in teaching and learning processes (Crawford & Southcott, 2017; Peppler, 2010; Liu & Liu, 2017).

In line with the views of Flores (2007) and Tobias (2012), music education needs to approach popular music in terms of the methods used by musicians themselves and the producers who create this type of music; this involves teaching music using recording technologies, an area often overlooked in secondary education (Tobias, 2013), in addition to the sound models that characterize these genres. Furthermore, according to Galera (2011), the almost unlimited options offered by recording technologies can help foster creative and cooperative attitudes, thereby encouraging students to develop basic skills (Baker & Green, 2013). Thus, music production techniques should be a basic prerequisite in a meaningful, valuable music curriculum.

As an example, a possible educational approach could consist of the inclusion of DAWs in CSE classrooms as basic tools for musical appreciation and creation (Green, 2002). Such software forms an integral part of the musical styles favoured by adolescents and is used to adapt songs to the latest music trends through the use of sound manipulation techniques, which make them more attractive (Fink et al., 2018). In addition, DAWs allow students without extensive musical knowledge or outstanding performance skills to create music with impressive results, not a million miles away from professionally produced music (Rudolph, 2004). AUTHOR (2019) demonstrated how the introduction of DAWs in CSE-level music classes improved the social climate and increased students' motivation, digital literacy and personal competence. Likewise, the fact that the musical examples explored in this research present a high level of homogeneity, in terms of frequency range, rhythmic mechanization and dynamic range, means that teaching students how to detect the musical production techniques responsible for the sound of the music genres they prefer and to understand how they function through the use of DAW software can help develop students' critical awareness with respect to the sound homogenization to which they are exposed.

Clearly, teaching adolescents music without exploring factors relating to the technology and techniques that determine the music genres they listen to most would give rise to a knowledge gap. It is important to note that technological advances in music recording and distribution have played a key role in the construction of new musical trends. These affect the musical awareness of adolescents, who access them through informal education, which plays a key role in influencing their musical preferences (North et al., 2000). Thus, the recording industry exerts a strong, direct and unfiltered influence over adolescents in terms of their music consumption and awareness, behaviours and attitudes (North & Hargreaves, 2007), individual and collective identities (Rentfrow & Gosling, 2003), and the image that they seek to project to others (North et al., 2000).

To tackle the vulnerability of adolescents due to the record industry's influence over their musical habits, a twofold approach is proposed: on the one hand, exploitation of the motivational value of familiar music styles (Gaver & Mandler, 1987; Huron, 2006) and, on the other hand, development of a critical eye in students that makes them aware of the homogenizing effect music production has on their musical preferences and identities, and how this can threaten their individual freedom. In short, they should be taught how to decipher these processes, which often go unnoticed.

Finally, the third suggestion for CSE involves diversification of the music styles taught in the classroom. Even though the popular music genres analysed account for virtually all adolescent musical preferences, sticking exclusively to these genres, in spite of their benefits for teaching, disregards other curricular aspects. Consequently, these lessons need to be complemented by traditional approaches to music education (McPhail, 2013). Musical diversity needs to be preserved to compensate for the phenomenon of homogenization, to increase awareness of the styles that coexist in different world cultures and, at a local level, to recover and preserve our own traditional musical heritage. The production processes analysed are currently present in virtually all musical recordings, although the settings and application procedures differ depending on the style and genre. Sound technologies have played a crucial role in defining the sound trends of each era (Théberge, 1997) and, over time, have given rise to creative new opportunities for musicians and producers (Homer, 2009). Thus, sound clichés have emerged and have defined the different music styles and genres (Aucouturier & Pachet, 2003) and the aesthetics with which they are associated (Melchiorre & Schedl, 2020). Therefore, formal education curricula should address all kinds of music, whether classical, traditional or popular, beyond the genres most favoured by adolescents, to ensure that students have the opportunity to explore the various sound models that make up the acoustic richness of different cultures and musical eras.

The above-mentioned producers warn of a shift in adolescents' music consumption habits as a result of their reduced attention span when listening to music, their lack of interest in anything beyond music trends and the dilution of their cultural identities through a globalized market characterized by intergenerational stratification (AUTHOR, 2020a).

Given this superficial, homogeneous way of listening to music, education should be strengthened; the repertoire already included in our educational traditions should be expanded through the addition of new music genres, but without replacing those that are already taught. Meaningful learning should be encouraged by aligning the subject of music with the realities of adolescents, but this should also serve to strengthen their critical ability with regard to the pressures of the record industry. It is important to help recover cultural diversity by working with diverse artistic music products; to promote closer ties with other music genres and other perspectives relating to the international musical scene. In this regard, applying ethnomusicology or comparative musicology to CSE curricula could encourage this much-needed broad-mindedness (Campbell, 2003). Once again, technology is a hugely valuable tool here; including digital resources for music delivery and peer-to-peer sharing in curricula will undoubtedly help broaden the musical spectrum in the classroom, since many of young people are creating and sharing music with a wide range of characteristics and cultural influences through their networks (Ruthmann & Hebert, 2012).

Similarly, underground music genres, in which recording technologies also play a major role, should not be ignored. Teaching young people about creative music recording could contribute to the musical diversification and cultural enrichment of the recording industry. Several authors have highlighted the fact that independent music production –music created outside of the major record labels– encompasses a multitude of musical offerings that are not confined to the canons of the mainstream industry, thereby contributing to the survival of local identities within the framework of a globalized business model. Thanks to the democratization of recording technologies, the increase in DIY productions and the home studio aesthetic, this is playing an increasingly important role in the market (Kruse, 2010; Eiriz & Pinto, 2017; Walzer, 2017).

As Warner put it, "musical creativity in pop music is inextricably bound to developments in audio technology and the working practices which ensue" (Warner, 2017, p. xi). Although this research has shed light on a trend towards sound homogenization in the music favoured by adolescents, the very tools used to produce such genres could be used to rewrite and expand the creative and sound spectrum of tomorrow's music. It remains in the hands of music teachers to foster an attitude that embraces cultural and artistic diversification in today's youth.

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Figure 1

Diagram showing the calculation of automatic analysis descriptors.
Source: prepared by the authors.

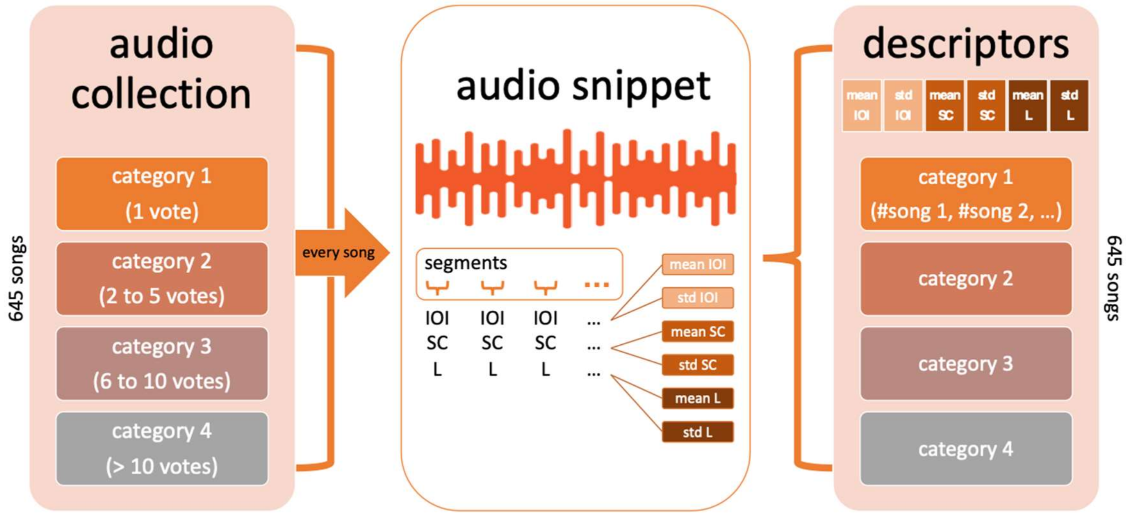

Figure 2

Graphic representation of the means and standard deviations, obtained with the spectral centroid descriptor

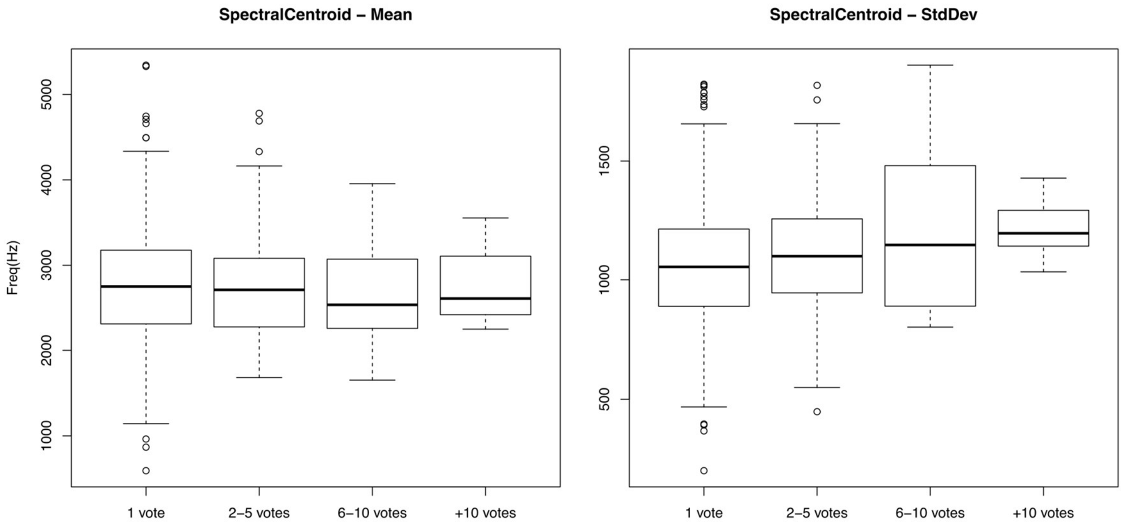

Figure 3

Graphic representation of the means and standard deviations, obtained with the IOI descriptor

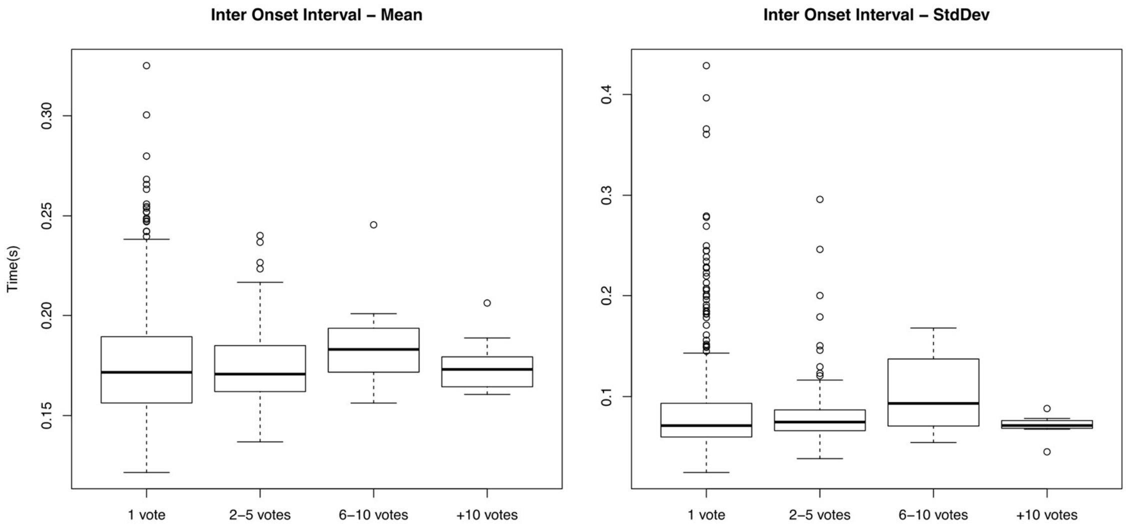

Figure 4

Graphic representation of the means and standard deviations, obtained with the loudness descriptor