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MIDI in Formal Music Education: Reflections on the Application of MIDI-Oriented Tools in Traditional Teaching and Learning Processes

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ABSTRACT

Since 1983, with the release of the MIDI protocol, new resources have been developed for musical editing, composition, arrangement and performance. Due to the growing expansion of computers' storage and processing capacities, it has also been possible to increase the quality and specificity of sample libraries. In this context, the following work reflects on possible educational impacts of the research which investigate different audiences' perceptions regarding audios recorded by drummers' performances and by MIDI tools. Supported by the respondents' perceptions, the general aim of this paper is to reflect on the challenges for the application of MIDI-oriented approaches in formal teaching and learning music processes. Excerpted from this, four specific aims can be drawn: 1) to present the basic elements of sampling and MIDI protocol; 2) to systematically and pedagogically describe the procedures employed in the process of sequencing the selected drummers' performances; 3) to apply quality-assessment questionnaires for the sequencing-generated audios; 4) to reflect on the connections between the questionnaires' results and the use of MIDI in formal music education contexts. Pursuing these aims, the current investigation employs qualitative and quantitative methods to gather the data, to analyze the materials and to develop the knowledge that will guide the proposed discussions. It is defended that the employment of MIDI resources in music education can be beneficial not only for the development of knowledge connected with digital and modern technologies but also for the improvement of traditionally pursued music competences.

Keywords: Electronic Musical Instrument, MIDI protocol, MIDI Sequencing, Music Perception, Music Technology

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1 Introduction

Since the release of the MIDI protocol (Musical Instrument Digital Interface)[1] at the beginning of the 1980s, new possibilities were developed for musical performance, editing, composition and arrangement (Airy & Parr, 2001; Chattah, 2014; MMA, 2009; Pejrolo & Derosa, 2017). The development of these resources linked with high-quality recording of musical instruments

[1] MIDI is a digital protocol that allows communication between electronic musical instruments, computers, interfaces, etc. Each MIDI link can have up to sixteen communication channels that can be assigned to different equipment. According to Pejrolo (2011, p. 6) "MIDI messages do not contain any audio information. MIDI and audio signals are always kept separately."

has significantly changed the music production scenario. Due to the growing extension of Hard Drives' (HD) storage space and computers' processing power, it was also possible to increase the quality level and the level specificity not only of synthesizers but also of sample libraries (Castellon et al., 2020; Gilreath, 2004; Pejrolo & Derosa, 2017).

On the other hand, the launch of the MIDI protocol and the insights regarding its possibilities also created a "run" that aimed the development of products that could be commercially explored to generate profit. Undoubtedly, this process brought countless benefits to the development of the MIDI protocol and its applications; it created a myriad of possibilities for musicians and music production. However, the companies' eagerness to design profitable items also developed products that were extremely criticized due to their lack of quality. It is important to underscore that at this initial period the processing power of electronic devices was very limited, especially when compared with today's technology.

In an effort to cope better with the issues, problems and criticism that surrounded the usage of MIDI for musical matters[2], some leading-market music-oriented companies (e.g. Roland and Yamaha) created the MIDI Manufacturers Association (MMA): a project that has as the main aim to integrate the efforts in the research, development and application of MIDI oriented tools (MMA, 2018; Pejrolo & Derosa, 2017). According to MMA's official website "The MIDI Manufacturers Association was officially established as a California nonprofit trade organization in 1985 with the goal to expand, promote, and protect MIDI technology for the benefit of artists and musicians around the world".

Despite MMA's efforts for the development of high-quality possibilities for the usage of MIDI, the "bad image" associated with Electronic Musical Instruments (EMI) was already constructed and fixed upon the music-community. This generally-accepted bad image led (and still leads) to prejudicial and discriminative attitudes towards the application of MIDI-oriented instruments and tools, especially among members of the traditional and classical Eurocentric music community. Considering the significance of Eurocentric music for formal music education contexts (Hess, 2015, 2017; M. V. M. Pereira, 2018), the bad image connected to MIDI tools tends to push EMIs away from music education scenarios. Following this vein, it can be inferred that the discrimination process created by a historical misuse of MIDI-oriented tools keeps harming formal music education processes by excluding the myriad of possibilities that can be offered by the application of MIDI protocol.

In this complex scenario, the current article is based on the investigation of drummers' performances with the aim of understanding features related to sound quality, rhythmic construction and interpretation to its application in MIDI oriented scenarios. It is proposed an active search for the closest possible correspondence between the original professional performances and the audio created by the association between the MIDI protocol and the acoustic drums' sample library. Thusly, this inquiry's general aim is to assess if the limited use of MIDI-oriented tools in formal music education contexts is appropriately established or if it is only a consequence of historical discriminative processes that led to a lack of knowledge regarding new possibilities brought by modern MIDI-related technologies. Derived from this, we can delineate four specific aims: 1) to present the basic elements of sampling and MIDI protocol; 2) to systematically and pedagogically describe the procedures employed in the process of sequencing the selected drummers' performances as a possible teaching and learning approach to develop knowledge that can lead to the achievement of results similar quality; 3)

[2] As a communication protocol, MIDI can also be used for non-musical purposes such as controlling lighting systems and video applications.

to apply evaluative questionnaires that verify the appropriateness of the audio tracks created by the MIDI-sequencing procedures; 4) to reflect on the connections between the questionnaires' results and the use of MIDI in formal music education contexts.

There is a goal of developing pathways that bring the MIDI-generated audio tracks closer to the "human-recorded live performances"[3] chosen as this investigation's reference. However, it is not expected that the MIDI generated tracks sound the same, but rather that they incorporate some "human-like" features like interpretation and variation. It is expected that after conducting all procedures, the MIDI-generated tracks make it difficult for the audience to distinguish between the human-recorded live performances and the sequenced ones, demonstrating that professional sequencing methods can simulate professional acoustic performances. Considering a successful application and the achievement of good results among the questionnaire's participants, the exclusion of MIDI-oriented tools from formal music education scenarios would be considered inappropriate if it is only based on terms of audio quality. A successful application would suggest that the currently available MIDI-oriented tools are able to offer a pathway for the achievement of results that reach the quality standards of the researched groups. However, to achieve certain results, it would also be necessary the acquirement of certain skills to appropriately manipulate the functionalities offered by MIDI-oriented products.

At the same time, it is also relevant to mention the rapid changing process that has been taking place the music business, especially in the last decades. Because of the increasing availability of economically accessible technologies related to studying, composing, recording, mixing, mastering, producing and delivering music, it is possible to notice that technology-oriented skills are being increasingly required for professional musicians. Accordingly, it is also possible to recognize a growing attention from music education institutions to these demands of the labor market. As examples, it is possible to mention the launch of the popular music graduation course at the Federal University of Bahia (Salvador, Brazil); the foundation of the School of Electronic Music (Manchester, United Kingdom); and the creation of myriad of online and on-campus courses at the Berklee College of Music (Boston, United States of America).

2 Materials and Methods

In the theoretical background's development, it was found scientific publications which promoted reflections addressing this article's contents, such as: Phillips (2014), who explains sample and sampling in MIDI contexts; Pejrolo (2011), which analyzes MIDI protocol procedures; and Carney (2015), who clarifies about contents related to commercial samplers, focusing on the application of the "Round Robin[4]" effect.

This research, which incorporates qualitative and quantitative approaches, was methodologically based on Cohen et al. (2007), Creswell (2010, 2012), Creswell & Creswell (2018), Silveira and Córdova (2009), Marconi and Lakatos (2003) and Moreira (2002).

[3] Even though a MIDI-sequence can be recorded live by a professional musician, in this article by "human-recorded live performance" we are referring to microphone-recorded performances of musical instruments, preferably (but not exclusively) acoustic instruments.

[4] Round Robin is a characteristic setting that commands the use of different samples every time a note with the same MIDI information (or an equivalent track) is triggered. According to Carney (2015) "What the round robin effect does is allow us to take advantage of the fact that drum sample companies record the same sound several times [...], so we can switch samples".

According to Silveira and Córdova (2009, p. 32)[5] "qualitative research is concerned [...] with aspects of reality that cannot be quantified, focusing on understanding and explaining the dynamics of social relations". Concomitantly, Creswell (2010, p. 43)[6] argues that such an approach is "a means to explore and understand the meaning that individuals or groups attribute to a social or human problem". Furthermore, the questionnaires will be applied as a quantitative instrument to gather data. By choosing narrow questions and focusing on methods that allow a carefully-conducted measurement based on the manipulation of a set of variables, quantitative inquires usually concentrate on collecting data by employing tools that pre-establish questions and their possible answers (Cohen et al., 2007; Creswell, 2012; Creswell & Creswell, 2018). As stated by Cohen et al. (2007, p. 148), "quantitative research assumes the possibility of replication; if the same methods are used with the same sample then the results should be the same. Typically, quantitative methods require a degree of control and manipulation of phenomena"

2.1. Choosing the Study Material

As with the use of acoustic musical instruments, obtaining satisfactory artistic results from Electronic Musical Instruments (EMI) require the adoption of specific techniques. Such techniques, in the digital environment, can be based not only on mechanical execution, rhythm, volume and timbre but also on the application of digital resources such as the ADSR envelope[7], sound layers, velocity layers, audio samples and the Round Robin effect.

Focusing on the audio's generation, recording, storage and manipulation it is possible to identify two main groups among the range of possibilities achieved throughout the use of EMIs: the "synthesized" and the "sampled" sounds. In the first group, the audios are created by synthesizers (hardware or software) that are able to "generate waveforms resembling original acoustic sonorities or create completely new waveforms such as pads and leads" (Pejrolo & Derosa, 2017, p. 60). In the second group, instead of being created electronically by waveform manipulation, the initial material comes from recordings (samples) that are stored, accessed and processed by the virtual instruments. Phillips (2014) affirms that "samples" are portions of audio that, for commercially-oriented applications, are saved in high-quality formats (e.g. WAVE, AIFF, etc.). According to the author,

> in the case of a musical instrument, a sample is usually a recording that captures the performance of a single note. Every note of an instrument can be recorded separately, and those notes can then be spread across the controller keyboard. This process, known as "multi-sampling," renders the musical instrument playable through the MIDI controller (Phillips, 2014, p. 200).

Both methods of audio generation have their own particular set of challenges and advantages, however, due to the very nature of its initial material, "sampling" usually achieves better results when there is a wish to simulate acoustic instruments (Pejrolo & Derosa, 2017). In addition, due to the notes' short time length and the rapid attack and release in their "natural envelopes", percussive instruments are usually more easily captured and reproduced by "samplers"

[5] Here and ahead: authors' translation
[6] Here and ahead: authors' translation
[7] ADSR is an acronym of English origin that means Attack, Decay, Sustain, Release. Attack(A) refers to the time that an instrument, after being played, takes to reach its maximum volume; Decay (D) is the time it takes for the sound to go from its maximum volume to reach its stable sustain point. Sustain (S) is the intensity with which the sound remains stable. Release (R) is the time the sound takes, after the instrument is no longer played, to reach silence (Mathew et al., 2015).

(Gilreath, 2004). These characteristics allow percussive sound libraries to store lighter samples than libraries dedicated to musical instruments from non-percussive families, making it possible to catalog a large number of variations and inflections in relatively small storage space. In this way, the following criteria were considered to choose the sample library: 1) general quality of the samples; 2) quantity of samples in the same velocity range ("Round Robin" effect); 3) quantity and quality of velocity layers[8]; 4) number and quality of samples related to the drumstick's attack location (i.e. center, edge, bell, etc.); 5) relationships between velocity[9], volume and samples; 6) variety of Kits and drum parts; and 7) possibility of exchanging drum parts within and outside the kits. By analyzing these criteria, the library named EZdrummer 2 - ToonTrack[10] was chosen to develop the research project.

Regarding the human-recorded live performances used as references to conduct the sequencing procedures, the following elements were considered to select the audiovisual materials: 1) recording quality; 2) different characteristics between excerpts (e.g. tempo, groove, genre, etc.); and 3) the existence of a video with reasonable quality that provides different viewpoints for the performance examination. Based on these elements, the following video's excerpts were chosen:

1. "Gaguinho" (Only Drums) - Ramon Pika - Pau – HD – between 00'28" and 01'34"[11]
2. "Eye of the Tiger" - Drums ONLY Cover - Drum Cover – between 00'14" and 01'48"[12]
3. Metallica - Drum Cover - "Enter Sandman" (Drums Only) – between 00'01" and 01'47"[13]

3 The Sequencing Processes

The sequencing processes had as main aim to reach the maximum possible similarity between the original audio (human-recorded live performance) and the audio track created using the MIDI protocol's functionalities accessed via Digital Audio Workstation (DAW). Since a DAW is typically a very complex software that offers a high range of music-oriented tools, it demands a long process of searching, exploring, learning and familiarizing with its interface. Thereby, the Logic Pro X was chosen as this project's Digital Audio Workstation due to the researchers' previous professional experiences.

The investigation processes were based on learning, selecting, applying and connecting the MIDI protocol's functions with the Sample library's sounds through the DAW's tools. In this way, despite the procedures described below have not been used in every sequencing section, they were considered the most effective procedures in terms of quality and agility. After the

[8] It is a sampler setting that controls the use of different samples based on the velocity informed via MIDI. Through this configuration, we seek to simulate different timbres achieved by an instrument based on the strength applied during the performance (Carney, 2015).

[9] As with all MIDI parameters, velocity has a scale ranging from zero to one hundred and twenty-seven or one to one hundred and twenty-eight(MMA, 2009). (MMA, 2009). Although commonly used for this purpose, velocities are not necessarily related to sample playback volume.

[10]Library's official website https://www.toontrack.com/product/ezdrummer-2/

[11]FERNANDES, R. "Gaguinho" (Só Bateria), 2014. Available at: <https://www.youtube.com/watch?v=8bI_4f6DFn0>. Accessed in: 3 mar. 2017.

[12] COOPER, C. Eye of the Tiger" - Drums ONLY Cover - Drum Cover, 2017. Available at: <https://www.youtube.com/watch?v=7D_DHn7HT20>. Accessed in: 20 fev. 2017.

[13] COOPER, C. Metallica - Drum Cover - "Enter Sandman" (Drums Only), 2015. Available at: <https://www.youtube.com/watch?v=26IaOLJoMe4>. Accessed in: 2 out. 2017.

auditions, the sequencing was carried out in accordance with the following steps: 1- sequencing, by playing a MIDI controller[14], the section's main rhythm using only two of the most important drum parts for that section's rhythm construction (the parts were usually chosen between snare drum, bass drum, ride and hi-hat); 2- individual sequencing of the remaining drum parts to complete the main rhythm (preferably playing a MIDI controller); 3 – In small excerpts, sequencing and editing[15] the presented variations (still disregarding the drum fills); 4 - sequencing the fills' basis using two or three drum parts; and 5 – Sequencing the remaining drum parts to complete the fills.

3.1. Remarks Regarding the Bass Drum Sequencing Process

The bass drum's sound quality was identified as an extremely important element to be considered during the sequencing process. A peculiarity of the chosen sample library is that there are velocity ranges that trigger very clear sample changes. When the velocity is set higher than a certain threshold, the activated sample presents an intense kick-pedal stroking sound and loses clarity in the lowest frequencies, misrepresenting the desired bass drum sound. Therefore, when this effect was not welcome, velocities were kept below 97, on a 0-127 scale[16].

3.2. Remarks Regarding the Hi-Hat Sequencing Process

Like any acoustic instrument, the hi-hat is capable of producing countless different sound inflections. By analyzing the video resources, it was possible to notice that variations in the place stroked by the drum stick, the hits between the pair of cymbals and pressure applied to the pedal during the drumstick hit are some of the parameters that enable the aforementioned sound variety. It was noticeable that in the reference material, the hi-hat produced a myriad of different sounds based on these types of nuances.

By classifying, categorizing and naming samples recorded with very specific settings (e.g. hi-hat ¼ open played by the edge, hi-hat ½ opened played by the bell), the sample mapping information offered by the EZdrummer 2 was particularly important for hi-hat sequencing procedures. Interpreting the available samples without the provided mapping information would be extremely complex for someone that is not a professional drummer or a drum set specialist.

In order to simulate the hi-hat's countless variations, after the initial sequencing process (using a midi controller), all notes had some of their parameters edited (e.g. velocity, length and position) to trigger different samples and make the whole audio track more similar to a performance recorded in an acoustic environment.

3.3. Remarks Regarding the Snare Drum's Sequencing Process

Variation, in different elements, was identified as a remarkably relevant characteristic of human performances. Accordingly, a professional sequencer needs to listen carefully to the variation in timbre between samples, especially among certain velocity ranges. In some cases, a small velocity alteration provokes a sample change (activation of a different velocity layer)

[14] Despite being primarily associated to keyboard instruments, controllers can also be found as instruments of other families such as strings, wind and percussion (Baalman, 2003; Laura A. Stambaugh, 2015; Singer et al., 2003; Swallow, 2016)

[15] Editing in this context refers to the employment of tools for creating, editing and excluding MIDI events and their attributes without a MIDI controller

[16] Some manufactures use the scale 1-128 but in both cases there are 128 possible values (MMA, 2009)

without affecting the volume level. This feature must be widely explored in order to make a MIDI sequence more realistic, especially in sample libraries with few samples devoted to the round-robin effect.

Starting from the 27th bar of "Enter Sandman" (Cooper, 2015), the drummer performs a particularly interesting interpretative *crescendo* with the snare drum and the floor tom. Cooper manages to execute this fill so skillfully that at the beginning it seems that there is no snare drum and at the end it seems that there is no floor tom. This fill, which lasts for one and a half bars, is performed so steadily and gradually that the presented effect becomes natural and organic. As shown in Image 1, to incorporate these features into the MIDI file, it was necessary to set growing velocities for both drums' parts. However, to achieve the desired result, the range of velocities used for the snare drum was significantly wider than the devoted to the floor tom.

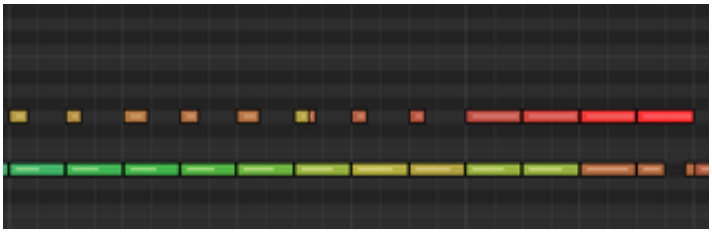

Figure 1. Crescendo of the snare drum and floor tom in "Enter Sandman"[17]
Source: the authors

As can be noticed at 01m26s of the video "Eye of the Tiger" (Cooper, 2017), the drumstick may eventually hit the drum set more times than it seems on a first audition. It is recommended that a sequencing-generated audio track that aims to simulate a human-recorded live performance reproduces these nuances. The number of rebounds is not fixed, the important feature is that the volume of each rebound (usually linked to velocity) is smaller than its predecessor.

3.4. Remarks Regarding the Toms' Sequencing Process

Selecting the kit and setting the drum parts for the song "Gaguinho" (Fernandes, 2014) was especially challenging due to the toms' high tuning. First, there was an unsuccessful search for parts with timbre and tuning compatible with the reference audio. Later, we tried to adjust the pieces' tuning: it worked well for the first two tons (high and mid), but to reach the desired pitch in the other toms it was necessary to alter too much the original sample, mischaracterizing the tom's sonority. As a third possibility, drum parts with the same diameters were chosen to occupy different parts of the drum kit; for example: employing a 10-inches tom as a high and mid toms. This procedure, aligned with the pitch manipulation, granted satisfactory results and proved to be effective in this context.

It was possible to notice that to reach a good audio quality during repeated toms' strokes (particularly if the strokes happen in a short time period), it is recommendable to increase the velocity parameter every time there are changes in the hit part; otherwise, the note will lose

[17] The events below refer to the snare and the upper ones to the tones - The colors closer to green correspond to lower velocities and the ones closer to red to higher velocities.

clarity, especially when the new stroke is in a drum part with lower frequencies than the previous one.

3.5. Remarks Regarding the Cymbals' Sequencing Process

Since the chosen sample library does not offer a "stopping function" for the cymbals (equivalent to the drummer using his/her hand to make the cymbal quiet), it was possible to realize the relevance of having at least one short-time-sound crash cymbal in the electronic drum kit. The smaller cymbals were the best-found option to fulfill this function.

Sample libraries usually offer at least three types of samples for each ride: stroking the bell, the bow and the edge. By analyzing the videos and the sample library it was possible to notice the clear differentiation regarding the intentions of using each ride's part: 1) the bell presents the biggest impact sound, the shorter time length and it emphasizes the higher frequencies – in the reference videos it was mainly used during aggressive and loud excerpts; 2) the bow produce an intermediary sound, lower frequencies (compared to the bell) and a satisfactory impact sound – used to create a continuous high-pitch sound and to conduct some rhythmic variations; 3) the edge produces the lowest frequencies with less impact sound – mainly used to create ambiance and effects.

After performing the sequencing procedures considering the aforementioned remarks related to each drum part it was possible to create satisfying audio tracks in terms of similarities with the selected human-recorded live performances. With the MIDI-created audio track, this research carried out questionnaires among different groups to assess the tracks' quality and applicability. The next session will be dedicated to presenting and reflecting on this process.

4 Results

4.1. Evaluative Questionnaire

The application of questionnaires aimed to verify the effectiveness of using MIDI sequencing procedures to reproduce human-recorded live performances. By choosing this quantitative approach, this investigation assumes a potential for replication and, possibly, generalization. Therefore, it is expected that if the same samples are used and the same methods are applied, the same results can be found (Cohen et al., 2007).

The selection of participants aimed to include representatives of groups that could hold different quality standards for drum set recordings. Aiming to achieve an appropriate "representativeness of the sample" (Cohen et al., 2007), the respondents' selection was guided by the procedures advocated by the "maximum variation sampling". Creswell (2013) asserts that this approach suggests the determination of some criteria that will distinguish groups of participants before the selection per se. As stated by the author, "this approach is often selected because when a researcher maximizes differences at the beginning of the study, it increases the likelihood that the findings will reflect differences or different perspectives". (Creswell, 2013, p. 157). Thereby, the respondents were selected to cover four sampling groups: 1) Musicians; 2) Non-musician; 3) Drummers; and 4) Sequencers[18]. The participants' placement in these categories was based on self-identification.

[18] For the purposes of this research, a sequencer will be understood as a person with expertise in sequencing or sampling processes

To carry out the questionnaires, the sequencing-generated audios and the original performances were mixed with other instruments in order to portray the scenario where these kinds of tracks are usually listened to. Therefore, six audio tracks were developed: three mixed with the original human-recorded live performances and three with the MIDI-based audios. Without knowing if they were MIDI-created or traditionally recorded, each participant was asked to listen to three performances, one of each song. The questionnaire was composed of only two questions that were repeated after each audition: 1) is the audio of the drums in this song midi-generated or acoustically-performed? 2) what led you to that conclusion? The questionnaires were carried out in person using the researchers' headset. The participants could repeat the audio as many times as they wish.

4.2. The Data Analysis Process

As a suitable procedure for quantitative analysis, the data provided by the questionnaire application was interpreted based on statistical comparisons between the participants' answers. As posited by Creswell (2012, p. 15), to examine quantitative data "you analyze the data using mathematical procedures, called statistics […] statistical procedures such as comparing groups or relating scores for individuals provide information to address the research questions or hypotheses". Likewise, the following sections will be devoted to presenting the questionnaires' analysis, one excerpt at a time.

"Gaguinho". Among the audience of drummers, the MIDI-generated audio had great results: 100% of the interviewees believed that it had been played live by a professional drummer. The drummers accepted the sequencing better than the original performance. Among non-musicians, the track with MIDI audio did not acquire good results, satisfying only 33% of respondents. Among the musician's audience, the sequenced audio performed relatively well: in spite of its 25% success rate[19], it obtained better results than the human-recorded live performance, which satisfied only 20% of this respondents' group. Among sequencers, neither the MIDI audio nor the human recording convinced the participants: no respondent (0%) believed that the audio was acoustically performed by a professional drummer. An overview of the results concerning the song Gaguinho can be seen in the two charts presented below (Char 1 and 2). The blue represents the percentage of times a respondent understood that the drum set in the listened audio track was performed by a professional musician in an acoustic instrument (considered a good result for this article's purposes) and the orange color describes the percentage of times the participants understood that the drum set's performance was developed from sequencing processes (considered a bad result).

[19] For this research's purposes, success rate represents the percentage of times an audio was considered "real" or "non-MIDI-generated"

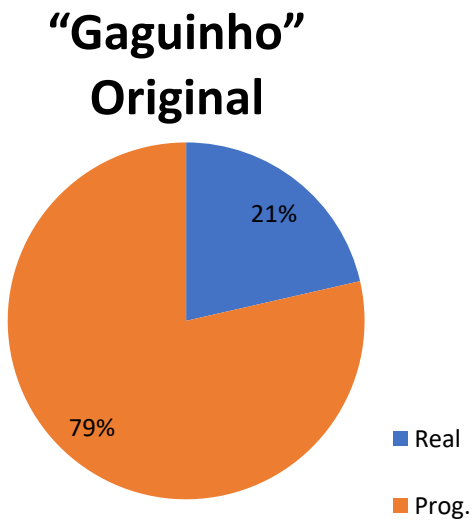

Chart 1. Evaluation of "Gaguinho's" audio produced by human-recorded live performances
Source: the authors

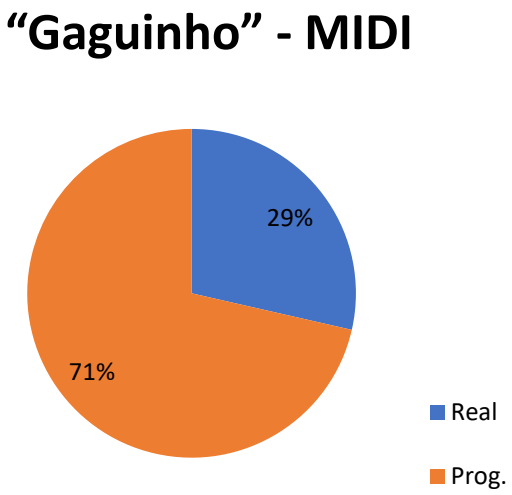

Chart 2. Evaluation of the Gaguinho's audio produced by MIDI sequencing processes, considering all studied groups
Source: the authors

"Enter Sandman". Since all respondents believed that the drum set in the presented audio track was played by a professional drummer, the sequencing achieved a 100% success rate among the non-musicians. Among the musicians, the MIDI-generated audio reached a 62% of success rate against the 100% success rate of the original audio. Among the drummers, only one questionnaire was carried out using the original performance (that acquired a 0% of success rate), not providing reliable information for a direct comparison between the original and MIDI-produced audios. However, comparing the 75% success rate with the results of the other audio tracks (including original and sequenced), it can be affirmed that the sequencing-produced track performed well. Among the sequencers, neither the MIDI-produced audio nor the human-recorded audio granted a good success rate: both with 25%. However, taking into

account a comparison between the two audios, the sequencing can be considered well rated. An overview of the results concerning the song “Enter Sandman” can be seen in the two charts presented below (Char 3 and 4).

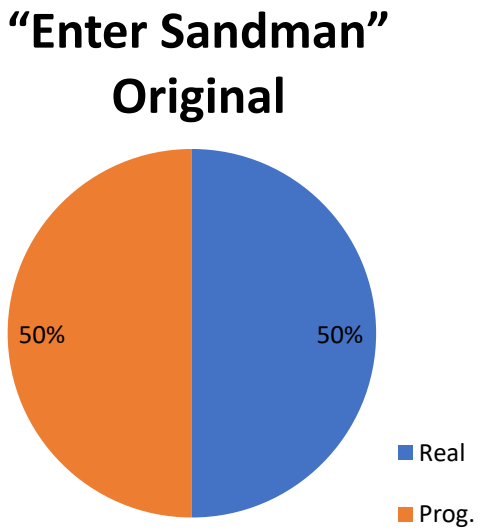

Chart 3. Evaluation of Enter Sandman’s audio produced by human-recorded live performance, considering all studied groups

Source: the authors

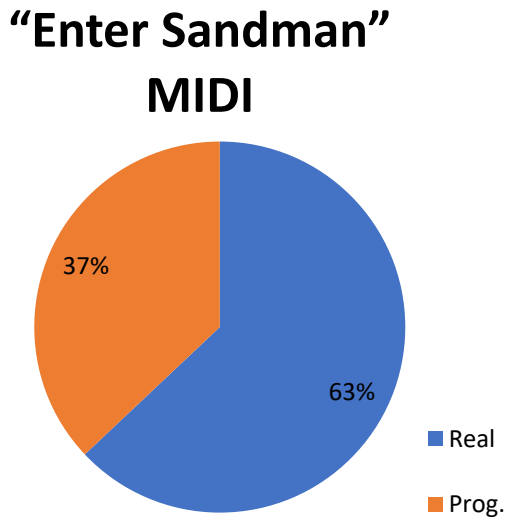

Chart 4. Evaluation of "Enter Sandman’s" audio produced by MIDI sequencing processes, considering all studied groups

Source: the authors

“Eye of the Tiger”. The sequencing had great results among the musical audience: 87% of respondents supposed that it had been played by a drummer. The sequencing was better accepted than the original performance, which only achieved a 43% of success rate. Unfortunately, no questionnaire was applied among the “non-musicians” using the MIDI-created audio; the original audio reached a 100% success rate among these participants. Among

the drummers, the sequencing convinced 100% of the respondents: an extremely good result, especially when compared with the original performance's total rejection (0% success rate). In the group of sequencers, the MIDI-produced audio got a relatively good assessment: whilst it achieved a 50% of success rate, the human-recorded live performance was totally rejected by the sequencers (0% success rate). An overview of the results concerning the song Eye of the Tiger can be seen in the two charts presented below (Char 5 and 6).

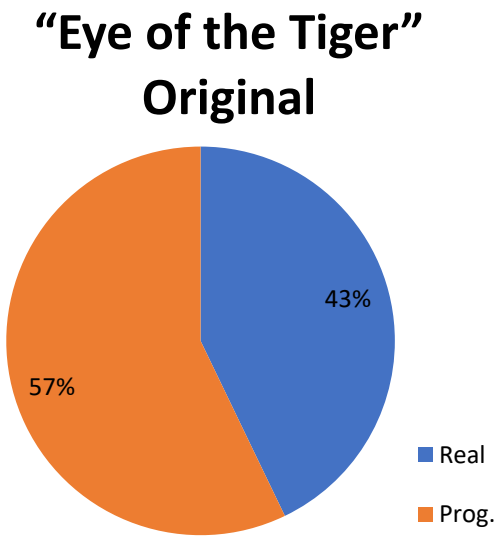

Chart 5. Evaluation of "Eye of the Tiger's" audio produced by human-recorded live performances, considering all studied groups

Source: the authors

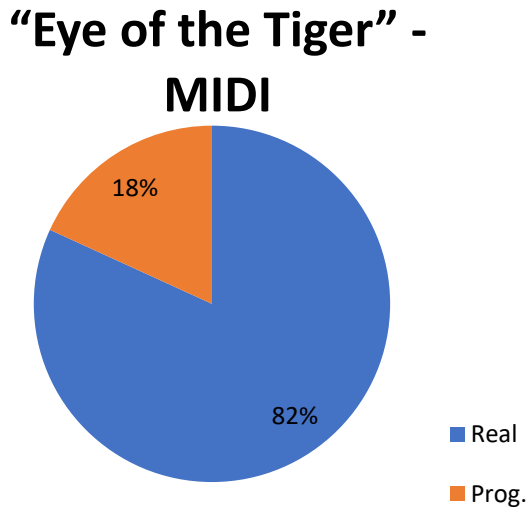

Chart 6. Evaluation of "Eye of the Tiger's" audio produced by MIDI sequencing processes, considering all studied groups

Source: the authors

General View (All excerpts). An overview of the whole questionnaire application process can be seen in the two charts presented below (Charts 7 and 8). By examining the totality of the

data collected during the questionnaires' application, it can be noted that the MIDI-generated audios granted excellent results, managing not only to acquire a good success rate but also to overcome the results achieved by the actual human-recorded live performances.

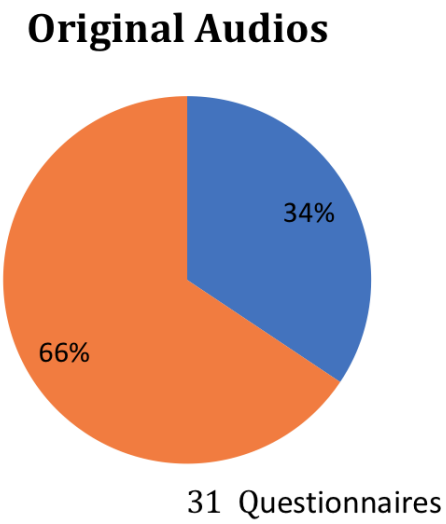

Chart 7. General evaluation considering all questionnaires conducted based on human-recorded live performances

Source: the authors

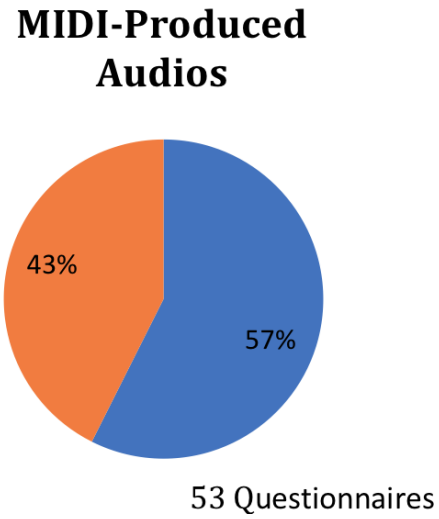

Chart 8. General evaluation considering all questionnaires conducted based on audios produced by MIDI sequencing processes

Source: the authors

5 Discussion and Final Considerations

Due to the need to listen carefully to drummers' performances, it was possible to notice frequently used techniques such as: 1) using the bass drum to reinforce strokes on crash cymbals; and 2) employing an open hi-hat as a crash cymbal in moments in which there is a wish for greater control over cymbals' sound length. The recognition of these techniques can be beneficial not only for the development of skills employed by professional sequencers but also by arrangers, songwriters and composers. Following this vein, it is possible to note that

practical activities related to the application of MIDI-oriented tools can be beneficial not only for the development of competences that are directly related to modern music technology but also for the development of competences that are traditionally required by a professional musician.

By analyzing this research's results, it is possible to perceive that the acceptance of the MIDI-generated audio was satisfying in all the studied groups. Due to the approach adopted by this inquiry (requesting the distinction of audios between "real" and MIDI), a relevant portion of the participants faced the questionnaire as a "quiz game", which enhanced their commitment to the process by adding a wish to find the "right answers" for the questions. However, despite this perceived extra effort, in the majority of the excerpts the sequencing audio tracks achieved better success rates than the reference performances. Examining the participants' decision criteria, characteristics like timbre, dynamics, groove, fills and rhythmic variation were found as fundamentally important to guide respondents' answers.

These results indicate that the currently available MIDI-oriented technology can offer appropriate tools for the application of synthesizers and sample libraries in contexts that were dominated by the usage of acoustic musical instruments. In spite of the historically constructed discrimination towards the usage of Electronic Music Instruments in formal music education, this "MIDI-related possibility" create a range of opportunities that can (and should) be exploited by the music education field. Similarly to learning a new musical instrument or a new craft, taking advantage of the opportunities provided by MIDI-oriented tools would require the development of a set of new skills and techniques for the music educators' community. Undoubtedly, it would not be an easy process but it is a necessary step toward the development of music education systems that are properly linked to the reality outside the academic world.

Moreover, a conscious application of MIDI-oriented tools can contribute to expand the musical possibilities of students: the sound of a Hungarian instrument can be used to conduct a class in South Africa; the sound of a Brazilian musical instrument can be used as an example in Japanese music schools; the sound on an Arabic musical instrument can be employed in courses of Canadian universities. This characteristic can be extremely important to increase the participation of the music field in the development of fairer societies. Considering the cross-feeding relation between the music education field and broader sections of society (A. E. Pereira, Konopleva, Nyamkhuu, et al., 2021; A. E. Pereira et al., 2022; Schmidt, 2005; Stanton, 2018), by assigning equal or similar values to musical instruments and musical manifestations that represent different ethnic groups, the music education field can foster the development of more democratic societies (Hess, 2015; A. E. Pereira, Konopleva, Do, et al., 2021). By stopping treating certain instruments as exotics and certain musics as a token (Hess, 2015), music education organizations can contribute to mitigate discriminative processes toward the groups that traditionally use those instruments and produce those musics.

The sequencing process was motivated by the assumption that, in certain contexts, the audio produced from MIDI files can be used as an alternative to the human live performances and this research was conducted to test and evaluate this hypothesis. Despite the good results, it is believed that there are huge differences between professional sequencing and professional human performances. Certain elements that are distinctive of individual professional performances are extremely difficult to be reproduced by MIDI events. Ultimately, every performance is unique and unrepeatable, even by the performers themselves. Due to the immense amount of sounds that can be produced by each of the drum parts, it would be impossible for sample libraries to provide every possible drum sound and, even if they did, it would be impracticable for a professional sequencer to employ every offered resource.

References

Airy, S., & Parr, J. M. (2001). MIDI, Music and Me: Students' Perspectives on Composing with MIDI. *Music Education Research*, *3*(1), 41–49. https://doi.org/10.1080/1461380020029941

Baalman, M. A. J. (2003). The STRIMIDILATOR: a String Controlled MIDI-Instrument. *Proceedings of the 2003 Conference on New Interfaces for Musical Expression (NIME-03)*, 19–23.

Carney, J. (2015). *Logic Pro X - Video Tutorial 56—EXS24 Tutorial (PART 3) Alternating Samples and Velocity Layers*. https://www.youtube.com/watch?v=DUlwrskND3U

Castellon, R., Donahue, C., & Liang, P. (2020). Towards realistic MIDI instrument synthesizers. *4th Workshop on Machine Learning for Creativity and Design at NeurIPS*, *4*, 1–8. https://cs.stanford.edu/~rjcaste/research/realistic_midi.pdf

Chattah, J. (2014). Musical instrument digital interface. In W. F. Thompson (Ed.), *Music in the Social and Behavioral Sciences: An Encyclopedia* (pp. 789–791). SAGE Publications. https://doi.org/10.4135/9781452283012

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education*. Routledge.

Cooper, C. (2015). *Metallica—Drum Cover—"Enter Sandman" (Drums Only)*. https://www.youtube.com/watch?v=26IaOLJoMe4

Cooper, C. (2017). *Eye of the Tiger"—Drums ONLY Cover—Drum Cover*. https://www.youtube.com/watch?v=7D_DHn7HT20

Creswell, J. W. (2010). *Projeto de pesquisa: Métodos qualitativo, quantitativo e misto* (L. de O. da Rocha, Trans.; 2nd ed.). Bookman.

Creswell, J. W. (2012). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Pearson.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3rd ed.). SAGE Publications.

Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications.

Fernandes, R. (2014). *"Gaguinho" (Só Bateria)*. https://www.youtube.com/watch?v=8bI_4f6DFn0

Gilreath, P. (2004). *The Guide To MIDI Orchestration* (J. Aikin, Ed.; 3rd ed.). Music Works.

Hess, J. (2015). Decolonizing music education: Moving beyond tokenism. *International Journal of Music Education*, *33*(3), 336–347. https://doi.org/10.1177/0255761415581283

Hess, J. (2017). Equity and Music Education: Euphemisms, Terminal Naivety, and Whiteness. *Action, Criticism, & Theory for Music Education*, *16*(3), 15–47. https://doi.org/10.22176/act16.3.15

Laura A. Stambaugh. (2015). Examination of a MIDI Wind Controller for use in wind performance research. *Music Performance Research*, *7*, 81–101.

Marconi, M. de A., & Lakatos, E. M. (2003). *Fundamentos de metodologia científica* (5th ed.). Atlas.

Mathew, T., Abraham, B., & Scaria, R. (2015). Music Synthesis using Sinusoid Generator, ADSR Envelope Generator and Composer Code. *International Journal of Scientific Engineering and Research*, *3*(2), 23–25.

MMA, MIDI Manufacturers Association. (2009). *An Introduction to MIDI*. MIDI Manufacturers Association. https://www.midi.org/images/easyblog_articles/43/intromidi.pdf

MMA, MIDI Manufacturers Association. (2018). *About the Midi Association*. MIDI Manufacturers Association. https://midi.org/about

Moreira, D. A. (2002). *O método fenomenológico na pesquisa*. Pioneira Thomson.

Pejrolo, A. (2011). *Creative sequencing techniques for music production* (2nd ed.). Elsevier.

Pejrolo, A., & Derosa, R. (2017). *Acoustic and MIDI Orchestration for the Contemporary Composer* (2nd ed.). Routledge.

Pereira, A. E., Konopleva, E., Alghneimin, J., Kasbary, N., & Mészáros, G. (2022). Musical Instruments' African-Based Studies: The Application of the Afro-Brazilian Knowledge to Study Non-African-based Musical Instruments—Extended Abstract. In D. P. Wick, A. Tryniecka, & O. Gkounta, *Humanities and Arts in a Global World: Abstract Proceedings of the 9th Annual International Conference* (pp. 66–70). Athens Institute for Education and Research (ATINER). https://www.researchgate.net/publication/358427655_Humanities_and_Arts_in_a_Global_World_Abstract_Proceedings_of_the_9th_Annual_International_Conference

Pereira, A. E., Konopleva, E., Do, D. T., Coelho, I. de C. P., Neto, & Mészáros, G. (2021). Educação Musical Afro-Brasileira: Uma investigação do Ijexá como ferramenta educacional descolonizadora. *10º Musicom - Encontro de Pesquisadorxs Em Comunicação e Música - Playlists Das Diversidade*, 1–15. https://redemusicom.files.wordpress.com/2022/01/adrian-musicom-final.pdf

Pereira, A. E., Konopleva, E., Nyamkhuu, B., Dung, D. T., & Mészáros, G. (2021). Ijexá and Music Education: The Study of African-based Music as a Pathway to Valorize Minority Groups' Collective Identities. *4th World Conference on Future of Education*, 36–47. https://www.dpublication.com/wp-content/uploads/2021/12/16-4566.pdf

Pereira, M. V. M. (2018). Possibilidades e desafios em música e na formação musical: A proposta de um giro decolonial. *Interlúdio*, *10*, 10–22.

Phillips, W. (2014). *A Composer's Guide to Game Music*. The MIT Press.

Schmidt, P. (2005). Music Education as Transformative Practice: Creating New Frameworks for Learning Music through a Freirian Perspective. *Visions of Research in Music Education*, *6*, 1–14.

Silveira, D. T., & Córdova, F. P. (2009). A Pesquisa Científica. In T. E. Gerhardt & D. T. Silveira (Eds.), *Métodos de pesquisa* (pp. 31–42). Editora da UFRGS.

Singer, E., Larke, K., & Bianciardi, D. (2003). LEMUR GuitarBot: MIDI Robotic String Instrument. *Proceedings of the 2003 Conference on New Interfaces for Musical Expression (NIME-03)*, 188–191.

Stanton, B. (2018). Musicking in the Borders toward Decolonizing Methodologies. *Philosophy of Music Education Review*, *26*(1), 4–23. https://doi.org/10.2979/philmusieducrevi.26.1.02

Swallow, M. J. (2016). *MIDI Electronic Wind Instrument: A Study of the Instrument and Selected Works* [Doctor of Musical Arts, West Virginia University]. https://researchrepository.wvu.edu/etd/6750