Revista Latinoamericana de Tecnología Educativa, 24(1)
https://doi.org/10.17398/1695-288X.24.1.101

RELATEC
Revista Latinoamericana de Tecnología Educativa

ARTICLE / ARTÍCULO

Digital technologies in music education. Using Digital Audio Workstations (DAW) with Project-Based Learning (PBL)

Tecnologías digitales en la educación musical. El uso de Estaciones de Trabajo de Audio Digital (DAW) con Aprendizaje Basado en Proyectos (ABP)

María Elena Cuenca-Rodríguez, Ignacio Pascual-Moltó & Raquel Pastor-Prada

Received: October 31, 2023
Reviewed: June 10, 2024
Accepted: October 11, 2024

Author's address:

Departamento de Música. Facultad de Formación del Profesorado y Educación. Universidad Autónoma de Madrid. C/ Francisco Tomás y Valiente, 3, Fuencarral-El Pardo, 28049 - Madrid (Spain).

E-mail / ORCID

maria.cuenca@uam.es

https://orcid.org/0000-0002-5419-2576

l.pascualmolto@edu.gva.es

https://orcid.org/0000-0002-8179-7917

raquel.pastor@uam.es

https://orcid.org/0000-0002-3713-8914

Abstract: *BandLab* and *Walk Band* are two mobile and web-based applications that let users create and record their own songs, providing them with a variety of virtual instruments, samples, loops and drum machines. These applications can be used as educational tools to encourage musical learning and creativity in secondary and higher education students. This article discusses the advantages and challenges of using these applications in education and offers some recommendations for their pedagogical use. The objective is to show how *BandLab* and *Walk Band* can contribute to the development of musical, artistic and digital proficiency in students as well as create collaborative learning communities. A literature review on previous uses of multitrack sequencers is also done, and some examples of didactic proposals on music creation and musical arrangements are offered on how to integrate these applications in the music curriculum in secondary education and in interdisciplinary projects in higher education. Finally, some challenges and opportunities are presented for research and educational innovation through the use of these technologies in the field of music creation.

Keywords: Music Education, Educational Technology, Digital Audio Workstations, Project-Based Learning.

Resumen: *BandLab* and *Walk Band* are two mobile and web-based applications that allow users to create and record their own songs, with a variety of virtual instruments, samples, loops and drum machines at the user's disposal. These applications can be used as educational tools to foster musical learning and creativity in secondary and higher education students. This article discusses the advantages and challenges of using these applications in the educational context and offers some recommendations for their pedagogical use. The objective is to show how *BandLab* and *Walk Band* can contribute to the development of musical, artistic and digital competences in students, as well as to the creation of collaborative learning communities. A literature review on previous uses of multitrack sequencers is also carried out and some examples of didactic proposals on music creation and musical arrangements are offered to integrate these applications in the music curriculum in Secondary Education and in interdisciplinary projects in Higher Education. Finally, some challenges and opportunities for research and educational innovation in the field of music creation through these technologies are presented.

Palabras clave: Educación Musical, Tecnología Educativa, Estaciones de Trabajo de Audio Digital, Aprendizaje Basado en Proyectos.

1. Introduction

Musical creation is one of the proficiencies developed in music education. It exists in the Music subject in Compulsory Secondary Education (Educación Secundaria Obligatoria, hereinafter ESO) (Royal Decree 217/2022) and in subjects within Teaching degrees in the Music Education major in Early Childhood Education and in the one for Primary Education at universities (Ministry of Education and Science Order ECI/3857/2007). There have already been authors such as Nielsen (2013) or Ocaña-Fernández et al. (2020) who have emphasized the change of attitude in students and the creative development that comes from collective musical creation in both educational stages. The use of digital resources can facilitate and enrich this process by offering tools and possibilities that expand the repertoire and types of musical expression (Lam, 2023). According to Calderón-Garrido et al. (2019), digital technology has influenced the practices in musical creation and composition that are done in the classroom, incorporating new hardware, software and 2.0 tools in teaching and learning processes. These authors note that, in the case of secondary education, a transversality of learning appears, although certain usage to reinforce traditional content is also present, which can mean missing out on new possibilities. Moreover, Tejada Giménez (2004, p. 21) suggests that «music technology can improve processes and reduce learning times.»

Both Sastre (2013) and Ellis (1995) emphasize the potential of new technologies in music education, the former focusing on collaborative creation and the latter on software development to support creativity in compositions. Cayari (2014) expands this debate by highlighting the role of music video creation in the development of musical and technological skills. Cano (2018) further explores the use of music information retrieval technologies in music education, including applications that allow separation of the voice accompaniment alone, or the automatic transcription of certain instruments. These studies collectively underscore the potential of technology to improve music creation and education, in the same way that Brown (2014) stressed that they could help in learning and teaching a wide range of didactic activities.

On the other hand, Giráldez (2012) adds some questions about the integration of technologies in music education, such as the advantages, objectives, the relationship with new musical practices and the training of teachers. Also Hernández-Sellés et al. (2015) present a corpus of web 2.0 applications for musical creation and consumption and analyze a sample of these to determine their specific educational characteristics and uses. All these proposals highlight the notable advance in the acquisition of musical skills from the practice, improvisation and musical creation itself with Learning and Knowledge Technologies (hereinafter LKT) (Dammers, 2010; Rosen et al., 2013).

1.1. BandLab and Walk Band as didactic applications to create musical arrangements

As can be seen, the use of digital resources for the composition and creation of musical arrangements in secondary and higher education is a topic that has aroused the interest of diverse researchers. These resources can provide benefits for students as well as teachers, provided they are used with clear pedagogical criteria that is appropriate for each context (Brown, 1999).

Among these tools is the use of totally free-of-charge multitrack sequencers like *BandLab* and *Walk Band*. *BandLab* is an online platform that lets musicians and fans easily create, collaborate and share music for free. *BandLab* also offers an educational version that adapts to the needs of teachers and students in the school context. *Walk Band*, on the other hand, is a mobile application that allows music to be created with different virtual instruments such as piano, guitar and drums, among others. These tools offer instruments, effects and a sound library for students to experiment with various parameters such as timbre, rhythm, harmony and melody. Students can explore different genres, styles and musical techniques, compose, record, do arrangements and/or edit their own songs or pieces. These days students are quite used to the amount of sound manipulation that takes place in the different processes of musical production in popular music genres (Faure Carvallo et al., 2020), so for them it is familiar and affordable to explore effects and modifications of the audio when doing projects on specific songs.

Both applications facilitate collaboration, communication and feedback between students and teachers, allowing for projects, assignments, grading and group messages. *BandLab* for Education provides greater privacy and security for minors, protecting their intellectual property and image rights. These free, easy-to-use tools promote the creation of music learning communities both inside and outside of the classroom, while promoting the integration of music into other areas of the curriculum such as languages, sciences or mathematics, creating interdisciplinary projects.

Nevertheless, there are some challenges or limitations to consider. These include the need for a stable Internet connection, compatibility or performance problems with certain browsers or devices – especially older or low-memory ones – and possible distractions or conflicts between students if the activity is not supervised and class standards are not established. Additionally, there is the need for prior training or constant support for teachers and students who are not familiar with technology or music production. Moreover, use of these programs is not a substitute for the experience of playing a real instrument. Still, they can be tools that encourage learning the language of music, literacy in music scores or auditory training.

Below, some didactic proposals that have been done with these programs will be explained to show the varied uses that have been applied in the field of formal education with the goal of acquiring musical and digital proficiencies.

1.2. Studies that have used multitrack sequencers for musical creation in the educational setting

Many authors have researched the impact on music education that teaching this discipline through digital media such as online multitrack sequencers can have. *BandLab*, *Walk Band* or similar platforms – such as GarageBand or Soundtrap – facilitate music creation and arranging in different educational settings, such as schools, universities and online communities (Hamilton, 2021). In this sense, *BandLab* has been introduced in higher education experiments such as those by Hamilton (2021, p. 28), applied to knowledge in music classrooms of styles such as hip hop, which raises the value of music that has been marginalized for racist reasons in much media. In a preliminary study, the authors of this article have also verified the didactic possibilities that *BandLab* or *Walk Band* can have in the context of ESO, such as an increase in musical creativity, motivation and cooperation between students (Pascual Moltó et al,

2021). Other authors who have put it into practice in their music classes have been Fick and Bulgren (2022), and they present a model for tablet-based music production instruction through five gradual steps: sequencing, recording, editing, effects processing, and mixing. Mash (1991) emphasizes that the possibility of combining the recording of live instrumental performances with the MIDI sequencing environment in an intuitive graphic interface in these types of applications poses new challenges for music studies. Moreover, Peters (2015) recommends using semi-structured and playful activities done by students by means of introducing musical production skills. The end result should be focused on considering programs such as *BandLab* or *Walk Band* as tools to develop creativity with methods based on Project-Based Learning (PBL).

On the other hand, recent studies such as one from Carroll and Harris (2022) highlight that the use of digital tools focused on musical creation encouraged positive changes in the training of music teachers in stages such as early childhood education and primary education, as they got involved in using these in educational practice when numerous advantages in skills acquisition were observed. In addition, Watson (2011) points out that use of these DAW (Digital Audio Workstations) on a pedagogical level is an essential curricular material for the subject of music.

Likewise, Thorgersen and Mars (2021) study how different teachers from the previously mentioned stages and ESO in Sweden shared advantageous learning situations – such as the use of these DAW – with their music students during the COVID-19 pandemic in 2020 with satisfactory results. In turn, Merchán-Sánchez-Jara and González-Gutiérrez (2023) created a structured and sequential model for the collaborative composition of musical productions in the field of urban popular music through the DAW within the university setting in musical training of ESO teachers. Casanova López and Serrano Pastor (2016, p. 420) also used *Walk Band* during the second year of a project in musical training and Learning and Knowledge Technologies (LKT, hereinafter) in higher education of future music teachers, observing an increase in motivation, interest and the effort to learn during the sessions. In addition, Díez Latorre (2018) noted that the pedagogical training of many teachers is deficient and they simply teach the use of software without giving much importance to its usefulness on an educational level. Other projects related to instrumental training through technological resources did not incorporate musical production programs and were limited exclusively to sound recording (Berrón-Ruiz et al., 2023).

The use of *BandLab* as well as *Walk Band* is quite low in Spanish music schools. The uses made of these applications didactically in the field of higher education at the international level are also anecdotal. There are some proposals developed in a book by Giráldez et al. (2015) where innovative examples are collected on the use of DAW in the school environment to encourage musical creation and arrangements with loops and to develop rhythmic skills through drum machines. Tejada and Thayer Morel (2019a; 2019b) and Thayer Morel et al. (2021) used the same action-research proposal in different universities, which consisted of technological training that was provided in the initial training of music education teachers in secondary education, where they used multitrack sequencers to record instruments. Even though these proposals work different types of software, none focuses on the didactic, systematic and sequential use of specific DAW. This is why it is necessary to propose more experiences adapted to the field of music teaching through these programs in ESO and in higher education.

1.3. Objectives

After having given a series of advantages, challenges and disadvantages on the use of multitrack sequencers such as *BandLab* and *Walk Band* in the field of music education, the aim of this article is to find out the degree to which ESO and higher education students acquire musical and digital skills through activities done with the above-mentioned DAW and Project-Based Learning (PBL). As specific objectives (SO), the following are proposed:

SO1. Describe the proposal for musical activities and analyze results from the students during the process of musical creation with the DAW

SO2. Develop a SWOT report based on collecting data from final debates with the student body to observe their perception of the digital tools introduced for musical creation

SO3. Observe the differences in implementation of these resources and the results achieved between the groups of students in ESO, the Bachelor's degree and the Master's degree.

2. Methodology

In order to achieve the goals proposed in this study, an action-research design was chosen along with the collection and processing of data from two different case studies: one carried out in compulsory secondary education (ESO) and the other in higher education (specifically, Bachelor's and Master's degree students, which will be detailed below).

In the didactic proposals, the teaching strategies of Project-Based Learning (PBL) and the cooperative method with students were implemented. In this sense, the methodology was very similar to the one used in various studies (Mendoza Ponce and Galera Nuñez, 2011; Lage Gómez and Zahonero Rovira, 2012; and Tejada and Thayer Morel, 2019b) that highlight the importance of student commitment and creativity in the process of musical learning, using cooperative learning. This encouraged an innovative and inclusive process for all group members, who organized themselves to do all the project's tasks with guidance from the respective teachers.

2.1. Context of participants

The context in which the didactic proposal was carried out is that of different educational centers at different educational stages. Thus it was decided to extract three differentiated groups to observe the differences between them in the results section:

– For ESO, there were 50 students from two different primary school 6th grade classrooms (1st ESO in Spain) at the IES Clot de l'Illot school, 2 boys and 28 girls. This will form category A, where *Walk Band* will be used in ESO. These students come from lower and middle class families and have not received any prior technological or digital media training. None of them had previously experimented with digital tools, such as multitrack sequencers, in the music subjects they had previously studied.

– For the higher education proposal, there were 58 students from the Universidad Autónoma of Madrid (UAM, hereinafter), who come from two different categories: the Bachelor's degree and the Master's degree. These students come from middle class families and have previous knowledge in LKT subjects and digital media from the degrees they are studying or have studied in the past. None of them had previously experimented with digital tools, such as multitrack sequencers, used in music studies.

  a) 30 students (23 women and 7 men between the ages of 22 and 39 in the 4th year of the Bachelor's degree in Teaching Primary Education (with a specialization in Music Education). These participants will be category B, where *BandLab* will be used.

  b) 28 students (11 women and 17 men between the ages of 24 and 44) in the Master's degree in Teacher Training for Compulsory Secondary Education and High School (Máster en Formación del Profesorado de Educación Secundaria Obligatoria y Bachillerato, hereinafter MESOB). This will form category C, where *BandLab* will also be used.

Each program has been assigned to each stage, due to the difficulty and range of resources of each one: While *Walk Band* has a simpler interface adapted to adolescents, *BandLab* is a more complex program with a wider range of resources. Students in these educational stages have also been chosen to observe the different behaviors and results when facing the use of very similar applications. All the groups participated willingly in the activities proposed, based on creating musical arrangements with these DAW.

In each process, permission was requested from the managerial team at both centers, as well as the ethics committee of the UAM, to carry out the research. This entity advised on the applicability, both legally and for safety, in the selected sample. The families of underage students were also given information and informed consent was requested in order to participate in the research experiment. The data processing has been completely anonymized, without revealing any identity of the students and respecting the Organic Law 3/2018 on Personal Data Protection and the guarantee of digital rights.

2.2. Procedure and timing of study

The teachers, authors of this article, used the didactic proposal based on *Walk Band* in ESO and Band Lab for higher education during six consecutive sessions of 50 minutes each. Each teacher – in ESO as well as higher education – followed the ensuing schematic model (each one adapted to the functionality and difficulty of each stage):

– Session 1: The program's functionality and its didactic applicability for musical creation was explained.

– Session 2: The teacher created various exercises with the PBL methodology for acquisition of musical and digital skills through the use of DAW. These are explained below in the results section.

– Sessions 3-5: The students – having previously practiced in Session 2 with the prior activities – had to develop a project to create song arrangements, following the

steps in a previous example that was structured and explained sequentially by the teachers. The teachers then guided the students' didactic process using advice and problem solving on a technical and musical level.

– Session 6: The results were observed and suggestions for improvement were provided on both the musical production and performance levels. In the case of higher education, use of the DAW applied to music teaching in primary and secondary education was also discussed.

2.3. Design and instruments

The design of the research is based on an educational activity in the classroom aimed at acquiring greater musical and digital skills through DAW. To do this, the experiment will have a social approach, done through collaborative teaching and project-based learning via technology.

For data collection, instruments designed to achieve the proposed objectives have been used. On the one hand, observations and annotations in log books of each of the strengths, weaknesses, opportunities and threats (SWOT report) in each group. On the other, the results of each of the projects have been analyzed, critically observing the positive and negative aspects in regard to musical and technical production in each of the groups. Finally, a last discussion group served to recognize the usefulness and employability of these tools to encourage musical creativity.

3. Results

The following results are divided into three sections. First, to achieve SO1, implementation of *Walk Band* is described and analyzed in regard to developing musical creativity and the exercises done in primary school 6th grade students (1st ESO) at the IES Clot de l'Illot school, plus the results of projects done with *BandLab* by students in the Bachelor's degree in Teaching Primary Education (with a specialization in Music Education) and by students of the MESOB. Next, to achieve SO2, results of the SWOT analysis on the use of these tools to encourage musical creativity are developed. Finally, to achieve SO3, the differences in the results after implementation of the DAW among the different groups of students will be studied.

3.1. Exercises with Walk Band in ESO

Utilizing the *Walk Band* application during the period it was in use managed to strengthen the content and processes typical of music studies in ESO. This has been verified through fulfillment of the exercises and observation of the questions and problems that arose in doing the exercises. The teacher guided the students throughout the entire process. This series of exercises has also encouraged learning mathematical and digital skills, among others, given that students learn to make good use of LKT (in this case, their smartphones).

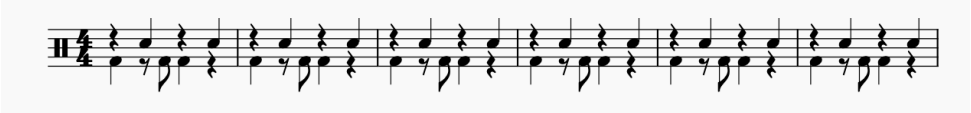


Figure 1. Drum fragment proposed to the class.

In the case of rhythm, it is worth noting that the length of the different musical figures was worked on using the drum machine tool. Once given the explanation to remember the different values of the musical figures, the students were able to transcribe the simple drum score (Figure 1), taking into account that each of the four squares of the same color is equivalent to a sixteenth note (Figure 2).

Figure 2. Diagram of the drum machine belonging to the previous score.

By using this drum machine, they have visually understood how fractional numbers work, thus improving this basic knowledge for mathematical competency.

Moreover, by using the virtual bass tools and the possibility of playing chords on the virtual guitar, students were able to make the base of the first section of the song by Gotye: «Somebody that I used to know» (Figure 3).

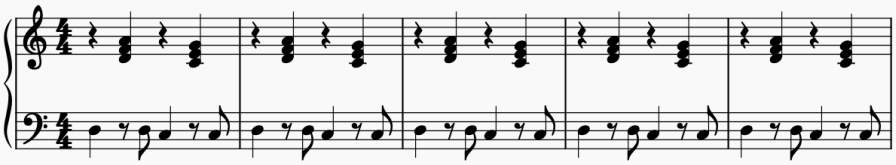
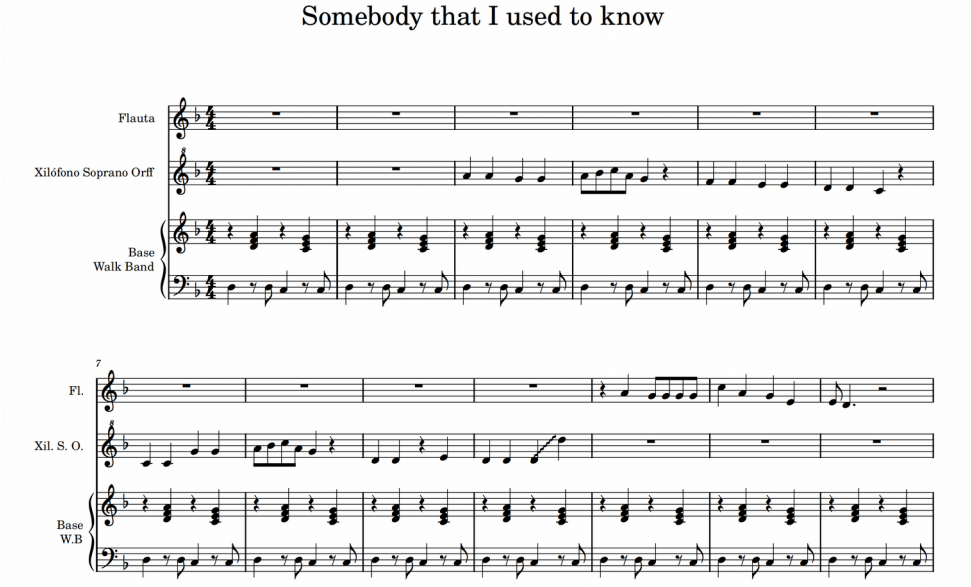


Figure 3. Arrangement by author of the song "Somebody that I used to know" by Gotye.

In this way, the goal is to promote both learning of the use of the bass clef in bass instruments as well as differentiation between the formation of a major chord (formed by a major and minor triad) or the formation of a minor chord (the inverse). Subsequently, the union of the bass with the guitar chords made with the application's virtual instruments served as a basis for the live performance of both the xylophone score in the introduction of the song and the singer's melody, performed on the flute. The score of the final performance can be seen in Figure 4.

Figure 4. Final score comprising the base made with *Walk Band*, along with the score of the acoustic



instruments played by the students.

One of the results from a group of ESO students has been this preliminary project that you can listen to in Example 1 in the repository uploaded to Zenodo[1].

Throughout the entire process, the students worked collaboratively and expressed interest in doing each activity, each of them developing a part and interpreting it later with their peers. At the same time, they acquired the numerous skills mentioned above along with interpersonal and digital ones.

3.2. Projects with BandLab in the Bachelor's degree

Next, projects are shown that have been developed based on the previous examples done by the teacher. The students in the Bachelor's degree in Teaching Primary Education as well as those in the MESOB in postgraduate education had no learning difficulties in gradually following the steps.

[1] https://doi.org/10.5281/zenodo.8364525

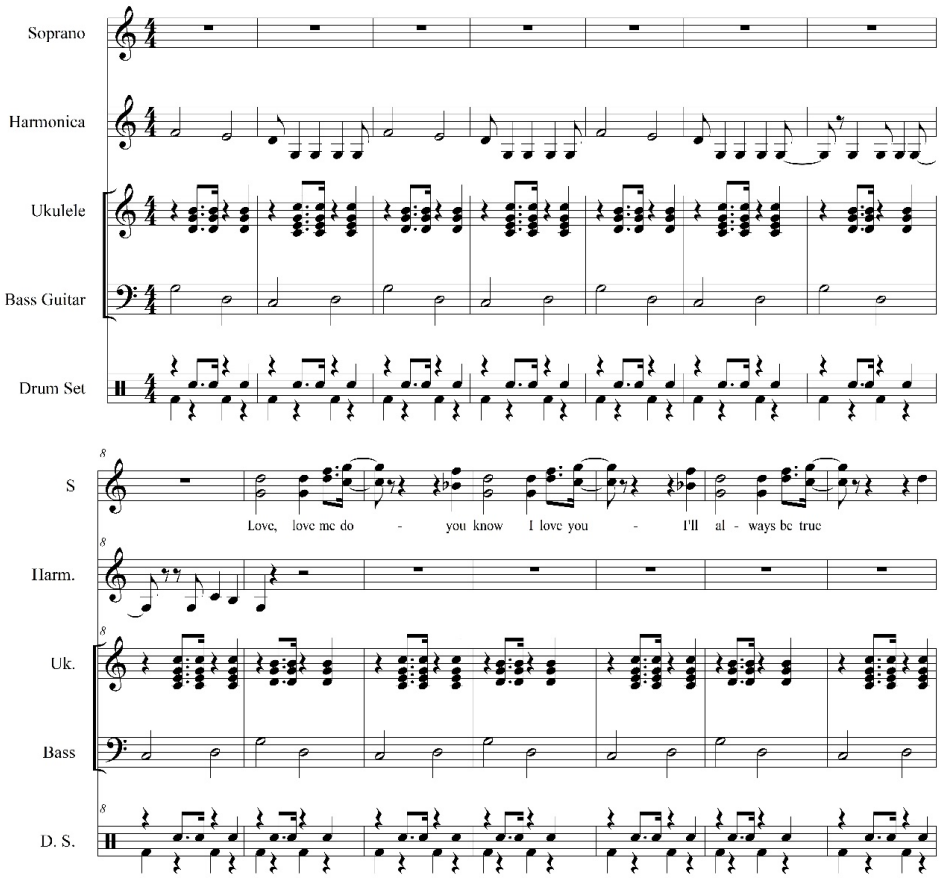


Figure 5. Final score of «Love Me Do» showing the interpretation done with *BandLab*.

First, a series of examples were taught that the students themselves used to put their performance skills into practice using MIDI instruments from the *BandLab* for Education program. Initially, they had to prepare the song «Love Me Do» by The Beatles with MIDI instruments and real recorded instruments. This was based on the above score (Figure 5), which they progressively prepared by introducing more and more instrumental parts. One member of the group prepared the Classic Rock drums by pressing the computer keys A (bass drum), F (snare drum) and P (cymbal) simultaneously (Figure 6); another member rehearsed the electric bass part, Electric Bass Legato, with a four-note melodic ostinato (sol, re, do, re).

A third member then rehearsed the accompanying guitar chords, recording the performance of a ukulele available in the music classroom, which was done with a Zoom H6 recorder microphone, also available in the classroom. Another member interpreted the accompanying melody of the harmonica on a MIDI instrument, and the last members sang lead and the secondary vocal part of the song (Figure 5). The students chose the instruments, adjusting their choices to the tone closest to the instrumental template used by The Beatles. The result made by the group 1 students of the Bachelor's degree in Teaching Primary Education can be heard in Example 2 in the Zenodo repository.

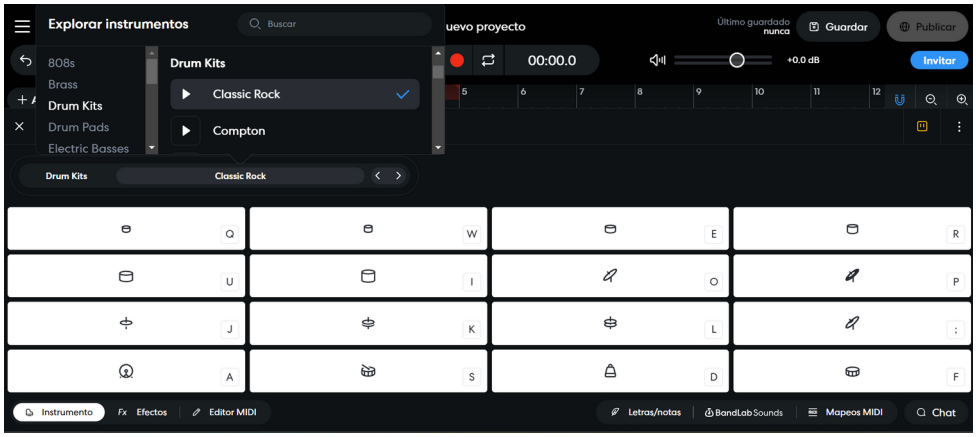


Figure 6. Pads from the drum part as MIDI instrument in *BandLab*.

After the initial example proposed by the teacher, the students had to develop and create new projects from already created songs in popular music. Each of the parts could be extracted by ear, or the score could be searched from numerous arrangements found on the Noteflight, MuseScore or IMSLP websites. From this, each member of the group was involved in developing the melody, harmony and rhythm of each instrument as well as singing the vocal part. The results of the groups in the Bachelor's degree in Teaching Primary Education can be observed in Examples 2 to 5.

The results are as follows: Example 3 is composed of a piece entirely interpreted on MIDI brass wind instruments and percussion from *BandLab*. To do this, the students composed the rhythmic base and reproduced the melody and harmony with a MIDI controller that played back each instrumental part with the song «Hit the Road Jack» by Ray Charles. Example 4 has interpretation of the choral song «Akai hana» from Japanese folk tradition. It is a piece with a lead vocalist and accompaniment (two voices per part, each recorded individually), plus parts with alto xylophone and bass xylophone as rhythmic and harmonic base. It is a fairly simple arrangement for the final courses in primary education. Example 5 is Coldplay's song «Paradise» recorded by a group of students who sang together in unison over a base with drum, bass and piano with MIDI instruments.

3.3. BandLab projects in the Master's degree

The project that was implemented with the students in the MESOB Master's degree was very similar to the one done in the Bachelor's degree in Teaching Primary Education except that the song arrangements had a higher level of difficulty. The results from the MESOB Master's students can be heard in Examples 6 to 10 in the Zenodo repository.

Example 6 is «Stand by Me» by Ben E. King. This is the song proposed by the group of students, who mixed MIDI instruments – drums, bass and piano – and recordings – maracas and vocals – in their interpretation. Example 7 is James Brown's «I Feel Good» with numerous MIDI instruments added (drums, bass, trumpet and sax) plus recorded vocals. Meanwhile, in Example 8 – Bruno Mars' «Uptown Funk» – they decided to introduce a drum machine, with a clapping rhythm and, after that, bass drum and snare drum. The keyboard and bass were added as MIDI instruments, and

they also decided to add a lead vocal part and recorded chorus effects. Example 9 has an interpretation of «Accidentally in love» by Counting Crows, from the Shrek soundtrack. It is a complex composition of MIDI instruments – drums, acoustic guitar, riff guitar and synthesizers – accompanied by lead and back-up vocals and a voice doing a downward octave, a sample of a clear example of a complete arrangement from the original song. Finally, Example 10 – Bob Marley's «One Love» – is also a sample of great instrumental development, adding melodies sung with three voices along with the recorded solo trumpet part plus bongo, organ, guitar, two keyboards and bass as part of harmonic crafting on MIDI instruments, as well as the MIDI drums as a rhythmic base.

Among the effects introduced in each song, students added compressors, equalizers, reverberation and normalization on virtually all tracks to achieve optimal results, similar to those done in a record production process.

3.4. SWOT analysis of debate on the didactic activity in ESO, the Bachelor's degree and Master's degree

After analysis of the last of the sessions, where a debate was held and new data was collected on the opinions and impressions of the students, the SWOT report was prepared on the use of DAW in the music classroom to achieve SO2. Following are the overall results for the three groups of participants:

- Strengths: Multitrack sequencers let you create original pieces or make complex musical arrangements by combining different audio tracks, effects and resources. Also, they encourage collaborative work, creativity and motivation in the students by offering them a means of personal and artistic expression. Likewise, they facilitate assessment and self-evaluation, allowing musical productions to be recorded and listened to. Both platforms are also very intuitive and permit rapid and progressive acquisition of musical and digital skills.

- Weaknesses: Multitrack sequencers require certain technical and musical knowledge for their use, which can be an entrance barrier for some students and teachers.

- Opportunities: The use of multitrack sequencers opens up new pedagogical and didactic possibilities, integrating not only these digital and musical skills into the curriculum but also others related to linguistic communication, mathematics, learning how to learn, and autonomy and personal initiative. They also favor inclusion and diversity, adapting to the needs and preferences of each student. Finally, they promote connection with the social and cultural environment, encouraging the exchange and dissemination of the musical work created.

- Threats: The use of multitrack sequencers can cause a loss of musical identity as they favor the imitation or plagiarism of existing work. They can also create unfair competition among students by valuing the quality of the final product over the learning process. Moreover, they can pose a legal risk if copyright is not respected.

Next, to fulfill SO3, is analysis of the differences found between groups:

a) The teacher needs to guide the process more closely when it comes to stages like ESO and also in the Bachelor's degree. In the Master's degree, almost all the students had greater autonomy in performing musical arrangements due to their greater knowledge of music and digital tools associated with production.

b) Through different methodologies used didactically – one with *Walk Band* for ESO and the other with *BandLab* for higher education – it was observed that the results are equally satisfactory in different ways: On the one hand, involving the entire class to do an arrangement of the same song in *Walk Band*; on the other, interpretive options and scores were researched by the groups to do different arrangements of various songs with *BandLab*.

c) Creating musical arrangements of songs has had very diverse results: simple adaptations in the case of ESO but with results that imply a clear acquisition of musical and digital skills, and more elaborate arrangements in the case of the Bachelor's degree students or even more complex ones in the case of the Master's students, with many more instrumental layers.

4. Discussion

Initially, it was shown how musical creation is an essential item in music education curricula, both in secondary education and higher education (Royal Decree 217/2022; Order ECI/3857/2007). In line with what has been noted in various research (Calderón-Garrido et al., 2019; Hamilton, 2021), teacher intervention developed through the use of LKT has been able to enrich the possibilities for musical expression and composition within an educational process.

In this sense, the results are consistent with other studies (Carroll and Harris, 2022; Casanova López and Serrano Pastor, 2016; Giráldez, 2012) in which the use of LKT in the initial training of teachers benefits their learning competencies, as well as their motivation and interest in the need for specific pedagogical training in this field (Author1 et al., 2021; Lam, 2023). It has been shown how, specifically, they have acquired musical and digital skills through the PBL methodology implemented, as also shown by Nielsen (2013) and Ocaña-Fernández et al. (2020) in their respective studies on musical creation via technological means.

Similarly, the data collected during the process confirms the benefits of digital resources for development of musical skills, such as instrumental practice and rhythmic skills (Giráldez et al., 2015). In this sense, it has been shown how technology can be used to improve music studies, facilitating creation and collaboration between students and teachers, as advocated by Brown (1999). Moreover, in the didactic proposal it has also been observed how these exercises with DAW favor the acquisition of other interdisciplinary competencies, like mathematical or interpersonal skills, which shows the transversality of the learning acquired, as noted by Calderón-Garrido et al. (2019).

Moreover, the different work done by the students highlights the opportunity to work with popular and traditional repertoires they feel close to and that are affordable (Faure Carvallo et al., 2020). Likewise, it is worth noting the design of teacher interventions through semi-structured activities that get progressively complex (Fick and Bulgren, 2022), which allows students autonomous learning that is playful and

collaborative, being able to develop creative group processes (Hernández-Sellés et al., 2015; Peters, 2015).

Therefore, it seems that the integration of resources such as *Walk Band* (2024) or *BandLab* (2024) in music education, both in ESO and in higher education, allows numerous skills to be developed in students. However, as Díaz Latorre (2018) argues, teachers must take into account the didactic objectives and not use this tool as an end in itself but rather as a resource for musical learning. For this reason, it is necessary to increase the didactic proposals that result in meaningful learning of musical concepts and procedures adapted to the different educational areas, as indicated by Giráldez et al. (2015) and Tejada and Thayer Morel (2019a and 2019b).

5. Conclusions

The above-mentioned results are clearly satisfactory for the reduced number of sessions, six, in which this didactic proposal was implemented. We can conclude by stating that this is a clear example of didactic sequencing and Project-Based Learning in which students notably collaborated to attain highly significant results.

Moreover, thanks to this proposal, numerous musical, digital and interpersonal skills were acquired that clearly showed the benefits in using DAW in the educational context. All of this makes these future music teachers – in the Bachelor's degree in Teaching Primary Education as well as in the MESOB – capable of using multitrack sequencers, in these stages of compulsory education, as digital tools for the development of musical expression and creativity. Although these resources require certain technical and musical knowledge for their operation, they also allow the creation of original pieces, complex arrangements and encourage collaborative work, creativity and motivation in the students. Therefore, teachers should be trained in these digital methodologies so they can be implemented in music classrooms.

As has been seen, there is still very little research referring to the pedagogy of these digital tools used primarily in music production but which are very useful and didactic for learning music. In addition, *BandLab* (2024b) and *Walk Band* (2024) are tools that facilitate assessment and self-evaluation, which allows the teaching-learning process to be observed progressively. This experiment has also shown the different degrees of interaction with the applications: While in ESO the arrangements were quite simple and supervised by the teacher, in the Bachelor's and Master's degrees greater development was shown both in the complexity of the arrangement (with many instrumental layers) and in the addition of effects that improved the musical production and final result.

Among the limitations of the study is the lack of a greater number of participants in the different groups and the short time available to implement the didactic proposal, due to the demands of the curriculum itself. It is hoped in the future to do mixed research – with quantitative and qualitative questions – on a larger group of students from various educational stages, including primary education. Said study will focus on the increase in musical abilities through the DAW used in the music classroom in basic education and the pedagogical benefits of the PBL methodology in the production of musical creation projects.

6. References

Berrón-Ruiz, E., Arriaga-Sanz, C. y Campayo-Muñoz, E.A. (2023). Recursos tecnológicos para la formación inicial del profesorado de Música: una intervención en el contexto universitario español. *Revista Electrónica de LEEME*, *51*, 16-35. https://doi.org/10.7203/LEEME.51.25680

Brown, A. R. (1999). Music, media and making: humanisin g digital media in music education. *International Journal of Music Education, 1*, 10-17.

Brown, A. R. (2014). *Music technology and education: Amplifying musicality*. Routledge.

Calderón-Garrido, D., Cisneros, P., García, I. D. y de las Heras-Fernández, R. (2019). La tecnología digital en la Educación Musical: una revisión de la literatura científica. *Revista Electrónica Complutense de Investigación en Educación Musical (RECIEM),* *16*(1), 1-15. https://doi.org/10.5209/reciem.60768

Carroll, C. y Harris, J. (2023). 'Because I'm not musical': A critical case study of music education training for pre-service generalist primary teachers in Australia. *British Journal of Music Education, 40*(2), 271-286. https://doi.org/10.1017/S0265051722000274

Casanova López, Ó., y Serrano Pastor, R. M. (2016). Internet, tecnología y aplicaciones para la educación musical universitaria del siglo XXI. *REDU: Revista de docencia Universitaria*, *14*(1), 405-421. http://dx.doi.org/10.4995/redu.2016.5801

Dammers, R. J. (2019). The role of technology in music teacher education. En R. Bader (Ed.), *The Oxford handbook of preservice music teacher education in the United States* (pp. 365-376). Springer.

Faure Carvallo, A., Gustems Carnicer, J. y Navarro Calafell, M. (2020). Producción musical y mercado discográfico: homogeneización entre adolescentes y reto para la educación. *Revista Electrónica de LEEME,* *45,* 69-87. https://doi.org/10.7203/LEEME.45.16625

Fick, J., y Bulgren, C. (2022). Developing 21st-century musicianship: Tablet-based music production in the general music classroom. *Journal of General Music Education*, *35*(2), 4-12. https://doi.org/10.1177/10483713211034434

Giráldez, A. (2012). *TIC y educación musical: Una revisión de las líneas de investigación sobre la creación musical en las aulas.* Recuperado el 6 de septiembre del 2023, de https://bit.ly/3trzlU4

Giráldez, A. (coord.) (2015). *De los ordenadores a los dispositivos móviles: Propuestas de creación musical y audiovisual*. Grao.

Hamilton, D. (2021). Hip-Hop Music Education: Engaging Students in Black Culture Creation and Social Justice Advocacy. *The Canadian Music Educator*, *63*(1), 20-28.

Hernández-Sellés, N., Martínez-Cerdá, J.-F. y Sánchez-Navarro, J. (2015). Herramientas y recursos para la creación y consumo musical en entornos virtuales. *Revista Electrónica De Tecnología Educativa (EDUTEC),* *54,* 1-15. https://doi.org/10.21556/edutec.2015.54.706

Lam, C. K. (2023). Technology-enhanced creativity in K-12 music education: A scoping review. *International Journal of Music Education*, 02557614231194073. https://doi.org/10.1177/02557614231194073

Lage Gómez, C. y Zahonero Rovira, A. (2012). El aprendizaje musical a través del pensamiento creativo: una investigación acción colaborativa en Enseñanaza Secundaria. En F. Guerra López, R. García Ruiz, N. González-Fernández, P. Renés Arellano, A. Castro Zubizarreta (coords.), *Estilos de aprendizaje. Investigaciones y experiencias:[V Congreso Mundial de Estilos de Aprendizaje]*. Universidad de Cantabria.

Latorre, N. D. (2018). La formación en TIC de los pedagogos de música. Análisis de la situación en las Enseñanzas Superiores de Música. *Revista Electrónica de LEEME*, *42*, 31-51. https://doi.org/10.7203/LEEME.42.13067

Mash, D. S. (1991). Acoustical and electronic instruments in jazz: An educational perspective. *The Journal of the Acoustical Society of America*, *90*(4_Supplement), 2353-2353.

Mendoza Ponce, J., & Galera Núñez, M. D. M. (2011). Tecnología Musical y Creatividad: Una experiencia en la formación de maestros. *Revista de la Lista Electrónica Europea de Música en la Educación, 28,* 24-36.

Merchán-Sánchez-Jara, J. F. y González-Gutiérrez, S. (2023). Collaborative Composition and Urban Popular Music in Digital Music Didactics. *Education Sciences*, *13*(8), 771. https://doi.org/10.3390/educsci13080771

Nielsen, L. D. (2013). Developing musical creativity: Student and teacher perceptions of a high school music technology curriculum. *Update: Applications of Research in Music Education*, *31*(2), 54-62.

Ocaña-Fernández, A., Montes-Rodríguez, R. y Reyes-López, M.-L. (2020). Creación musical colectiva: análisis de prácticas pedagógicas disruptivas en Educación Superior. *Revista Electrónica Complutense de Investigación en Educación Musical, 17*(1), 1-16. https://doi.org/10.5209/reciem.67172

Orden ECI/3857/2007, de 27 de diciembre, por la que se establecen los requisitos para la verificación de los títulos universitarios oficiales que habiliten para el ejercicio de la profesión de Maestro en Educación Primaria. *Boletín Oficial del Estado, 312*, de 29 de diciembre de 2007, pp. 53747 a 53750. https://www.boe.es/eli/es/o/2007/12/27/eci3857

Pascual Moltó, I., Cuenca Rodríguez, M. E., y Pastor Prada, R. (2021). Bandlab y *Walk Band*: aplicaciones para la composición de canciones en Educación Secundaria. En I. M. Monreal Guerrero y D. Carabias Galindo (Eds.), *Intersección: arte, sociedad y tecnología en la innovación musical* (pp. 12-15). Procompal Publicaciones.

Peters, K. (2015). *A guide to Key Stage 1 iPad apps*. Incorporated Society of Musicians. www.ism.org/blog/a-guide-to-keystage-1-ipad-apps

Real Decreto 217/2022, de 29 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Secundaria Obligatoria. *Boletín Oficial del Estado, 76*, del 30 de marzo de 2022. https://www.boe.es/eli/es/rd/2022/03/29/217/con

Rosen, D., Schmidt, E. M. y Kim, Y. E. (2013, June). Utilizing music technology as a model for creativity development in K-12 education. In E. Yi-Luen Do, S. Dow, J. Ox, S. Smith, K. Nishimoto, C. Tien Tan (Eds.), *Proceedings of the 9th ACM Conference on Creativity & Cognition* (pp. 341-344). ACM Digital Library. https://doi.org/10.1145/2466627.2466670

Tejada Giménez, J. (2004). Música y mediación de la tecnología en sus procesos de aprendizaje. *Educación XX1*(7), 15-26. http://www.redalyc.org/articulo.oa?id=70600701

Tejada Giménez, J. y Thayer Morel, T. (2019a). Diseño, implementación y evaluación de una intervención de formación en tecnología musical basada en TPACK y ABP en la formación inicial del profesorado de música de Educación Secundaria. *RELATEC: revista latinoamericana de tecnología educativa*. http://hdl.handle.net/11162/197423

Tejada, J. y Thayer Morel, T. (2019b). Design and validation of a music technology course for initial music teacher education based on the TPACK framework and the project-based Learning approach. *Journal of Music, Technology & Education*, *12*(3), 225-246. https://doi.org/10.1386/jmte_00008_1

Thayer Morel, T., Tejada, J. y Murillo Ribes, A. (2021). La formación tecnológica del profesorado de música en educación secundaria; un estudio de intervención basado en la integración de contenidos musicales, tecnológicos y pedagógicos en la universidad de valencia. *Revista electrónica interuniversitaria de formación del profesorado, 24*(3), 1-20. https://doi.org/10.6018/reifop.442501

Thorgersen, K. A., y Mars, A. (2021). A pandemic as the mother of invention? Collegial online collaboration to cope with the COVID-19 pandemic. *Music Education Research*, *23*(2), 225-240.

https://doi.org/10.1080/14613808.2021.1906216

Watson, S. (2011). *Using technology to unlock musical creativity*. Oxford University Press USA.