ARTICLES

Digital platforms for music production (DAW): educational innovation from music teacher training

Plataformas digitales de producción musical (DAW): innovación educativa desde la formación docente del profesorado de música

Javier Félix Merchán Sánchez-Jara[1]
Instituto Universitario de Ciencias de la Educación, Universidad de Salamanca (España)
Sara González Gutiérrez[2]
Instituto Universitario de Ciencias de la Educación, Universidad de Salamanca (España)
Susana Olmos Migueláñez[3]
Instituto Universitario de Ciencias de la Educación, Universidad de Salamanca (España)
Manuel Antonio García Malheiro[4]
Facultad de Educación, Universidad de Salamanca (España)

Abstract

This article analyses the possibilities of digital music production tools in the field of music teacher training. To do so, it identifies the different fields of action and the projection of music production resources in the educational environment, as well as the tools and functionalities of the Digital Audio Workstation (DAW) as a didactic resource. Based on the above, an action-research is carried out within the framework of secondary education teacher training of the music specialty of University of Salamanca, through a series of learning situations developed using the DAW and aimed at the acquisition of basic knowledge, the development of competences and the assimilation of music production concepts. The work shows how the DAWs are a very powerful and versatile resource for articulating learning situations that promote meaningful learning in real contexts, the development of creativity, the assimilation of complex and abstract concepts, while at the same time boosting self-esteem, motivation, and commitment to the subject.

Key words: Musical education; Digital didactics; Secondary Education; ICT.

Resumen

El presente artículo analiza las posibilidades de las herramientas digitales de producción musical en el ámbito de la formación docente del profesorado de música. Para ello, se identifican los diferentes ámbitos de actuación y la proyección de los recursos de producción musical en el entorno educativo, así como las herramientas y funcionalidades de las *Digital Audio Workstation* (DAW) como recurso didáctico. A partir de lo anterior, se desarrolla una investigación-acción en el marco de la formación del profesorado de Educación Secundaria de la especialidad de Música de la Universidad de Salamanca, a través de una serie de situaciones de aprendizaje desarrolladas mediante las DAW y orientadas a la adquisición de saberes básicos, desarrollo de competencias y asimilación de conceptos sobre producción musical. El trabajo pone de manifiesto como las DAW son un recurso muy potente y versátil para articular situaciones de aprendizaje que fomenten el aprendizaje significativo en contextos reales, el desarrollo de la creatividad, la asimilación de conceptos complejos y abstractos, al tiempo que potencien la autoestima, la motivación y el compromiso con la materia.

Palabras claves: Educación musical; didácticas digitales; Educación Secundaria; TIC.

---

[1] Assistant Professor Doctor, University Institute of Education Sciences, https://orcid.org/0000-0003-1828-5182
*Contact and correspondence: Javier Félix Merchán Sánchez-Jara, University Institute of Education Sciences, University of Salamanca, javiermerchan@usal.es, Faculty of Education, Pº de Canalejas, 169, 37008 Salamanca. Spain.
[2] Predoctoral Research Trainee, University Institute of Education Sciences, https://orcid.org/0000-0002-5706-4705
[3] Professor of University, University Institute of Education Sciences, https://orcid.org/0000-0002-0816-4179
[4] Independent Researcher, Faculty of Education, https://orcid.org/0009-0000-3857-6716

1. Introduction

The advances that have taken place in the field of technology from the last century to the present day have had a great impact on the field of music; both in the ways of creating, performing, recording, or disseminating/accessing music (Bauer, 2020) and in the epistemological and methodological foundations that inspire didactic innovations in the field of music education. The tools and resources resulting from these advances constitute a potential learning mediating agent that can be used from different perspectives depending on the objectives and their didactic projection (Tejada, 2004). From this perspective, the implementation of digital technologies in the music classroom not only implies new ways of approaching composition, performance, and response to the musical phenomenon (Dammers, 2012), but also favours the acquisition of digital competence and the development of interconnected educational communities that play a fundamental role both in the structuring of educational ecosystems and in the achievement of certain SDGs (Merchán, *et al.*, 2023). In this context it is important to understand what can be achieved through the creative use of music technology and its potential to transform the nature of music itself and how it is taught (Savage, 2010).

Therefore, this paper aims to highlight how the use of the Digital Audio Workstation (DAW) in music teacher training enables the articulation of learning situations that favour the connection with the students' musical world beyond the classroom, incorporating the artistic and functional practices of the contemporary socio-cultural environment both in the spaces of formal education and in those of continuing teacher training. As Berrón and Monreal (2020) point out, in the field of music pedagogy, university teachers cannot ignore the importance of developing pedagogical competence in methodological innovation in the initial training of future teachers. In this context, this action-research (AR) project (Sandín-Esteban, 2010) is highly significant because the development of new teaching methodologies through DAWs is an object of study that is emerging with great vitality in the academic field, with the particularity that its learning and mastery curve can be challenging for those teachers who do not have previous knowledge in this area; and it also represents a paradigmatic resource for the validation and improvement of teaching methodologies. Imbernón (2012) further states that although the research-teacher training relationship has advanced considerably and has provided clues on how to better plan teaching, a future can be foreseen in which this type of research on training processes in educational institutions must assume a greater presence in order to improve the educational ecosystem.

From this methodological framework, this article confirms how the easy access to DAWs and the enormous possibilities they offer, their proximity to the musical paradigm of the students, as well as the advantages they offer both for musical learning and for the promotion of autonomy and creativity, are aspects that justify their integration in the music classroom as a resource that supports paradigmatic learning situations to address a large part of the basic knowledge and the development of specific competences in music education. Furthermore, the research validates its implementation in university teacher training programmes, highlighting how reflection from educational research should be situated in the detection of emerging pedagogical needs (Holdhus, *et al.*, 2022) and how to provide a critical response adapted to the new technological possibilities, "transcending the mere translation of teaching-learning processes that took place in the analogue world to the digital world" (González, & Merchán, 2022, p.3).

2. Digital Audio Workstation: the portable production studio as a musical instrument

Nowadays it is possible to use music production as an educational resource through what are known as DAWs, software platforms for recording, editing, and producing music, by manipulating, organising, and processing digital sound in different tracks, many of them, such as BandLab, SoundTrap, Soundstation or Amped Studio, which are freely available online. The main advantage of these tools is that they allow all the stages of the process of creating, recording, and producing music in a professional studio to be carried out from a computer by abstracting all the elements and devices that make up the studio and integrating them into a flexible, modular, and portable virtual space. These platforms make it possible to record real sounds, work from advanced sound synthesis, design and apply digital sound effects, favouring the elaboration of arrangements, the creation of soundtracks or backing tracks and, in general, to produce and edit all kinds of music or sound recordings.

Likewise, DAWs offer practically unlimited possibilities in the service of fostering creativity, which translates into a great potential for the transmission and development of musical and aesthetic ideas, transforming its original character from an auxiliary tool for sound recording to its current conception as a musical instrument directly involved in almost all the processes of creation and performance (Bell, 2015). Moreover, it allows working with sound synthesis and manipulation, introducing the possibility of entering other musical paradigms centred on the sound element as a taxonomic unit of sound-based musical creation (Landy, 2007), expanding the aesthetic and creative possibilities beyond the boundaries of the tonal sphere, making it possible to introduce other aesthetic frameworks in the environment of electronic and/or experimental music. For this purpose, DAWs have a virtual mixer that facilitates working together with different tracks, sequencers, different types of sound synthesisers, virtual instruments, effects modules or sound libraries that allow almost any imaginable creative process to be tackled. In addition, they allow the import of musical works edited using score editors such as MuseScore or Sibelius, favouring the creation of productions through conventional musical writing.

In DAW studios, interaction with the elements of musical logic is carried out through a section called piano roll (Figure 1), which consists of a grid system representing time on its horizontal axis and musical pitches on the vertical axis, which favours the manipulation of sound events in a simple and intuitive way. In this sense, Kardos (2012) highlights the usefulness of this section for the assimilation of contents related to harmony, melody, rhythm, formal structure, or the production of arrangements in a very visual and didactic way and points out how these systems help to balance the possible disparity of levels in the classroom by virtue of their ability to show interactive contents at a lower level of abstraction and granularity.
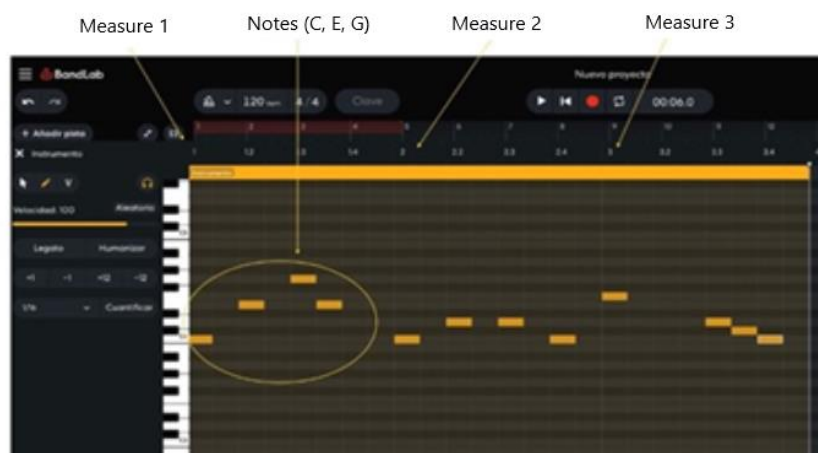
Figure 1. Piano Roll in DAW BandLab

3. Method

3.1. Context

This research has been developed in two annual cycles within the master's degree in Secondary Education and Baccalaureate, Vocational Training and Language Teaching at the University of Salamanca, from 2020 to 2022, extending these methodologies and proposals to subjects such as musical expression in Early Childhood Education.

3.2. Objectives

The main objective of the research is to analyse the didactic possibilities and the perception of DAWs as a resource for the specific training of music teachers through the approach and discussion of a series of learning situations (LS) related to the basic knowledge and competence development prescribed by the curricular regulations.

3.3. Design

The present work is articulated around a methodological apparatus (developed in the field of active methodologies) that integrates action research (AR) from a practical perspective (Kemmis, 2009), which implies a transitive and reciprocal relationship between the teacher (researcher) and the students and project-based learning (PBL) as a creative and consensual process. The eminently practical approach of these methodologies aligns very conveniently with the concept of DAWs as an instrumental resource for critically interrelating theory, practice, and artistic creativity, aimed at improving teaching practice (Lankshear, & Knobel, 2004). To this end, a series of stages are established, following the proposal of Kemmis and McTaggart (2005):

- Analysis of the issue: presentation of the technological resource (DAW) and its possibilities in the field of education; debate on music education based on creative practice; identification of areas for improving teaching through innovation through PBL.
- Planning: analysis of the stage objectives, basic knowledge and curricular competences, and identification and selection, among them, of the areas of application of the DAWs.

- Development: the design of a series of group learning situations (LS) related to the previously selected fields of action is proposed and discussed.
- Observation: analysis of the course of some of the activities and the results, both from the perspective of the development of the process and of the final product.
- Discussion and evaluation: finally, spaces are created for discussion and reflection on processes and outcomes and for obtaining data on the perception and performance of these.

In each academic year, a diagnostic evaluation of the students' competences and a final evaluation were carried out by means of oral questioning and observation of the students, to be able to compare the degree of achievement of the didactic objectives set and the perception of the technologies used through critical debates directed by means of semi-structured questions. Similarly, to reduce the perceptive bias of the participating researcher, the results obtained by the teacher-researcher are triangulated and contrasted with the participating students' own perceptions. A total of 47 students (N=47) took part in the research.

4. Methodological proposal for classroom work

The efforts made by educational institutions to implement digital technologies in teacher training processes have become essential to ensure quality and inclusive education, while maintaining a system that is able to meet the new educational challenges (Domínguez, & Pino, 2020). In this sense, the Master's Degree in Secondary Education and Baccalaureate, Vocational Training and Language Teaching (MUPES) at the University of Salamanca is a professional qualification that qualifies students to work as teachers in Secondary Education and Baccalaureate and has as its main objective (OG1)[5] that students know how to apply, as future teachers, the knowledge acquired and their ability to solve problems in environments related to the speciality studied. Within this framework, this degree includes specific subjects in the teaching innovation blocks aimed at the implementation of digital didactics and methodological developments based on the use of technology. In the current regulatory framework for Secondary Education in Spain (*Organic Law 3/2020, of 29 December, which amends Organic Law 2/2006, of 3 May, on Education, LOMLOE*), technological resources and tools in the subject of music, from the first to the third year, are considered transversally both in the specific competences and in the assessment criteria and basic knowledge. In this context, DAWs are a technological resource that can be applied in all the basic knowledge blocks[6] and facilitate the development of specific competences. This methodological proposal shows learning situations (LS) grouped in relation to the blocks (A) *Listening and Perception*; (B) *Performance and Improvisation and Scenic Creation* and (C) *Contexts and Cultures*, indicating the specific competences (SC) to which each of them is related[7].

4.1. Block A. Listening and perception

4.1.1. Physical qualities of sound and the use of virtual instruments. SC (1)(4)

Starting from a previously selected musical fragment, the possibilities of manipulating the sound characteristics of each track (timbre, intensity, duration) are considered to analyse their

---

[5] Referenced according to the curricular regulations of the MUPES Master's Degree (University of Salamanca). Available at: https://www.usal.es/files/competencias_1_0.pdf
[6] Referenced according to the EducaGob portal. Available at: https://lc.cx/cojV3T
[7] Curricular elements referenced in relation to the classification established in: EducaGob: Portal del Sistema Educativo Español. Available at: https://lc.cx/cojV3T

repercussion on the musical proposal, from the point of view of perception and impact at an artistic level. Among these, the manipulation of the editing parameters in different virtual instruments stands out, investigating the configuration possibilities they offer, with the aim of analysing how they help to establish stylistic marks in different genres of contemporary popular music. This learning situation favours the discussion of issues such as the general classification of instruments and the role of timbre in sound discourse.

4.1.2. Sound analysis, generation, and synthesis. SC (4)(2)(1)

Along the same lines, this LS proposed the analysis and projection of timbre as a compositional structure (Peyrou, 2022), and experimentation with some of the predetermined sounds offered by the synthesizers integrated in DAWs (presets). Once familiarised with these possibilities, and as a reverse process, the selection of a series of paradigmatic sounds of current music is proposed to try to synthesise and emulate them through the tools of the DAW. The LS approach serves as a theoretical-practical substrate to address how a large part of the sound profiles, understood as the main components at a timbral and structural level, characterise many of the genres of today's popular music. Similarly, the question can be transferred to the field of classical music, discussing how the conductors of large orchestras and instrumental and/or vocal ensembles develop their own aesthetic imprint by manipulating assimilable sound parameters, or how compositional structures based on timbral aspects are often representative of genres, periods and/or cultures.

4.1.3. The sound effect as an artistic resource. SC (2)(4)

The following SA is developed through the use of a musical fragment (accompanied melody) elaborated through the MuseScore platform and exported as a MIDI file to the DAW BandLab[8], and consists of the application of different digital effects to the tracks that make up the work, experimenting with the available editing parameters. This proposal is carried out after active listening and the corresponding explanation of the main types of effects, grouped into the following categories:

- Delay: Reverberb, echo and delay.
- Modulation: Chorus, tremolo, flanger and phaser.
- Dynamics: Distortion and compression.

The tasks developed in this LS allow us to deal with concepts related to musical acoustics such as modulation, frequency, or amplitude, linked to the qualities of sound and its incidence at an aesthetic and discursive level in musical production (Thibeault, 2017).

4.1.4. Pedagogical projection: DAWs in *Listening and Perception*

The act of critical listening is inherent to the enjoyment, understanding and learning of music. In this sense, music production has been revealed as a process that facilitates competences related to the understanding of sound as a physical entity, allowing the identification, evaluation

---

[8] Available at: https://www.bandlab.com/

and manipulation of certain characteristics and parameters directly related to constitutive aspects of forms, styles, or aesthetic paradigms of musical expression.

The intervention favours an interesting debate in relation to the implications of the elements of sound from the point of view of its use as a compositional resource for the creation of textures and creative resources, introducing examples such as timbre consonance/dissonance or concepts and functions such as orchestration and its relevance as a structural factor in musical discourse (Walzer, 2016). From this perspective, the impact that these issues have on musical creation, performance and their use as an element shaping the musical canon of many styles in the context of urban popular music is highlighted (Reuter, 2021). In the same way, the pupils state as extremely interesting the possibility of experimenting with the creation of their own sounds with the intention of representing concepts, feelings, or moods, configured through free experimentation with the controls in terms of different applications (narration, programme music, ambient music, etc.). Finally, the effect of Auto-tune as a creative resource and its semiotic projection in different musical styles was analysed on a technical and aesthetic level.

4.2. Block B. Performance, improvisation, and stage creation

4.2.1. Creation of backing tracks. SC (2)(4)

Backing tracks (BT) are instrumental accompaniment productions, generally used for musical practice and/or improvisation. These recordings replace the soloist's accompanying parts, emulating a particular instrumental ensemble. In this LS the students were faced with the creation of a BT, based on a blues progression, for improvisation practice, analysing and discussing issues related to harmony, instrumentation, tempo, tonality, etc. The possibility of working on tracks offered by DAWs made it possible to implement complementary didactic strategies related to the substitution of specific parts, rhythmic superimposition, identification, and application of arrangement techniques, etc.

4.2.2. Music creation based on loops and mash-ups. SC (1)(2)(2)(4)

Loop-based composition is a technique for creating simple musical works by creatively joining together pre-configured musical fragments. Extending the concept, the mash-up technique refers to the combination (Figure 2) of two or more songs (or fragments thereof), while maintaining the integrity of their constituent elements, to create a new and original work. This requires a certain degree of similarity between them in terms of tonality, harmony, or rhythm, so that the new creation is musically coherent. In a preliminary way, the skills of musical analysis and the search for musical information are worked on according to the criteria that affect musical logic itself. The LS results in one of the most paradigmatic products of this type of creations by synthesis of pre-existing works, consisting of combining recordings of vocal works (*a cappella*), which play the melodic function, with another work of an instrumental nature that acts as the rhythmic-harmonic base of the latter.
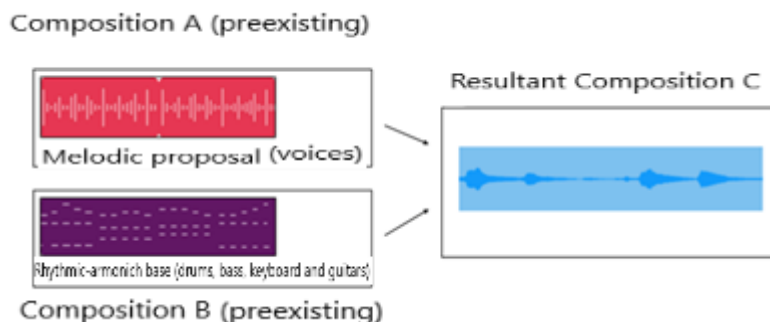
Figure 2. Process of music creation by mash-up

4.2.3. Improvisation. SC (2)(3)

Using the BTs created in the previous LS, the future teachers took advantage of the instrumental practice to work with the DAWs on their improvisations in the classroom. This task was preceded by an analysis of the blues structure as a framework for improvisation, the development of motifs or adaptation to the style, addressing issues such as the scale-chord relationship, the superimposition of triads, modal improvisation, etc. This practice was used in parallel to work on the approach to different musical genres from the perspective of achieving respect for multiculturalism (Bernabé, 2013).

4.2.4. Creation, recording and basic editing of a musical work. SC (1)(3)(4)

Following Bielmeier's proposal (2021) for the elaboration of a musical production (planning, pre-production, recording, post-production, and distribution), a LS is proposed aimed at approaching the production of an original creation. The project contemplates the approach to musical creation as a process for tackling basic knowledge about the constituent elements of the musical phenomenon: form, structure, tonality, musical scales, harmonic development and rhythm, arrangements, prosody, etc. Likewise, the production process analyses the phases of recording acoustic instruments with editing and mixing of virtual instruments and was the guiding thread for the presentation and acquisition of specific competences such as exploring the expressive possibilities of different musical techniques, developing criteria for selecting the most suitable techniques for the expressive intention or identifying the main stylistic features of different forms and styles.

4.2.5. Pedagogical projection: DAWs in *Performance, Improvisation and Stage Creation*

The process for the elaboration of backing tracks (Figure 3) favoured the internalisation of the basic elements of music and formal schemes for the construction of musical productions, being used in performance and improvisation activities through which questions related to phrasing, the development of motifs or the discursive possibilities of each harmonic progression are addressed. Along these lines, DAWs encourage creativity by allowing experimentation with their wide range of sounds, effects and timbral possibilities in the elaboration of the most appropriate instrumental bases for each of the musical aspects to be worked on.

Figure 3. Example of the process of composing backing tracks

The more complex music creation activities (Figure 4) are carried out when the students have a certain degree of familiarity with the DAWs, focusing on the musical aspects and the development of musical creativity. This process proves to be well suited to address, in an interrelated way, the most basic aspects of composition in a real environment, adapted to the context and closely conducive to experimentation.
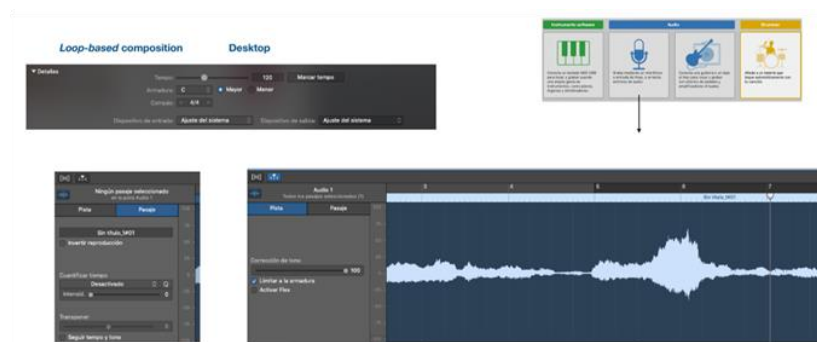

Figure 4. Example of the compositional process using loops

4.3. Block C. Contexts and cultures

4.3.1. Music in audiovisual narrative. SC (2)(4)

The first LS related to the *contexts and cultures* block deals with the capacities of expression, connotation, and significance of music in relation to the image from an extradiegetic perspective. To this end, a scene from the film *The Shape of Water* (2017) is proposed as an example, to elaborate two variants of it: in one case, by choosing different pre-existing musical fragments, and in another, by producing an original fragment aimed at evoking preconceived effects. In this context, the process of identifying and selecting the music was discussed, and the effects on the viewer's perception, the sensations and emotions generated, the expressive projection and the semiotic and narrative transformations resulting from the application of different musical backgrounds were critically analysed.

4.3.2. Music and video games. SC (1)(2)(4)

Continuing with the issues addressed in the previous scenarios, in this LS, the development of certain musical fragments is proposed, as a soundtrack, to accompany a series of

predetermined passages of the music video game *Lost in Harmony* (2016). The planning includes a series of guidelines and resources to structure the productions: analysis of the narrative aspects of the audiovisual fragment, selection of the musical style, instrumentation, tempo, meter, questions of tonality and harmony, soloist, and accompaniment functions, etc. In addition, it is proposed to begin the process by starting from a generative motif on which to build the rest of the composition: a rhythmic scheme, a chord progression, or a melodic motif.

4.3.3. Pedagogical projection: DAWs in *Contexts and Cultures*

Working with DAWs as a means of producing audiovisual-oriented productions reinforces the acquisition and understanding of basic curricular knowledge and the understanding of the musical phenomenon through artistic self-experimentation, enabling the development of creativity without the need for highly specialised prior knowledge. Furthermore, the use of DAWs and music technology provides a wide variety of new possibilities for educational applications. In this sense, experimentation with the recording process led the students to a critical reflection on current musical trends and their own musical tastes through a series of approaches and discussions that allowed triangulation with the rest of the data obtained in the study. In short, basic notions of DAWs at an operational and conceptual level allow for a significant understanding of the compositional structures of music, its forms, the role of organological expressions or the characterisation of genres and styles through the exploration and interaction with the structural elements of music.

5. Evaluation of proposals

Competence assessment in creative processes is a multifaceted and complex issue that does not offer generalisable, context-independent solutions. On the other hand, as Bielmeier (2021) points out, assessing performance based on the result of the product and artistic quality in a basic level project is counterproductive because it delegitimises the pedagogical value of procedural development. Therefore, assessment is approached through the analysis of the development of the technical, creative, and social skills involved in the students. In this way, musical, creative, and concept-application results are assessed and quantified, focusing on the skills to manage, apply and develop the creative process. In short, the ability to solve problems creatively, autonomously and in terms of the application of knowledge and competences, as well as their level of appropriateness, are valued. In these cases, as Clauhs, *et al.* (2019) argue, the use of rubrics is very useful for assessing music teaching/learning through technology, especially given the difficulty of assessing artistic and creative aspects through other types of procedures. Table 1 below shows the rubric developed and used for the evaluation of the projects:

Table 1. Rubric model for assessment of DAW-based Learning Situations

	Superficial	**Acceptable**	**Very good**	**Excellent**
Level of capacity to identify operational strategies	Partially identifies, with significant errors, some strategy to solve the problems posed by the LS	Identifies different strategies for solving LS problems	Clearly identifies a set of appropriate strategies to solve the problems posed by LS	Clearly identifies optimal strategies for solving LS problems
	Superficial	**Acceptable**	**Very good**	**Excellent**

	Superficial	Acceptable	Very good	Excellent
Identification of techniques and functionalities related to the requirements	Partially identifies, with significant errors, some of the appropriate techniques and functionalities to solve the objectives set	Identifies different techniques and functionalities to solve the objectives set out	Clearly identifies a set of techniques and functionalities appropriate for solving the stated objectives	Clearly identifies the optimal techniques and functionalities to solve the stated objectives
	Superficial	**Acceptable**	**Very good**	**Excellent**
Level of adequacy of objectives/results	The results are only partially in line with the objectives of the LS	The results correspond well with the objectives of the LS	The results correspond very well with the objectives of the LS	The results correspond in an optimal way with all the objectives set out in the LS
	Superficial	**Acceptable**	**Very good**	**Excellent**
Level of creative development	Superficial or uninteresting artistic and aesthetic appeal	Acceptable artistic and aesthetic appeal with some original and interesting musical ideas	Great artistic and aesthetic appeal. Conveys originality, aesthetic coherence, and musical interest	Artistically and aesthetically impressive with great power of persuasion and musical communication

Subsequently, after analysing the assessment results of the first annual cycle, two items (Table 2) related to the degree of adaptation to the criteria previously established by the teaching staff and to the self-perception of performance through self-assessment, to be filled in by the students for self-management of the process, were incorporated into this assessment instrument as a proposal for improvement.

Table 2. Development of the rubric for evaluation of DAW-based Learning Situations

	Superficial	Acceptable	Very good	Excellent
Adequacy	Little or no compliance with the criteria previously established by the teacher	Irregular adequacy, exclusively fulfils some criteria previously established by the teacher	Good compliance with the criteria previously established by the teacher	Full compliance with the criteria previously established by the teacher
	Superficial	**Acceptable**	**Very good**	**Excellent**
Self-assessment	The perception of the work carried out in the group is superficial. Very low degree of involvement in the project	The perception of group work is good. Low degree of involvement in the project	The perception of the work carried out individually and/or in groups is very good. High degree of involvement in the project	The perception of the work done in the group is excellent. Very high degree of involvement in the project

Similarly, a rubric is applied to ascertain the suitability of each of the LS and the DAW as a technological resource for tackling each of the basic knowledge and developing the different basic competences related to each of the LS. The results (Table 3) are evaluated by means of a synthesis of the perception of the students themselves and of the teacher in charge of tutoring the LS. In this case, a similar generic scale is retained with the values superficial, acceptable, very good and excellent.

6. Results and discussion

The use of DAWs and knowledge of the music production process is shown to be a resource with great impact in the music classroom, offering multiple possibilities for the development of learning situations related to the basic knowledge reflected in the curricular regulations. These resources act as a backbone to interrelate and create spaces where autonomous learning, specific technological literacy and musical contents converge (Figure 5), and their implementation for the development of learning situations is perceived as very positive.
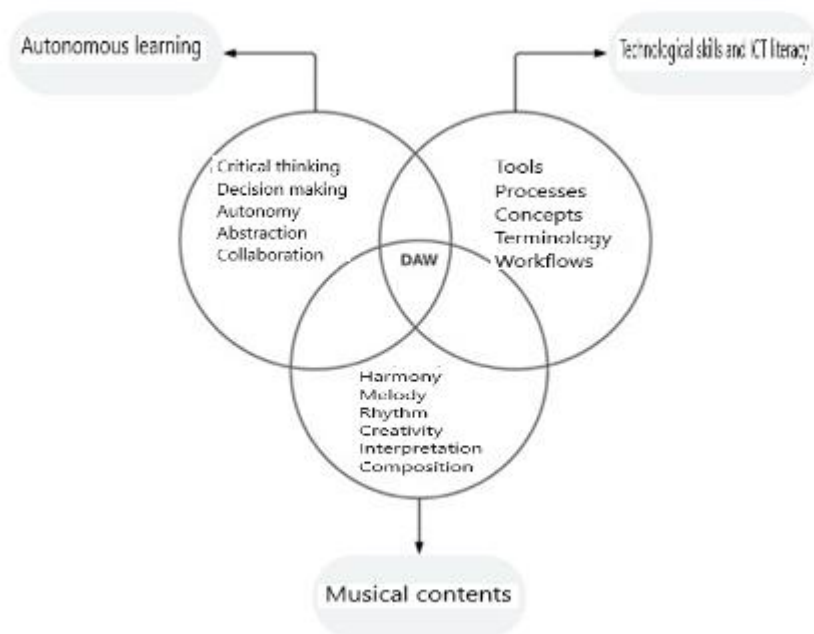
Figure 5. DAWs as the backbone of the teaching-learning process

The results obtained (Table 3) show descriptively the perceived level of operability of the DAWs for the acquisition of basic knowledge and the development of the specific competences associated with each LS.

Table 3. Results obtained from the perception of the level of operability of DAWs in the music classroom

	Superficial	Acceptable	Very good	Excellent
SA. The sound	0%	0%	42%	58%
SA. Sound synthesis	8%	16%	42%	33%
SA. Sound effects	8%	25%	25%	42%
SA. Backing tracks	0%	8%	17%	75%
SA. Loops and mash-ups	0%	25%	33%	42%
SA. Improvisation	0%	0%	8%	92%
SA. Creation	0%	0%	16%	84%
SA. Narrative	0%	16%	25%	59%
SA. Video games	0%	16%	17%	67%

As can be seen, most of the LS are perceived as very good or excellent, reaching almost 100% in areas such as improvisation or creation; it is clear in this case that the activities related to purely creative aspects, where students can express themselves individually, propose their own vision or develop artistic expressiveness, are the ones that are significantly more attractive. In the rest of the areas, DAWs are perceived as acceptable, very good or excellent, and there are only

two areas (synthesis and sound effects) where some of the participants consider them to be a superficial resource; in these cases, the high technicality, and the relation with acoustic or technological aspects, far from the musical subject itself, may be the underlying causes for a less enthusiastic perception.

From a qualitative perspective, the data show how activities centred on the production of many of the most popular musical genres among young pupils enable the development of creativity through productions that serve to promote different skills, assimilate concepts and knowledge in a real context and encourage motivation and commitment to learning the subject thanks to the proximity and recognition of an aesthetic paradigm perceived as their own. Classroom discussions highlight how pupils systematically opt to incorporate, make visible and situate these musical paradigms as repertoires of their own in the curriculum on an equal footing with other musical cultures traditionally assimilated as academic or canonical. Furthermore, the strengthening of the creative aspects of the proposals developed allows us to overcome the traditional approach to technologies focused on the understanding of technical and operational procedures, lacking a strong creative approach (Wise, 2016), to move on to explore, as a priority, their creative and expressive possibilities as an organological element and musical instrument (Bell, 2018). In this way, the proposed approaches are shown as a reference to enhance the way in which students apply digital technologies to their own learning and creative production, emphasising the development of the capacity for expression through technology and not only the technical skills necessary for the management and operation of systems or applications (Pierard, & Lines, 2022).

The development of the creative facet fosters in parallel an evident motivational commitment closely related to the increase of self-esteem and the self-perceived improvement of competence. After various discussions related to the post-intervention questioning, it can be seen (Figure 6) that a large majority of students (76.6%) show a high degree of motivation in relation to the perceived artistic experience and the course of the learning process. Only 8.5% of the students perceive the tool and the training approaches as not very motivating and none of the participants find it not motivating at all. From this fact (no rejection) it can be deduced, moreover, that both the operational issues and the relation of the proposals with the curricular contents are understandable, close, and assimilable by the students.


**Figure 6.** Degree of motivation and perceived satisfaction of the student

Similarly, the data support the significance of the music production practices and aesthetic frameworks from which many of today's popular music genres are developed. In this sense, understanding how music is created and recorded, and the process from the original idea

to the final product, "cannot be sufficiently analysed and understood without taking into account all the technical and creative processes in the recording studios" (Faure, *et al.*, 2020, p.80). Consequently, music production, besides strongly favouring the acquisition of specific skills and promoting technological literacy, has made it possible to raise LS related to the process of music creation, listening and critical reflection on genres, periods, aesthetic and stylistic features, and the role of music in a multimedia environment. The instantaneous feedback offered by the sound reproduction of each editing or creation process allows students to handle multiple representations of the contemporary musical imaginary and to analyse the different parts of the creation, facilitating decision-making and discussion on musical aspects in a less abstract way (Biasutti, & Concina, 2020), producing a significant transformation at the epistemological level between traditional pedagogies based, to a large extent, on the transmission of theoretical knowledge through the magisterial discourse.

In a subsidiary way, it is very eloquently corroborated (Figures 7 and 8), in line with Faure *et al.* (2019) and Baño and Pozo (2023), how the use of DAWs in music education improves the social climate in the classroom and develops and enhances personal autonomy and creativity. This question is particularly interesting in an educational context such as the present one in which the development of creativity through technological interaction is a characterising precept of music education in the 21st century (Ferguson, & Brown, 2016).
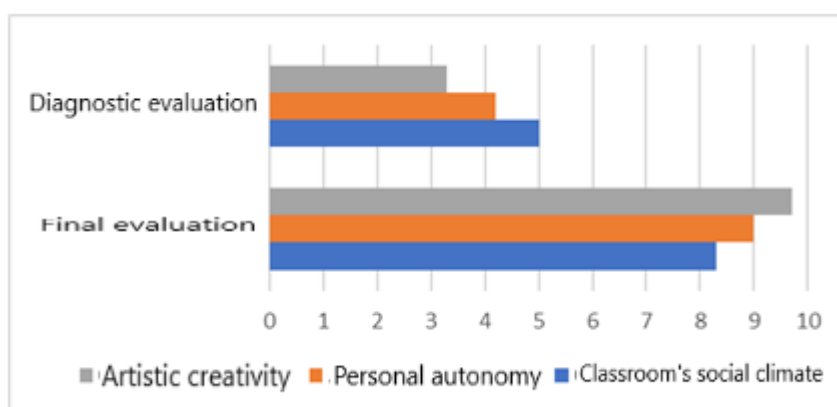
Figure 7. Implementation of DAWs in the first annual cycle: Social climate, personal autonomy, and creativity in the classroom
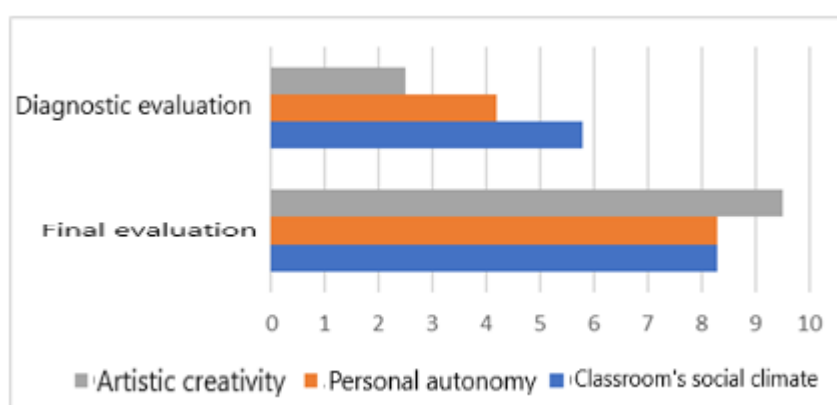
Figure 8. Implementation of DAWs in the second annual cycle: Social climate, personal autonomy, and creativity in the classroom

In the context of digital literacy, it is clear from the various debates held that the use of ICT in student education has not gone beyond the anecdotal and is limited, in many cases, to the

projection or reproduction of audiovisual content, information search and selection tasks or the sporadic use of applications for mobile devices, findings that are in line with the ideas set out in Merchán *et al.* (2022). In this sense, DAWs emerge as a resource that makes it possible to alleviate many of these technological deficiencies and contribute significantly to the development of specialised digital competences through the creative application of basic knowledge, content and specific competences related to curricular regulations.

Figure 9. Students using DAW platforms in the music classroom

From a pedagogical perspective, it favours the integration in the classroom of current popular music repertoires and a large part of its paradigmatic processes and contexts of creation and production which, as Hoon (2018) points out, allow for the establishment of links between learning and informal musical practice and curricular requirements to promote authentic learning through the representation of varied experiences that amplify musical learning and understanding. In this vein, the perception of the technological element as a centralising agent promotes a shift from an instructivist to a more constructivist pedagogical approach that also favours a shift in the pragmatic domain from teacher-directed to learner-centred activities (Wise, *et al.*, 2011).

These issues are in line with pre-existing studies in which the activities articulated through this type of platforms allow the integration of content, the strengthening of self-confidence in technological competence and the perception of usefulness in the field of professional praxis, both processes and of the products developed. Specifically, and as noted in Thayer *et al.* (2021), the study highlights how this type of intervention makes it possible to meet the different needs of students and integrate different musical styles using innovative, creative, constructive, and multipurpose strategies.

Finally, there is a lack of prior technological skills related to the knowledge and use of applications and resources for recording, editing, and processing audio and, in general, of all types of digital resources related to music education, which are reflected in turn in other studies such as the one proposed by Tejada and Thayer (2020). In it, they highlight the lack of technological skills before the start of the intervention and how this produces insecurity and stress in the face of the challenge of technological performance. This issue necessarily implies addressing the fact that the use of these tools implies a long learning curve (González, & Merchán, 2022), and a familiarisation with certain concepts that must be known and assimilated beforehand. Learning to exploit all the possibilities of DAWs implies a parallel learning process that must be progressive, well-planned, and aligned with the evolution of students in the internalisation of knowledge and competences. Moreover, the implementation of DAWs within educational ecosystems is based on the theoretical assumption that music learning through music production technologies should focus on the process rather than on the result. For this reason, the emphasis is placed on avoiding

placing music production at the centre of music teaching, nor as a resource to replace other teaching methodologies and practices, but rather on placing the focus on its educational projection and raising the possibilities of its application in music teaching classrooms. On the other hand, a high degree of receptiveness on the part of students towards this type of development is observed, highlighting how these enable them to acquire skills and possibilities that they had never thought possible through approaches that are developed with great satisfaction (Tejada, & Thayer, 2020).

7. Conclusions

Digital technologies represent a significant advance and inaugurate a new horizon of perspectives in the field of Music Education with the clear and undeniable objective of making it a more inclusive and creative practice (Merchán, *et al.*, 2023). Specifically, the production and treatment of sound through the so-called DAW platforms in the educational field offers a series of opportunities to implement more meaningful musical teaching-learning processes, fostering the development of creativity through the creation and manipulation of sound material in the digital environment. This research documents and identifies its most relevant areas of action and relates various proposals for application that highlight its didactic potential in the music classroom; its accessibility and flexibility, the promotion of creativity, abstract, critical, and multimodal thinking in students lays the foundations for a methodological renewal for the development and design of LS that favour the acquisition of specific competences in real environments. Within this framework, it becomes clear how DAWs offer a critical response to emerging professional needs, based on new technological possibilities, and transcending the mere translation of teaching/learning processes that took place in the real physical world to the digital world (González, & Merchán, 2022). As March (2006) states, selecting learning and teaching methodologies that favour an approach to professional reality to achieve meaningful, deep, and constructive learning, which allows us to continue learning on a permanent basis, must become one of the central themes in educational research.

To this end, it should be borne in mind that the approaches related to the use of DAWs encourage the acquisition of the technological competences that underpin the teaching/learning process in this context and that, ultimately, allow the wide range of possibilities and functions offered by this resource to be exploited. In this sense, the role of the teacher as a guide in the development of the methodological process is key (Walzer, 2020; 2021) to observe which aspects, require greater attention and to provide students with the optimal support and tools according to their pedagogical needs. From this approach, the use of DAWs in the music classroom can help to enhance motivation and engagement, enjoyment and artistic understanding of the musical phenomenon, critical analysis, and self-confidence, as well as the acquisition of skills related to autonomy, decision-making and problem-solving.

Funding and acknowledgements

References

Baño, L., & Pozo, J.I. (2023). The influence of musical production structures in group learning management. *Research Studies in Music Education*, *0*(0). https://doi.org/10.1177/1321103X231175389

Bauer, W.I. (2020). *Music learning today: Digital pedagogy for creating, performing, and responding to music*. Oxford University Press.

Bell, A.P. (2015). DAW democracy? The dearth of diversity in 'Playing the Studio'. *Journal of Music, Technology & Education*, *8*(2), 129-146. https://doi.org/10.1386/jmte.8.2.129_1

Bell, A.P. (2018). *Dawn of the DAW: The studio as musical instrument*. Oxford University Press.

Bernabé, M. (2013). Importance of music as a means of intercultural communication in the educational process. *Teoría De La Educación. Revista Interuniversitaria*, *24*(2), 107-127. https://doi.org/10.14201/10357

Biasutti, M., & Concina, E. (2020). Online composition: strategies and processes during collaborative electroacoustic composition. *British Journal of Music Education*, *38*(1), 1-16. https://doi.org/10.1017/S0265051720000157

Bielmeier, D. (2021). Linking Creative Practice with Audio Production Education in the Music Industry Classroom. *Journal of the Music and Entertainment Industry Educators Association*, *21*(1), 45-63. https://doi.org/10.25101/21.2

Clauhs, M., Franco, B., & Cremata, R. (2019). Mixing It Up: Sound Recording and Music Production in School Music Programs. *Music Educators Journal*, *106*(1), 55-63. https://doi.org/10.1177/0027432119856085

Dammers, R.J. (2012). Technology-based music classes in high schools in the United States. *Bulletin of the Council for Research in Music Education*, *194*, 73-90. https://doi.org/10.5406/bulcouresmusedu.194.0073

Domínguez-Lloria, S., & Pino-Juste, M. (2020). Comparative analysis of initial teacher education for primary and secondary music teachers in Europe. *Electronic Journal of LEEME*, *46*, 224-239. https://doi.org/10.7203/LEEME.46.18033

Faure, A., Gustems, J., & Navarro, M. (2020). Music production and the record market: homogenisation among adolescents and challenge for education. *Revista Electrónica de LEEME*, *45*, 69-87. https://doi.org/10.7203/LEEME.45.16625

Faure, A., Oriola, S., & Montoya, A. (2019). The Digital Audio Workstation and its contribution to the development of competences in secondary education. In Vaquero, E., Brescó, E., Coiduras, J.L., & Carrera, X. (Eds.), *EDUcación con TECnología: un compromiso social. Initiatives and results of research and experiences in educational innovation* (pp.889-899). Edicions de la Universitat de Lleida. https://repositori.udl.cat/handle/10459.1/64975

Ferguson, J.R., & Brown, A.R. (2016). Fostering a post-digital avant-garde: research-led teaching of music technology. *Organised Sound*, *21*(2), 127-137. https://doi.org/10.1017/S1355771816000054

González-Gutiérrez, S., & Merchán-Sánchez-Jara, J. (2022). Digital humanities and educational ecosystem towards a new epistemic structure from digital didactics. *ThinkEPI Yearbook*, *16*, 1-7. https://doi.org/10.3145/thinkepi.2022.e16a35

Holdhus, K., Christophersen, C., & Partti, H. (2022). Soundtrapped? Socio-material perspectives on collaborative teaching within the music classroom. *Research Studies in Music Education*, *0*(0). https://doi.org/10.1177/1321103X221115978

Hoon, H. (2018). Enabling popular music teaching in the secondary classroom-singapore teachers' perspectives. *British Journal of Music Education*, *35*(3), 301-319. https://doi.org/10.1017/S0265051717000274

Imbernón, F. (2012). Research on and with teachers. The impact on teacher training, how to do research? *Revista Electrónica de Investigación Educativa*, *14*(2), 1-9. http://redie.uabc.mx/vol14no2/contenido-imbernon2012.html

Kardos, L. (2012). How music technology can make sound and music worlds accessible to student composers in Further Education colleges. *British Journal of Music Education*, *29*(2), 143-151. https://doi.org/ 10.1017/S0265051712000186

Kemmis, S. (2009). Action Research as a Practice-Based Practice. *Educational Action Research*, *3*(17), 463-474. https://doi.org/10.1080/09650790903093284

Kemmis, S., & McTaggart, R. (2005). Participatory Action Research: Communicative Action and the Public Sphere. In Denzin, N.K. and Lincoln, Y.S. (Eds.), *The Sage handbook of qualitative research* (pp.559-603). Sage Publications Ltd

Landy, L. (2007). *Understanding the art of sound organisation*. MIT Press.

Lankshear, C., & Knobel, M. (2004). *A Handbook for Teacher Research: From design to implementation.* Open University Press.

March, A.F. (2006). Active methodologies for competence training. *Educatio siglo XXI*, *24*, 35-56. https://revistas.um.es/educatio/article/view/152

Merchán Sánchez-Jara, J., Ramos Ahijado, S., & Montoya Rubio, J.C. (2022). Educational ecosystems for music practice in the Social Web environment: a systematic literature review. *Revista de Investigación Educativa*, *40*(2), 565-587. https://doi.org/10.6018/rie.477721

Merchán-Sánchez-Jara, J.F., González-Gutiérrez, S., & Cruz-Rodríguez, J. (2023). Sustainable Development Goals and Music Education: initiatives from the training of secondary education teachers. In C. López-Esteban (Ed.), *Propuestas docentes para la integración de la Agenda 2030 y los ODS en la Universidad de Salamanca: modelos y experiencias en el Máster en Profesor de Educación Secundaria Obligatoria y Bachillerato, Formación Profesional y Enseñanzas de Idiomas* (pp.389-404). Ediciones Universidad de Salamanca.

Merchán, J.F., González, S., Olmos, S., and García, M.A. Digital platforms for music production (DAW): educational innovation from music teacher training. *Revista Electrónica de LEEME*, *52*, 53-72. doi:10.7203/LEEME.52.27178

Merchán Sánchez-Jara, J., González-Gutiérrez, S., Navarro-Cáceres, M., Olarte-Martínez, M.M., & Pedrero-Muñoz, C. (2023). The Co-Poem project: didactic resources and pedagogical projection for music education in Primary Education. *Education in the Knowledge Society (EKS)*, *24*, e30981. https://doi.org/10.14201/eks.30981

Peyrou, M. (2022). *Ears that do not see: Against the idea of intellectual music*. Taurus.

Pierard, T., & Lines, D. (2022). A constructivist approach to music education with DAWs. *Teachers and Curriculum*, *22*(2), 135-145. https://doi.org/10.15663/tandc.v22i2.406

Reuter, A. (2021). Who let the DAWs Out? The Digital in a New Generation of the Digital Audio Workstation. *Popular Music and Society*, *45*(2), 113-128. https://doi.org/10.1080/03007766.2021.1972701

Berrón, E., & Monreal, I.M. (2020). The initial training of future teachers through Project Based Learning from Music Education. *Revista electrónica de LEEME*, *46*, 208-223. https://doi.org/10.7203/LEEME.46.18031

Sandín-Esteban, M.P. (2010). Action research. In Nieto, S. (Ed.), *Principios, métodos y técnicas esenciales para la investigación educativa (*pp.525-556). Dykinson.

Savage, J. (2010). A survey of ICT usage across English secondary schools. *Music Education Research*, *12*(1), 89-104. https://doi:10.1080/14613800903568288

Tejada, J. (2004). Música y mediación de la tecnología en sus procesos de aprendizaje. *Educación XX1*, (7), 15-26. https://www.redalyc.org/pdf/706/70600701.pdf

Tejada, J., & Thayer, J. (2020). Design and validation of a music technology course for initial music teacher education based on the TPACK Model and the Project-Based Learning approach. *Journal of Music, Technology, and Education*, *12*(3), 225-246. https://doi.org/10.1386/jmte_00008_1

Thayer, T., Tejada, J., & Murillo, A. (2021). The technological training of music teachers in Secondary Education. An intervention study based on the integration of musical, technological and pedagogical contents at the University of Valencia. *Revista Electrónica Interuniversitaria Interuniversitaria de Formación del Profesorado*, *24*(3), 1-20. https://doi.org/10.6018/reifop.442501

Thibeault, M.D. (2017). Sound studies and music education. *Journal of Aesthetic Education*, *51*(1), 69-83. https://doi.org/10.5406/jaesteduc.51.1.0069

Walzer, D. (2016). Software-Based Scoring and Sound Design. *Music Educators Journal*, *103*(1), 19-26. https://doi.org/10.1177/0027432116653449

Walzer, D. (2020). Blurred lines: Practical and theoretical implications of a daw-based pedagogy. *Journal of Music, Technology and Education*, *13*(1), 79-94. https://doi.org/10.1386/jmte_00017_1

Walzer, D. (2021). Sonic thinking as a tool for creativity, communication, and sensory awareness in music production. *Thinking Skills and Creativity*, *42*. https://doi.org/10.1016/j.tsc.2021.100953

Wise, S. (2016). Secondary school teachers' approaches to teaching composition using digital technology. *British Journal of Music Education*, *33*(3), 283-295. https://doi.org/10.1017/S0265051716000309

Wise, S., Greenwood, J., & Davis, N. (2011). Teachers' use of digital technology in secondary music education: illustrations of changing classrooms. *British Journal of Music Education*, *28*(2), 117-134. https://doi.org/10.1017/S0265051711000039