Article

Digital technologies in music subjects on primary teacher training degrees in Spain: Teachers' habits and profiles

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Abstract
Many recent proposals in music education relate to digital technologies. Technology can act as a mediator in the teaching-learning processes. Educators' digital competence comprises the knowledge and skills in both instrumental and didactic use and methodological use that each teacher possesses. This work focuses on music education teachers at Spanish universities. It examines their knowledge of different digital resources, use of them to prepare classes, use of them in class and teaching of them, as well as considering how they learned to use these resources and any problems they encounter while teaching them. For this purpose, an ad hoc questionnaire was administered to a total of 93 teachers from 45 different universities. The results show superficial knowledge of technologies, limited use in class preparation, minimal use in class and almost non-existent teaching. They also reflect teaching staff who are largely self-taught and who complain of the limited resources available in the classroom.

Keywords
Digital technologies, educators' digital competence, initial teacher training, music education

Use of technology in music education

The recent history of the field of music education is marked by its relationship with technology (Delalande, 2004). This technology has resulted in advances and, as Webster (2002) predicted, has sought to transcend cultures and reach a mass audience by adapting and by optimising the

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cost–benefit relationship. Consequently, there are ever more suggestions and voices calling for existing curricula to be modified and for digital technologies to be included in music teaching-learning processes (Southcott & Crawford, 2011).

This adaptation can be intended to meet the needs of current students (Kim, 2016) and, in the case of music education, digital tools provide opportunities for new ways of exploring and doing, which may lead to new ways of thinking about music and music making. This student body connects with the world through ever more sophisticated mobile phones (Kongaut & Bohlin, 2016) and tablets, which they use for creating, recording, managing and editing sound (Stephenson & Limbrick, 2015). It is effectively literate in digital (Hagood & Skinner, 2012) and multimodal settings (Gainer, 2012) and so demands an education that covers this area in greater depth.

Digital technologies are associated with a type of student body and teaching where the process is more important than the end product, where students control their learning experience, fostering innovation and creativity, and participating in their own educational process (Jeffrey & Craft, 2004). The application of digital technologies to music education is based on the use of computers and mobile devices, both for reproducing audio and video and for carrying out simulations and presentations or searching for information (Gorgoretti, 2019), or, for example, sampling and creating sounds, digital composition, creation and performance on virtual instruments, coding and design for interactive instrument building, and so on. In this regard, the presence of digital technologies in music education – as in other disciplines and areas of the curriculum – is shaped by two basic aspects: the equipment in each centre and classroom, and how teachers are trained to use it (Román Álvarez, 2017).

With regard to the possibilities of digital technologies, the Technology Institute for Music Education (2019) has proposed six areas where it can be incorporated into education: (1) Electronic Musical Instruments (controllers and synthesisers). These make it possible to edited timbres, and creation of new or layered sounds, give performances with recorded accompaniments and so on. (2) Electronic Music Production (digital audio, MIDI protocols, sound sequencing and design). The use of digital tools in the musical production offers an endless range of possibilities for classroom work as edit and modified audio and MIDI data, using DAW software to explore and create music of varying styles and genres, and so on. (3) Computer Music Notation. This makes it possible to create or adapt the scores of the music the teacher wishes to use with students, entering and editing musical data, connecting music notation software with other kinds of music and productivity software, helping students compose, and so on. (4) Music Instruction Software (educational software, Internet-based learning, accompaniment tools). All types of locally installed and web-based software designed especially for developing certain competences, such as listening, music theory, reading music and so on. (5) Multimedia Development. Multimedia authoring and distributing, capturing digital images, strategies for gathering, storing, repurposing and distributing analog and digital media elements using the Internet and so on. (6) Productivity Tools, Classroom and Lab Resources. Including conversion, virtual spaces for storing and distribution data and other general applications, productivity software to create materials for classroom use, responsible and productive uses of social media for communication, distribution of work, and so on.

While these areas can be transversal, taking them as a starting point and according to classroom activities, we can categorise the use of the different technological resources as score editors (Bellini, 2008), sequencers and sound generators (Farrimond et al., 2011), audio editors (Silveira & Gavin, 2016), listening training tools (Chan et al., 2006), software for learning to play a musical instrument (Nijs & Leman, 2014; Rowe et al., 2015), developing vocal capacities (Reid et al., 2017) and even audiovisual education resources in the music classroom (Aróstegui, 2010). In these different categories, other types of elements can be transversely included, such as composition

using score editors, sequencers, and sound generators and audio editors; coding music using audio editors and sound generators; and so on.

Educators' digital competence in the field of music at university

The 21st-century university is marked by a process of innovation in which teachers can act as catalysts and explore new frontiers in music education. Teachers' training processes throughout their professional life will inevitably be linked to the development of information and communication technologies (ICT), and so we must consider their skills in this area (European Commission, 2016).

Since the publication of the Delors Report (1996), which was prepared for United Nations Educational, Scientific and Cultural Organisation (UNESCO) by the International Commission on Education for the Twenty-First Century, considering the state of the art education and what path it should follow, many initiatives have proposed models, standards and instruments for evaluating ICT competences (International Society for Technology in Education, 2017; Ministerio de Educación de Chile, 2006; Organisation for Economic Co-operation and Development, 2018; UNESCO, 2011). These all make up educators' digital competence. This, as the DIGCOMP (Digital Competence) report describes, is a transversal competence that makes it possible to acquire other competences and relates closely to many of the necessary skills citizens today must develop to be able to participate actively in society (Ferrari, 2013). The version of this report focusing on education emphasised the need to include digital competence in education (Redecker, 2017).

This competence comprises knowledge and skills of two types: instrumental use of digital technologies, and didactic and methodological skills. Accordingly, the Tuning Educational Structures in Europe project (González & Wagenaar, 2003) distinguishes between general competences (comprising instrumental, interpersonal and systemic ones) and the specific competences corresponding to each subject area.

In this respect, the indicators from the now classical TPACK (Technological Pedagogical Content Knowledge) model proposed by Mishra and Koehler (2006) could be followed. It identifies three types of knowledge: content, pedagogical and technological. All three aspects can interact without neglecting any of them as they all influence one another in this model. For that reason, it is necessary to study university teachers according to their area of knowledge if we are to make accurate findings about how they use digital technologies in education. Therefore, when positioning educators' digital competence in the area of music education, we first refer to their knowledge of the different categories of technological resources described above and also to their skills in teaching them.

While TPACK focuses on examining a teacher's knowledge, the SAMR model examines the utilisation of technology in teaching, comparing it with past practice (Dammers, 2019). On the Substitution, Augmentation, Modification and Redefinition (SAMR) model, Puentedura (2015) proposes a four-tier model for evaluating the use of technology: substitution, augmentation, modification and redefinition. The first two tiers, substitution and augmentation, are of enhancement and represent the use of technology in previously existing learning activities. The latest two tiers (modification and redefinition) are considered transformative. In these tiers, the learning activity is facilitated by technology to the point where the activity may not have existed or been possible prior to the availability of a particular technology. In the case of the use of digital technology, it seems logical to think that it is a question of overcome tiers according to educational needs, in order to move from enhancement to transformation (Bauer & Mito, 2017).

In the university context, specifically in initial teacher training, university teachers play a dual role as they must not only acquire digital competence but also ensure that the future primary school teachers acquire it as well. Therefore, because of the teachers' influence on the use of ICT, it is

especially important to improve this competence (UNESCO, 2012). Therefore, teachers must increasingly be experts in, or at the very least knowledgeable about, a wide variety of resources based on digital technologies (Adams et al., 2017). Primary school teachers also see this as necessary in their initial training as it helps them adapt to their professional future (Stronge, 2018).

However, in the case of Spain, it appears that universities are not reacting to this need. This is apparent in the fact that only 25.2% of modules relating to music on degree courses in primary school teaching at all of Spain's universities feature blocks of content relating to digital technologies (Calderón-Garrido et al., 2018).

In any case, and despite the importance of implementing digital technologies in the university setting, most research examining it goes no further than case studies that require constant revision and updating (Bartolomé & Gallego-Arrufat, 2019). With regard to music education in the initial training for primary and early years teachers, most research relate to classroom experience. In the case of Spain, we must stress the legislative differences in the training of primary school music teachers observed by Rusinek and Starfson (2017). Despite those differences, with regard to the digital competence framework described above, the situation is the same as in other countries.

Hence, this research focuses on the instrumental use of the resources digital technology offers in the field of music education. It focuses specifically on music education teachers at universities in Spain, their knowledge of different digital resources, use of them to prepare classes, use of them in class and teaching of them, the potential correlations between each aspect and differences by gender, and teaching experience at university. We also intend to establish what training these teachers have received and what problems they encounter when teaching the different resources in class, as well as their awareness of the importance of digital technologies in the professional future of their students. Thus, the research questions are as follows: What knowledge does music teachers in primary and early years teaching degrees at Spanish universities have of digital technologies and how do they use them? How have they acquired this knowledge? What problems do they encounter when teaching the different resources?

Methodology

In order to achieve the proposed aims regarding training, knowledge and use, we designed and validated an ad hoc questionnaire covering the specific features of university-level music teachers working on the degrees in early years education and primary education and the double major degree in early years and primary education at Spanish universities. The questionnaire was based on each teacher's self-perception of his or her knowledge of the different resources, use of them for preparing classes, use of them in class and teaching of them. When preparing the questionnaire, we used a panel of 16 experts (the questionnaire can be viewed at https://reunir.unir.net/handle/123456789/6965 and in the supplemental material). We administered it online using the *formsite* platform, allowing a period of 1 month for responses to it. The questionnaire was sent to university teachers' email addresses, which are available on each university's website. The teachers who participated gave free, prior and informed consent which was set out in the questionnaire itself. They were informed that they could withdraw from the study at any moment.

The sample comprised 93 teachers from 45 different universities (the study population was 423 teachers from 61 Spanish universities which offer primary teacher training), 51 of whom were men (45.2%) and 42 women (54.8%). Their mean age was 47.22 ($SD = 8.59$). With regard to university teaching experience, 12 staff (12.9%) had under 5 years' experience, 26 (28%) between 5 and 10 years, 23 (24.7%) between 11 and 15 years, 12 (12.9%) between 16 and 20 years, 19 (20.4%) between 21 and 30 years, and 1 person (1.1%) had over 30 years' experience. Of these university teachers, 61 (65.6%) worked at university full-time and 32 (34.4%) part-time.

The questionnaire showed excellent internal reliability (Cronbach's $\alpha = .944$). We used the IBM Statistic Package for Social Science (SPSS) program, version 21.0 to calculate and statistically analyse the results. In all cases, a minimum confidence interval of 95% was established. We used the Mann–Whitney and Kruskal–Wallis statistical tests to find statistically significant differences, having first applied the Kolmogorov–Smirnov or Shapiro–Wilk normality of sample tests as required, as well as Levene's test for equality of variance and Bartlett's test of sphericity for cluster analysis. We used the ATLAS.ti program, version 1.5.2, for the qualitative analysis of the answers. With this program, we created the corresponding initial codes, based on the most significant data, and the subsequent concept map.

Results

The data, in general, showed almost no or low knowledge, use in preparation of classes, use in class and teaching of tools intended for listening education, development of audiovisual skills, sound generators and sound sequencers, software for learning to play musical instruments and software for developing vocal capacities. Knowledge of audio editors was a little broader, although use of them for preparing classes was superficial, and use in class and teaching of the resource only occurred sometimes. Score editors were undoubtedly the most commonly used tool among university teachers, with knowledge of them being widespread and their use in class habitual. In contrast, the small number of respondents reporting in-depth knowledge and continuous use in the case of resources for audiovisual, listening education, sound generators, sequencers, instrument and vocal software is noteworthy. Table 1 shows the data obtained.

We observed no statistical differences according to gender, teaching experience, or whether staff were full-time or part-time.

With regard to the age of the participants, we only observed a slight negative correlation with knowledge of audiovisual tools ($r = -.215$; $p = .039$) and with knowledge of audio editors ($r = -.259$; $p = .012$).

We also observed that, in all cases, knowledge of a resource was directly correlated with use of it for preparing classes, use of it in class and teaching of it. Table 2 shows these correlations.

Here, the cluster analysis (Bartlett's test of sphericity $p < .001$) showed similarities between teachers who reported knowledge of software intended for learning an instrument and software intended for vocal development. However, as we have already seen, these teachers were a small part of the total sample, and so we cannot generalise from this.

Regarding acquisition of this knowledge, with the analysis of the open answer, a categorization and coding procedure was followed. In this way, an open-ended codification was started in order to identify the most relevant topics and concepts. Following this first classification of data, more extensive coding work was carried out defining the categories in line with the theoretical framework of the research. It made it possible to identify three main sources: a majority reported that it was through self-study ($n = 77$), a small group said it was through courses ($n = 45$), and a minority of the teachers did it through interaction with colleagues ($n = 8$). The most common form was basically self-study ($n = 32$) or a combination of this and formal courses ($n = 33$). With regard to self-study, educational videos hosted on YouTube were mentioned in most cases ($n = 9$). In the case of official courses, participants mentioned their time as students ($n = 18$) and only mentioned training offered by their own institution in three cases.

Regarding problems with implementing digital technologies in teaching, 34 teachers (36.6%) believed there was no such problem. Among those who did feel there were problems, some of them attributed them to their own lack of knowledge ($n = 20$). Nevertheless, most of teachers claimed that the problems were linked to the universities themselves ($n = 34$). For example, Teacher 49 said

Table 1. Answers for different tools.

	None/never	Superficial/ sometimes	Extensive/often	In depth/always
Audiovisual				
Knowledge	29 (31.2%)	32 (34.4%)	23 (24.7%)	9 (9.7%)
Preparing classes	36 (38.7%)	35 (37.6%)	15 (16.1%)	7 (7.5%)
Use in class	46 (49.5%)	30 (32.3%)	13 (14%)	4 (4.3%)
Teaching	47 (50.5%)	35 (37.6%)	7 (7.5%)	4 (4.3%)
Listening education				
Knowledge	34 (36.6%)	35 (37.6%)	18 (19.4%)	6 (6.4%)
Preparing classes	53 (57%)	26 (28%)	10 (10.8%)	4 (4.2%)
Use in class	54 (58.1%)	27 (29%)	10 (10.8%)	2 (2.1%)
Teaching	51 (54.8%)	30 (32.3%)	10 (10.8%)	2 (2.1%)
Audio editors				
Knowledge	10 (10.8%)	23 (24.7%)	37 (39.8%)	23 (24.7%)
Preparing classes	18 (19.4%)	28 (30.1%)	27 (29%)	20 (21.5%)
Use in class	22 (23.7%)	31 (33.3%)	28 (30.1%)	12 (12.9%)
Teaching	27 (29%)	31 (33.3%)	24 (25.8%)	11 (11.8%)
Score editors				
Knowledge	4 (4.3%)	12 (12.9%)	43 (46.2%)	34 (36.6%)
Preparing classes	10 (10.8%)	30 (32.3%)	23 (24.7%)	30 (32.3%)
Use in class	17 (18.3%)	25 (25.8%)	34 (36.6%)	18 (19.4%)
Teaching	20 (21.5%)	27 (29%)	26 (28%)	20 (21.5%)
Sound generators				
Knowledge	22 (23.7%)	34 (36.6%)	25 (26.9%)	12 (12.9%)
Preparing classes	38 (40.9%)	35 (37.6%)	11 (11.8%)	9 (9.7%)
Use in class	41 (44.1%)	33 (35.5%)	15 (16.1%)	4 (4.3%)
Teaching	44 (47.3%)	33 (35.5%)	15 (16.1%)	4 (4.3%)
Sequencers				
Knowledge	24 (25.8%)	36 (38.7%)	20 (21.5%)	13 (14%)
Preparing classes	44 (47.3%)	31 (33.3%)	7 (7.5%)	11 (11.8%)
Use in class	46 (49.5%)	31 (33.3%)	9 (9.7%)	7 (7.5%)
Teaching	48 (51.6%)	31 (33.3%)	8 (8.6%)	6 (6.5%)
Instrument software				
Knowledge	46 (49.5%)	33 (35.5%)	11 (11.8%)	3 (3.2%)
Preparing classes	63 (67.7%)	22 (23.7%)	6 (6.5%)	2 (2.2%)
Use in class	59 (63.4%)	27 (29%)	4 (4.3%)	3 (3.2%)
Teaching	59 (63.4%)	28 (30.1%)	5 (5.4%)	1 (1.1%)
Vocal software				
Knowledge	44 (47.3%)	34 (36.6%)	14 (15.1%)	1 (1.1%)
Preparing classes	59 (63.4%)	23 (24.7%)	9 (9.7%)	2 (2.2%)
Use in class	65 (69.9%)	20 (21.5%)	6 (6.5%)	2 (2.2%)
Teaching	62 (66.7%)	23 (24.7%)	5 (5.4%)	3 (3.2%)

Table 2. Correlations between knowledge of a resource and other parameters.

	Preparation	Use	Teaching
Knowledge of listening education	$r = .697$; $p < .001$	$r = .610$; $p < .001$	$r = .657$; $p < .001$
Knowledge of audiovisual tools	$r = .757$; $p < .001$	$r = .636$; $p < .001$	$r = .596$; $p < .001$
Knowledge of audio editors	$r = .661$; $p < .001$	$r = .712$; $p < .001$	$r = .558$; $p < .001$
Knowledge of score editors	$r = .704$; $p < .001$	$r = .618$; $p < .001$	$r = .595$; $p < .001$
Knowledge of sound generators	$r = .706$; $p < .001$	$r = .632$; $p < .001$	$r = .553$; $p < .001$
Knowledge of sequencers	$r = .686$; $p < .001$	$r = .674$; $p < .001$	$r = .582$; $p < .001$
Knowledge of instrument software	$r = .703$; $p < .001$	$r = .633$; $p < .001$	$r = .563$; $p < .001$
Knowledge of vocal software	$r = .763$; $p < .001$	$r = .691$; $p < .001$	$r = .635$; $p < .001$

that the obstacle was caused by 'lack of resources, specific software, and access to computers with music programs'. Teacher 12 said 'the connection in the classrooms is very slow'. Teacher 16 said that 'the quality of the equipment is very poor and it doesn't let you do anything'. They did not attribute these problems to the students in any cases.

Finally, regarding how important teachers believe digital technologies will be in their students' future careers, most of them (57.1%) felt that it will be important or very important (14%).

Discussion and conclusions

In general, the data collected reflect superficial knowledge, lack of use of said knowledge in preparing classes, minimal use in class and almost non-existent teaching by university teachers of the different technological resources available in music education. This maybe due to a diversity of understandings and applications of technical knowledge, as what 'knowing' each of the proposed resources means was not specified.

We therefore find teachers who do not take advantage of all of the benefits of using technology in music education and do not pass these benefits on to students (Belgrave & Keown, 2018; Calderón-Garrido et al., 2019; Creech, 2019; Johnson, 2017; Webster, 2002). The exception to this is score editors, which have proven to be an ally, not just when editing and digitising scores, but also when composing, listening, developing music reading skills and so on (Brodsky et al., 2008; Wöllner et al., 2003).

The Horizon Report: 2017 Higher Education Edition (New Media Consortium, 2017) stressed the idea that digital competence not only involves understanding how to use technologies, but that it must also necessarily include the need to understand the major impact of technologies in a digital world and promote collaboration to integrate them effectively. This is also an unfinished task in the case that interests us here. The results show that most teachers are aware of the importance of digital technologies in their students' future careers and they understand the major impact of technologies in a digital world, at least as far as future music teachers are concerned. However, it seems that university teachers do not teach the use of different resources, so they may not help students understand how to use technologies.

Of previous works on educators' digital competence, the work by Mishra and Koehler (2006) has had the greatest impact with its TPACK model, which comprises disciplinary, technological and pedagogical knowledge. While our study does not consider the last of these aspects, it has found an impediment in the development of the organisation of the teaching-learning process, probably owing to a lack of knowledge, which is repeatedly mentioned. Therefore, we can state that teachers do not acquire all digital competences in Spanish universities and also that educators' digital competence is not developed in the initial training of primary school music teachers.

Accordingly, as this research has shown, teachers mainly acquire their limited knowledge through self-instruction. While teachers in Spain (Aneas-Novo et al., 2019) value the results of self-study very highly, and it is necessary in the ongoing training of music teachers (Ferm Thorgersen et al., 2016), it is also insufficient. This means there is a need to complement self-training, as used on its own, it does not provide teachers with the necessary knowledge of the different resources.

Regarding gender, previous studies in the use of digital technologies concluded that the intensity of use of technologies depended on culture in many cases. Accordingly, for example, women make more use of it in African countries (Jackson et al., 2008). However, in the cultural setting of Spain, men are more likely to use technologies (Cai et al., 2017; Roberts et al., 2014). In the area of music education, studies such as that by Suki (2011) have shown that men feel a greater attraction to digital technologies. However, this study has shown how, in the Spanish university setting, there are no differences in this matter.

With regard to problems with the implementation of digital technologies in the music classroom, the data show a widespread complaint about university facilities. While the report prepared by the Conferencia de Rectores de la Universidades Españolas (Gómez, 2016) recorded a significant improvement in facilities that favoured the implementation of educational technology in Spanish universities, in the case of music classrooms, the teachers displayed dissatisfaction. On these lines, Bauer and Dammers (2016) found similar problems in the National Association of Schools of Music (NASM; United States), where teachers regarded a lack of resources and funds as common obstacles for integrating technologies into the music teacher education curriculum. Nonetheless, we should recall that multiple applications are available through mobile phones, devices whose use is entirely widespread and habitual in Spain, that do not require the use of the tools of the classroom itself (Cho et al., 2019).

In any case, considering other countries, we conclude that there is still much work to be done. Examples include Croatia, where Vidulin-Orbanić and Duraković (2011) have shown that future teachers found digital technologies offer a way to optimise their time and reach their pupils more directly compared with the traditional transfer of musical knowledge; Turkey, where Talsik (2015) reached similar conclusions after carrying out activities in an online setting with future music teachers; and Canada, where Bolden and Nahachewsky's (2015) experience of future primary and early years teachers' use of podcasts (easily made with any audio editor) showed that working on personal stories increased self-esteem and strengthened personality while also developing future teachers' creativity.

In conclusion, this study shows that there are major shortcomings that must be considered in the field of educational technology relating to music education in university settings. Therefore, and despite the highly technological world in which students get involved, many music teacher preparation programmes in Spain seem not to reach their potential to provide students with a solid technological background. This study has found that teaching staff lack knowledge of the different tools, which correlates with an almost non-existent use of them. This lack of knowledge is partly the result of a lack of training proposals from the different institutions, meaning that alternative self-study systems are needed based on the teachers' interests. In any event, the data collected pressure the relevant agencies to take measures and organise training courses to mitigate this situation.

Accordingly, these courses could also focus on the needs of university teaching staff and of teachers in their initial training. To this end, we suggest that the responsible authorities consult teachers and the different faculties about these needs in order to optimise the existing resources. In other words, we suggest 'made to measure' training activities that solve real problems rather than much broader and more ambitious activities. These activities could, for example, include using *musescore* in primary classrooms to edit scores, using *Audacity* as an audio editor to assimilate all of the elements of music, using *karaoke* to develop vocal skills, audiovisual publishing and films giving a graphic representation of the sounds of music (*musicomovigramas*), LMMS for recording

and publishing sounds, Musagi for creating melodies in the classroom, composing using Song Maker, Online Sequencer with the orchestra in the classroom, *GarageBand* to form small bands to perform versions of popular songs or create a new chord progression in a few seconds, *Flat* to create an online composition jointly with another student located at other country, and so on. In this way, university teachers might become involved in this type of activity having seen the usefulness of this type of training in their day-to-day life and in the future professional practice of the teachers going through their initial training.

Furthermore, and in relation to the problems of implementing digital technologies, while the excuse some years ago might have been the high cost of equipment and software, there is now an unlimited range of open access resources like the aforementioned *Musescore*, *Audacity*, *Kantaokey* or *LMMS*. Along these lines, there are widespread complaints about classroom facilities. While this might be true, and again alluding to the teachers' training, there are resources with almost no costs that are available to anyone who wishes to use them and, if he or she decides it is worthwhile, teach people how to use them. As teachers, educators and companions of future generations, it is our obligation not to look away but to reflect on this reality and act to transform it.

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Supplemental material

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